Doc No. ERD-ED-000X

SOUTHERN NEVADA WATER AUTHORITY

Environmental Resources Division

Spring Valley Stipulation Biological Monitoring Plan 2009 Annual Report

March 2010

Prepared by
Southern Nevada Water Authority
Water Resources Division
P.O. Box 99956
Las Vegas, Nevada 89193-9956

Submitted to
Nevada State Engineer
and the Stipulation
Executive Committee

Suggested citation: Southern Nevada Water Authority, 2010, Spring Valley Stipulation Biological Monitoring Plan 2009 Annual Report: Southern Nevada Water Authority, Las Vegas, Nevada, Doc. No. ERD-ED-000X, XX p.

CONTENTS

List of Figures . . . v
List of Tables . . . xvii
List of Acronyms and Abbreviations . . . xxxi

1.0 Introduction . . . 1-1
1.1 Background . . . 1-1
1.2 Major Activities Performed in 2009 . . . 1-1
1.3 Purpose and Scope . . . 1-2

2.0 Biological Monitoring Program Status and Methods . . . 2-1
2.1 Physical Habitat Mapping . . . 2-1
2.2 Site Assessment . . . 2-3
2.3 Water Quality . . . 2-3
2.4 Springsnails . . . 2-3
2.5 Macroinvertebrates . . . 2-7
2.6 Northern Leopard Frog (Rana pipiens) . . . 2-9
2.7 Relict dace (Relictus solitarius) . . . 2-11
2.8 Pahrump Poolfish (Empetrichthys latos) . . . 2-13
2.9 Big Springs Creek/Lake Creek Native Fish Community . . . 2-13
2.10 Vegetation . . . 2-15
2.11 Valley-Floor Rocky Mountain Juniper (Juniperus scopulorum) (VFRM Junipers) . . . 2-18
2.12 Fixed Station Photography . . . 2-20
2.13 Data Management . . . 2-20

3.0 Biological Monitoring Plan Results . . . 3-1
3.1 Physical Habitat Mapping . . . 3-1
3.2 Water-Quality . . . 3-1
3.2.1 Standard Water Quality Data . . . 3-1
3.2.1.1 Temperature . . . 3-3
3.2.1.2 Conductivity . . . 3-3
3.2.1.3 pH . . . 3-3
3.2.1.4 Dissolved Oxygen . . . 3-3
3.2.1.5 Velocity . . . 3-7
3.2.1.6 Turbidity . . . 3-7
3.2.2 Nitrogen and Phosphorus . . . 3-7
3.2.3 Temperature Logger Data . . . 3-12
3.3 Springnails . . . 3-13
3.4 Macroinvertebrates . . . 3-15
3.5 Northern Leopard Frog . . . 3-19
3.6 Relict Dace . . . 3-24
3.6.1 Keegan Spring Complex North . . . 3-24
3.6.2 Stonehouse Complex . . . 3-27

3.7 Big Springs Creek/Lake Creek Native Fish Community . . . 3-29
3.7.1 Reach 1 . . . 3-31
3.7.2 Reach 2 . . . 3-31
3.7.3 Reach 3 . . . 3-33
3.7.4 Reach 4 . . . 3-35
3.7.5 Reach 5 . . . 3-35
3.7.6 Reach Comparisons . . . 3-37
3.8 Vegetation . . . 3-39
3.8.1 Aquatic Transects . . . 3-41
3.8.1.1 Summary of Aquatic Vegetation Data Overall . . . 3-41
3.8.1.2 Summary of Aquatic Transect Data by Site . . . 3-46
3.8.1.2.1 Stonehouse Complex . . . 3-46
3.8.1.2.2 Willow Spring . . . 3-46
3.8.1.2.3 Keegan Ranch Complex . . . 3-52
3.8.1.2.4 West Spring Valley Complex . . . 3-55
3.8.1.2.5 South Millick Spring . . . 3-57
3.8.1.2.6 Unnamed 5 Spring . . . 3-58
3.8.1.2.7 Four Wheel Drive Spring . . . 3-62
3.8.1.2.8 Willard Spring . . . 3-64
3.8.1.2.9 Minerva Spring Complex . . . 3-67
3.8.1.2.10 Swallow Spring . . . 3-69
3.8.1.2.11 North Little Spring . . . 3-71
3.8.1.2.12 Big Springs . . . 3-73
3.8.1.2.13 Unnamed 1 Spring . . . 3-73
3.8.1.2.14 Stateline Springs . . . 3-73
3.8.2 Wetland/Meadow Transects . . . 3-75
3.8.2.1 Summary of Wetland/Meadow Vegetation Data Overall . . . 3-75
3.8.2.2 Summary of Wetland/Meadow Vegetation Data by Site . . . 3-79
3.8.2.2.1 Stonehouse Complex . . . 3-86
3.8.2.2.2 Keegan Ranch Complex . . . 3-86
3.8.2.2.3 West Spring Valley Complex . . . 3-93
3.8.2.2.4 Shoshone Ponds . . . 3-93
3.8.2.2.5 The Seep . . . 3-96
3.8.2.2.6 Minerva Spring Complex . . . 3-102
3.8.2.2.7 Blind Spring . . . 3-102
3.8.2.2.8 Burbank Meadows . . . 3-103
3.8.3 Phreatophytic Shrubland Transects . . . 3-110
3.8.3.1 Summary of Shrubland Vegetation Data Overall . . . 3-110
3.8.3.2 Summary of Shrubland Vegetation Data by Site . . . 3-110
3.8.3.2.1 North Spring Valley . . . 3-110
3.8.3.2.2 Middle Spring Valley . . . 3-114
3.8.3.2.3 South Spring Valley . . . 3-117
3.8.3.2.4 Hamlin Valley . . . 3-117
3.8.3.2.5 Snake Valley . . . 3-118
3.8.4 VFRM Juniper Woodland Transects . . . 3-121

CONTENTS (CONTINUED)

3.9 Valley Floor Rocky Mountain Juniper (Juniperus scopulorum) (VFRM Juniper) 3-131
3.9.1 Tree Counts and Sizes 3-131
3.9.2 Stem Elongation 3-131
3.10 Site Assessments 3-131
3.11 Fixed Station Photography 3-131
3.12 Pahrump Poolfish 3-132

4.0 Anticipated Biological Monitoring Plan-Related Activities in 2010 4-1

5.0 References 5-1

Appendix A - Greasewood Transect and Monitoring Well Proximity

Appendix B - Maps and Associated Data for Aquatic Sites (Springs, Ponds, and Creek Reaches)

Appendix C - Water Quality Data

Appendix D - Springsnail Distribution Graphs Spring and Fall 2009

Appendix E - Macroinvertebrate Metric Results (as provided by Rithron Laboratories)

Appendix F - Vegetation Data Species Lists, Micro-Community Dominant Species, and Percent Cover Overall and by Line Transects on VFRM Juniper Belt Transects)

Appendix G - Fixed Station Photography

Appendix H - Nevada Department of Wildlife Native Fish and Amphibians Field Trip Report

This Page Left Intentionally Blank

FIGURES

NUMBER	TITLE	PAGE
1-1	Locations of Biological Monitoring Sites within the IBMA	1-3
2-1	Locations of Physical-Habitat-Mapping Monitoring Sites within the IBMA	2-2
2-2	Locations of Site Assessment Monitoring Sites within the IBMA	2-4
2-3	Locations of Water-Quality Monitoring Sites within the IBMA	2-5
2-4	Locations of Springsnail Monitoring Sites within the IBMA	2-6
2-5	Locations of Macroinvertebrate Monitoring Sites within the IBMA	2-8
2-6	Locations of Northern Leopard Frog and Egg Mass Monitoring Sites within the IBMA	2-10
2-7	Locations of Relict Dace Monitoring Sites within the IBMA	2-12
2-8	Location of Pahrump Poolfish Monitoring Site within the IBMA	2-14
2-9	Locations of Big Springs Creek/Lake Creek Native Fish Community Monitoring Reaches within the IBMA	2-16
2-10	Locations of Vegetation Monitoring Sites within the IBMA	2-17
2-11	Locations of Valley-Floor Rocky Mountain Juniper VFRM Juniper Monitoring Sites within the IBMA	2-19
2-12	Locations of Fixed Station Photography Monitoring Sites within the IBMA	2-21
3-1	Springsnail Density (Mean Springsnail Count per Sample Point), Spring and Fall 2009	3-15
3-2	Percent of Open Water and Emergent Vegetation along each Northern Leopard Frog Breeding Habitat Transect by Site, Spring 2009	3-23
3-3	Percent Emergent Vegetation along and Number of Egg Masses Associated with each Northern Leopard Frog Breeding Habitat Transect, Spring 2009	3-24
3-4	Relict Dace Length-Frequency Histogram for Keegan Spring Complex North	3-26
3-5	Relict Dace Length-Frequency Histogram for Pool Habitat in the Spring and Fall for Keegan Spring Complex North	3-27

FIGURES (CONTINUED)

NUMBER	TITLE	PAGE
3-6	Relict Dace Length-Frequency Histogram for Channel Habitat in the Spring and Fall for Keegan Spring Complex North	3-28
3-7	Relict Dace Length-Frequency Histogram Stonehouse Complex	3-30
3-8	Relict Dace Length-Frequency Histogram for Pool Habitat in Spring and Fall for Stonehouse Complex	3-30
3-9	Relict Dace Length-Frequency Histogram for Channel Habitat in Spring and Fall for Stonehouse Complex	3-31
3-10	Native Fish Species Composition for Big Springs Creek/Lake Creek Reach 1, September 2009	3-32
3-11	CPUE for the Native Fish Species Documented in Big Springs Creek/Lake Creek Reach 1, September 2009	3-32
3-12	Native Fish Species Composition for Big Springs Creek/Lake Creek Reach 2, September 2009	3-33
3-13	CPUE for the Native Fish Species Documented in Big Springs Creek/Lake Creek Reach 2, September 2009	3-34
3-14	Native Fish Species Composition for Big Springs Creek/Lake Creek Reach 3, September 2009	3-34
3-15	CPUE for the Native Fish Species Documented in Big Springs Creek/Lake Creek Reach 3, September 2009	3-35
3-16	Native Fish Species Composition for Big Springs Creek/Lake Creek Reach 4, September 2009	3-36
3-17	CPUE for the Native Fish Species Documented in Big Springs Creek/Lake Creek Reach 4, September 2009	3-36
3-18	Native Fish Species Composition for Big Springs Creek/Lake Creek Reach 5, September 2009	3-37
3-19	CPUE for the Native Fish Species Documented in Big Springs Creek/Lake Creek Reach 5, September 2009	3-38
3-20	Total Number of Native Fish by Mean Percent Vegetation Points (Emergent and Submergent) for Big Springs Creek/Lake Creek Reaches (1-5)	3-40

FIGURES (CONTINUED)

NUMBER	TITLE	PAGE
3-21	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (39-43) at the Stonehouse Complex in 2009	3-50
3-22	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (49-53) at Willow Creek in 2009	3-52
3-23	Spatial Heterogeneity (most abundant species by meter) along the Five Aquatic Transects (021-150) at Keegan Ranch Complex in 2009	3-55
3-24	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (86, 88, 94-96) at West Spring Valley Complex in 2009	3-58
3-25	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (16-20) at South Millick Spring in 2009	3-60
3-26	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (54-58) at Unnamed 5 Spring in 2009	3-62
3-27	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (59-63) at Four Wheel Drive Spring in 2009	3-64
3-28	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (64-68) at Willard Spring in 2009	3-66
3-29	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (01, 04, 06, 07, 10) at the Minerva Spring Complex in 2009	3-69
3-30	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (44-48) at Swallow Spring in 2009	3-71
3-31	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (174-178) at North Little Spring in 2009	3-72
3-32	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (169-173) at Big Springs in 2009	3-75
3-33	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (164-168) at Unnamed 1 Spring in 2009	3-77
3-34	Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (131-135) at Stateline Springs in 2009	3-78

FIGURES (CONTINUED)

NUMBER	TITLE	PAGE

3-35 Spatial Heterogeneity (most abundant species by meter) along the Ten Wetland/Meadow Transects (029-038) at Stonehouse Complex in 2009 3-89

3-36 Spatial Heterogeneity (most abundant species by meter) along the Eight Wetland/Meadow Transects (021-028) at Keegan Ranch Complex in 2009. 3-92

3-37 Spatial Heterogeneity (Most Abundant Species by Meter) along the Eight Wetland/Meadow Transects (085-092) at the West Spring Valley in 2009. 3-96

3-38 Spatial Heterogeneity (most abundant species by meter) along the Ten Wetland/Meadow Transects (074-079, 081-084) at Shoshone Ponds in 2009 3-99

3-39 Spatial Heterogeneity (most abundant species by meter) along the Five Wetland/Meadow Transects (069-073) at the Seep in 2009 3-101

3-40 Spatial Heterogeneity (most abundant species by meter) along the Seven Wetland/Meadow Transects (002-006) at the Minerva Complex in 2009. 3-106

3-41 Spatial Heterogeneity (most abundant species by meter) along the Five Wetland/Meadow Transects (011-015) at Blind Spring in 2009 3-108

3-42 Spatial Heterogeneity (most abundant species by meter) along the Ten Wetland/Meadow Transects (139-148) at Burbank Meadows in 2009 3-111

3-43 Spatial Heterogeneity (most abundant species by meter) along the Five Shrubland Transects (153-154, 157-158, 185) in North Spring Valley in 2009 3-115

3-44 Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Shrubland Transects (151, 152, 155, 156, 184) in Middle Spring Valley in 2009. . . . 3-116

3-45 Spatial Heterogeneity (most abundant species by meter) along the Five Shrubland Transects (130, 136-138, 149) in South Spring Valley in 2009 3-118

3-46 Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Shrubland Transects (159-163) in Hamlin Valley in 2009 3-119

3-47 Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Shrubland Transects (179-183) in Snake Valley in 2009. 3-120

B-1 Big Springs/Lake Creek Reaches #1-5 Physical Habitat Maps for Fall 2009 . . . . .B-2

B-2 Big Spring Physical Habitat Map for Spring 2009. . . . . .B-4

FIGURES (CONTINUED)

NUMBER	TITLE	PAGE
B-3	Big Spring Physical Habitat Map for Fall 2009	B-5
B-4	Four Wheel Drive Physical Habitat Map for Spring 2009	B-8
B-5	Four Wheel Drive Physical Habitat Map for Fall 2009	B-9
B-6	Keegan Spring Complex North Physical Habitat Map for Spring 2009	B-12
B-7	Keegan Spring Complex North Physical Habitat Map for Fall 2009	B-13
B-8	Minerva Spring Complex Middle Physical Habitat Map for Spring 2009	B-16
B-9	Minerva Spring Complex Middle Physical Habitat Map for Fall 2009	B-17
B-10	Minerva Spring Complex North Physical Habitat Map for Spring 2009	B-20
B-11	Minerva Spring Complex North Physical Habitat Map for Fall 2009	B-21
B-12	North Little Physical Habitat Map for Spring 2009	B-24
B-13	North Little Physical Habitat Map for Fall 2009	B-25
B-14	Shoshone Ponds Physical Habitat Map for Spring 2009	B-28
B-15	Shoshone Ponds Physical Habitat Map for Fall 2009	B-29
B-16	South Millick Physical Habitat Map for Spring 2009	B-32
B-17	South Millick Physical Habitat Map for Fall 2009	B-33
B-18	Stateline Springs Physical Habitat Map for Spring 2009	B-36
B-19	Stateline Springs Physical Habitat Map for Fall 2009	B-37
B-20	Stonehouse Physical Habitat Map for Spring 2009	B-40
B-21	Stonehouse Physical Habitat Map for Fall 2009	B-41
B-22	Swallow Creek Physical Habitat Map for Spring 2009	B-44
B-23	Swallow Creek Physical Habitat Map for Fall 2009	B-45
B-24	Unnamed 1 Spring North of Big Physical Habitat Map for Spring 2009	B-48

FIGURES (CONTINUED)

NUMBER	TITLE	PAGE
B-25	Unnamed 1 Spring North of Big Physical Habitat Map for Fall 2009	B-49
B-26	Unnamed 5 Physical Habitat Map for Spring 2009	B-52
B-27	Unnamed 5 Physical Habitat Map for Fall 2009	B-53
B-28	West Spring Valley Complex 1 Physical Habitat Map for Spring 2009	B-56
B-29	West Spring Valley Complex 1 Physical Habitat Map for Fall 2009	B-57
B-30	Willard Physical Habitat Map for Spring 2009	B-60
B-31	Willow Spring Physical Habitat Map for Spring 2009	B-62
B-32	Willow Spring Physical Habitat Map for Fall 2009	B-63
C-1	Big Springs Hourly Temperature Measurements at Springheads	C-1
C-2	Middle Minerva Hourly Temperature Measurements at Springheads	C-1
C-3	South Millick Hourly Temperature Measurements at Springheads	C-2
C-4	Stateline Hourly Temperature Measurements at Springheads	C-2
C-5	Swallow Hourly Temperature Measurements at Springheads	C-3
C-6	Unnamed 1 Hourly Temperature Measurements at Springheads	C-3
C-7	West Spring Valley Complex Hourly Temperature Measurements at Springheads	C-4
C-8	Willow Hourly Temperature Measurements at Springheads	C-4
D-1	Big Spring Springsnail Distribution, 2009	D-1
D-2	Middle Minerva Springsnail Distribution, 2009	D-1
D-3	North Minerva Springsnail Distribution, 2009	D-2
D-4	Stateline Springsnail Distribution, 2009	D-2
D-5	Stonehouse Springsnail Distribution, 2009	D-3
D-6	Unnamed 1 Springsnail Distribution, 2009	D-3

FIGURES (CONTINUED)

NUMBER	TITLE	PAGE
D-7	West Spring Valley Springsnail Distribution, 2009	D-4
D-8	Willow Springsnail Distribution, 2009.	D-4
E-1	Spring 2009 Macroinvertebrate Metric Results for Big Springs	E-1
E-2	Fall 2009 Macroinvertebrate Metric Results for Big Springs	E-2
E-3	Fall 2009 Macroinvertebrate Metric Results for Big Springs/Lake Creek.	E-3
E-4	Spring 2009 Macroinvertebrate Metric Results for Keegan.	E-4
E-5	Fall 2009 Macroinvertebrate Metric Results for Keegan	E-5
E-6	Spring 2009 Macroinvertebrate Metric Results for Minerva Middle.	E-6
E-7	Fall 2009 Macroinvertebrate Metric Results for Minerva Middle	E-7
E-8	Spring 2009 Macroinvertebrate Metric Results for Minerva North	E-8
E-9	Fall 2009 Macroinvertebrate Metric Results for Minerva North	E-9
E-10	Spring 2009 Macroinvertebrate Metric Results for South Millick.	E-10
E-11	Fall 2009 Macroinvertebrate Metric Results for South Millick	E-11
E-12	Spring 2009 Macroinvertebrate Metric Results for Stateline.	E-12
E-13	Fall 2009 Macroinvertebrate Metric Results for Stateline	E-13
E-14	Spring 2009 Macroinvertebrate Metric Results for Stonehouse	E-14
E-15	Fall 2009 Macroinvertebrate Metric Results for Stonehouse.	E-15
E-16	Spring 2009 Macroinvertebrate Metric Results for Swallow.	E-16
E-17	Fall 2009 Macroinvertebrate Metric Results for Swallow	E-17
E-18	Spring 2009 Macroinvertebrate Metric Results for Unnamed 1	E-18
E-19	Fall 2009 Macroinvertebrate Metric Results for Unnamed 1.	E-19
E-20	Spring 2009 Macroinvertebrate Metric Results for Unnamed 5	E-20

FIGURES (CONTINUED)

NUMBER	TITLE	PAGE
E-21	Fall 2009 Macroinvertebrate Metric Results for Unnamed 5	E-21
E-22	Spring 2009 Macroinvertebrate Metric Results for West Spring Valley Complex	E-22
E-23	Fall 2009 Macroinvertebrate Metric Results for West Spring Valley Complex	E-23
E-24	Spring 2009 Macroinvertebrate Metric Results for Willow	E-24
E-25	Fall 2009 Macroinvertebrate Metric Results for Willow	E-25
G-1	Swallow Spring (top) and Big Springs (bottom), Fall 2009	G-4
G-2	Minerva Spring Complex Middle (top) and VFRM Juniper South (bottom), Summer 2009	G-5
G-3	West Spring Valley Complex Pool and Channel during Spring (top) and Fall (bottom), 2009	G-6
G-4	Unnamed 5 Spring Pool and Channel during Spring (top) and Fall (bottom), 2009	G-7
G-5	Stonehouse Complex, Summer 2009	G-8
G-6	Swallow Spring, Summer 2009	G-8
G-7	Greasewood (Phreatophytic Shrubland) Vegetation Transect (Spring Valley North), Summer 2009	G-9
G-8	The Seep, Summer 2009	G-9
G-9	Four Wheel Drive Spring, Fall 2009 (top) and Keegan Spring Complex, Fall 2009	G-10
G-10	North Little Spring, Fall 2009 (top) and Shoshone Ponds (Stock Pond), Fall 2009 (bottom)	G-11
G-11	South Millick Spring, Fall 2009 (top) and Stateline Springs Flowing into Lake Creek, Fall 2009 (bottom)	G-12
G-12	Unnamed 1 Spring North of Big, Fall 2009 (top) and Willard Spring, which was dry in Fall 2009 (bottom)	G-13
G-13	Willow Spring, Fall 2009	G-14

TABLES

NUMBER	TITLE	PAGE

3-1 Area Summaries for Spring Sites in Spring and Fall 2009by HMU Type and Total Aquatic Area 3-2

3-2 Water Temperature (°F) at Springs during Spring and Fall 2009. 3-4

3-3 Specific Conductivity (µS/cm) at Springs during Spring and Fall 2009 3-5

3-4 pH at Springs during Spring and Fall 2009 3-6

3-5 Dissolved Oxygen Levels (mg/L) at Springs during Spring and Fall 2009 3-8

3-6 Springbrook Velocity (ft/sec) at Springs during Spring and Fall 2009 3-9

3-7 Turbidity Levels (NTU) at Springs during Spring and Fall 2009. 3-10

3-8 Total Nitrogen and Phosphorus Concentrations (µg/L) at Springs during Spring and Fall 2009 3-11

3-9 Monthly Summaries of 2009 Temperature Logger Data (Water Temperature °F) for Springs. 3-12

3-10 Springsnail Counts at Spring Sites, Spring and Fall 2009 3-14

3-11 Mean-Water Quality Data Taken at Springsnail Transects, Spring and Fall 2009. 3-16

3-12 Percent Relative Abundance of Macroinvertebrates for Spring and Fall 2009 Monitoring Program 3-17

3-13 Macroinvertebrate Taxa and EPT Richness Measures for Spring and Fall 2009 Monitoring Program 3-18

3-14 Northern Leopard Frog Survey Locations with the Type of Survey Conducted in 2009 3-19

3-15 Summary of Visits to Unnamed 5 Spring with the Number and Age Class (AC) of New Egg Masses Documented and Tadpoles Observed 3-20

3-17 Summary of Visits to West Spring Valley Complex 1 with the Number and Age Class (AC) of New Egg Masses Documented and Tadpoles Observed. 3-21

3-16 Summary of Visits to Keegan Spring Complex North with the Number of Age Class (AC) of New Egg Masses Documented and Tadpoles Observed 3-21

TABLES (CONTINUED)

NUMBER	TITLE	PAGE

3-19 Keegan Spring Complex North Trap CPUE Values for the Spring and Fall Sampling . . 3-25

3-18 Water Quality Measurements for Each Northern Leopard Frog Breeding Habitat Transect, June 2009 3-25

3-20 Keegan Spring Complex North Trap CPUE Values for the Spring and Fall Sampling by Habitat Type 3-26

3-21 Water-Quality Measurements Taken at Keegan Spring Complex North 3-28

3-22 Stonehouse Complex Trap CPUE Values for Spring and Fall Sampling. 3-28

3-23 Stonehouse Complex Trap CPUE Values for Spring and Fall Sampling by Habitat Type 3-29

3-24 Length Data for Each Native Fish Species at Big Springs Creek/Lake Creek Reaches 3-39

3-25 Summary of Overall Species Composition, Cover, and Number of Plant Taxa on the Aquatic Transects in 2009 3-41

3-26 Plant Taxa Present along Aquatic Transects in 2009 3-42

3-27 Mean Percent Cover of Major Species in 2009 at the 14 Sites with Aquatic Transects 3-47

3-28 Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the Stonehouse Complex in 2009 3-49

3-29 Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at Willow Spring in 2009 3-50

3-30 Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the Keegan Ranch Complex in 2009 3-53

3-31 Mean Percent Cover, Overall and Species, of Vegetation a long Aquatic Transects at the West Spring Valley Complex in 2009 3-56

3-32 Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the South Millick Spring in 2009 3-59

3-33 Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the Unnamed 5 Spring in 2009 3-60

TABLES (CONTINUED)

NUMBER **TITLE** **PAGE**

3-34 Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at Four Wheel Drive Spring in 2009. 3-63

3-35 Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at Willard Spring in 2009 3-65

3-36 Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Minerva Springs Complex in 2009 3-67

3-37 Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Swallow Spring in 2009 3-70

3-38 Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at North Little Spring in 2009. 3-72

3-39 Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Big Springs in 2009 3-74

3-40 Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Unnamed 1 Spring in 2009 3-76

3-41 Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Stateline Springs in 2009 3-77

3-42 Summary of Overall Species, Composition, Cover, and Number of Plant Taxa on the Wetland/Meadow Transects in 2009 3-78

3-43 Plant Taxa Present on the Wetland/Meadow Sites in 2009 3-80

3-44 Mean Cover (%) of Major Plant Taxa in 2009 at the Wetland/Meadow Transect Sites . 3-84

3-45 Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Stonehouse Complex in 2009 3-87

3-46 Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Keegan Ranch Complex in 2009 3-90

3-47 Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the West Spring Valley Complex in 2009 3-94

3-48 Mean Percent Cover, Overall and by Species, of Vegetation Along Wetland/Meadow Transects at Shoshone Ponds in 2009. 3-97

TABLES (CONTINUED)

NUMBER TITLE PAGE

3-49 Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Seep in 2009 3-99

3-50 Fall 2009 Site Assessment 3-103

3-51 Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Minerva Spring Complex in 2009 3-104

3-52 Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at Blind Springs in 2009 3-107

3-53 Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at Burbank Meadows in 2009 3-108

3-54 Summary of Overall Species Composition, Cover, and Number of Plant Taxa on the Phreatophytic Shrubland Transects in 2009 3-112

3-55 Plant Taxa Present on the 25 Phreatophytic Shrubland Transects in 2009 3-112

3-56 Mean Cover (%) of Plant Taxa in 2009 at the Five Phreatophytic Shrubland Sites. . . . 3-113

3-57 Mean Percent Cover, Overall and by Species, of Vegetation along the Five North Spring Valley Phreatophytic Shrubland Transects in 2009 3-114

3-58 Mean Percent Cover, Overall and by Species, of Vegetation along the Five Middle Spring Valley Phreatophytic Shrubland Transects in 2009 3-115

3-59 Mean Percent Cover, Overall and by Species, of Vegetation along the Five South Spring Valley Phreatophytic Shrubland Transects in 2009 3-119

3-60 Mean Percent Cover, Overall and by Species, of Vegetation along the Five Hamlin Valley Phreatophytic Shrubland Transects in 2009 3-120

3-61 Mean Percent Cover, Overall and by Species, of Vegetation along the Five Snake Valley Phreatophytic Shrubland Transects in 2009 3-121

3-62 Mean Percent Cover of Vegetation on VFRM Juniper Belt Transects at the Two Sampled Sites (Middle and South) in 2009 3-123

3-63 Mean Percent Cover of Vegetation along the Wet-Site VFRM Juniper Transects in Middle Spring Valley in 2009 3-125

TABLES (CONTINUED)

NUMBER	TITLE	PAGE
3-64	Mean Percent Cover of Vegetation along the Dry-Site VFRM Juniper Transects in Middle Spring Valley in 2009	3-127
3-65	Mean Percent Cover of Vegetation along the Wet-Site	3-128
3-66	Mean Percent Cover of Vegetation along the Dry-Site VFRM Juniper Transects in South Spring Valley in 2009	3-130
A-1	Proximity of Greasewood Transects to Existing or Planned Spring Valley Stipulation Hydrologic Monitoring Program Monitoring Wells (Spring Site Piezometers and Basin Fill Wells) and SNWA ET Research Monitoring Wells	A-1
B-1	Mapped Area at Creek Reaches Summarized by Physical Habitat Type	B-1
B-2	Spring Season Mapped Area at Big Springs Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-3
B-3	Fall Season Mapped Area at Big Springs Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-3
B-4	Spring Season Mapped Area at Four Wheel Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-7
B-5	Fall Season Mapped Area at Four Wheel Drive Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-7
B-6	Spring Season Mapped Area at Keegan Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-11
B-7	Fall Season Mapped Area at Keegan Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-11
B-8	Spring Season Mapped Area at Minerva Middle Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-15
B-9	Fall Season Mapped Area at Minerva Middle Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-15
B-10	Spring Season Mapped Area at Minerva North Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-19
B-11	Fall Season Mapped Area at Minerva North Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-19

TABLES (CONTINUED)

NUMBER	TITLE	PAGE
B-12	Spring Season Mapped Area at North Little Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-23
B-13	Fall Season Mapped Area at North Little Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-23
B-14	Spring Season Mapped Area at Shoshone Ponds Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-27
B-15	Fall Season Mapped Area at Shoshone Ponds Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-27
B-16	Spring Season Mapped Area at South Millick Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-31
B-17	Fall Season Mapped Area at South Millick Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-31
B-18	Spring Season Mapped Area at Stateline Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-35
B-19	Fall Season Mapped Area at Stateline Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-35
B-20	Spring Season Mapped Area at Stonehouse Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-39
B-21	Fall Season Mapped Area at Stonehouse Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-39
B-22	Spring Season Mapped Area at Swallow Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-43
B-23	Fall Season Mapped Area at Swallow Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-43
B-24	Spring Season Mapped Area at Unnamed 1 Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-47
B-25	Fall Season Mapped Area at Unnamed 1 Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area	B-47

TABLES (CONTINUED)

NUMBER **TITLE** **PAGE**

B-26 Spring Season Mapped Area at Unnamed 5 Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area B-51

B-27 Fall Season Mapped Area at Unnamed 5 Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area B-51

B-28 Spring Season Mapped Area at West Spring Valley Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area B-55

B-29 Fall Season Mapped Area at West Spring Valley Complex Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area. B-55

B-30 Spring Season Mapped Area at Willard Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area B-59

B-31 Spring Season Mapped Area at Willow Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area B-61

B-32 Fall Season Mapped Area at Willow Spring Valley Complex Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area. B-61

F-1 Scientific Names, Common Names, and Synonyms of Plant Taxa Encountered on the Vegetation Transects in 2009 and Which Transect Types the Taxa are Present F-1

F-2 Plant Species that were Micro-Community Dominants along the Vegetation Transects in 2009 Classified by Typical Habitat Type. F-7

F-3 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 098 in 2009 . . . . . F-10

F-4 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 099 in 2009 . . . . . F-11

F-5 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 100 in 2009 . . . . . F-11

F-6 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 101 in 2009 . . . . . F-12

F-7 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 102 in 2009 . . . . . F-12

TABLES (CONTINUED)

NUMBER TITLE PAGE

F-8 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 103 in 2009 . . . . F-13

F-9 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 104 in 2009 . . . . F-14

F-10 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 105 in 2009 . . . . F-15

F-11 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 106 in 2009 . . . . F-15

F-12 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 107 in 2009 . . . . F-16

F-13 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 108 in 2009 . . . . F-17

F-14 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 109 in 2009 . . . . F-17

F-15 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 110 in 2009 . . . . F-18

F-16 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 111 in 2009 . . . . F-19

F-17 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 112 in 2009 . . . . F-20

F-18 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 113 in 2009 . . . . F-20

F-19 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 114 in 2009 . . . . F-21

F-20 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 115 in 2009 . . . . F-21

F-21 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 116 in 2009 . . . . F-22

TABLES (CONTINUED)

NUMBER **TITLE** **PAGE**

F-22 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 117 in 2009 . . . . . F-22

F-23 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 118 in 2009 . . . . . F-23

F-24 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 119 in 2009 . . . . . F-23

F-25 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 120 in 2009 . . . . . F-23

F-26 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 121 in 2009 . . . . . F-24

F-27 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 122 in 2009 . . . . . F-24

F-28 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 123 in 2009 . . . . . F-25

F-29 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 124 in 2009 . . . . . F-25

F-30 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 125 in 2009 . . . . . F-26

F-31 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 126 in 2009 . . . . . F-27

F-32 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 127 in 2009 . . . . . F-28

F-33 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 128 in 2009 . . . . . F-29

F-34 Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 129 in 2009 . . . . . F-30

F-35 Site, Transect Number (SNWA Permanent Transect Number) and Length (meters), Date of Sampling of Transect, and UTM Coordinates for the Aquatic Transects, 2009 . . . . . F-31

TABLES (CONTINUED)

NUMBER	TITLE	PAGE
F-36	Site, Transect Number (SNWA Permanent Transect Number) and Length (meters), Date of Sampling of Transect, and UTM Coordinates of Wetland/Meadow Transects, 2009	F-33
F-37	Site, Transect Number (SNWA Permanent Transect Number) and Length (meters), Date of Sampling of Transect, and UTM Coordinates of Shrubland Transects, 2009	F-35
F-38	Site, Transect Number (SNWA Permanent Transect Number), Date of Sampling, and UTM Coordinates of Woodland Transects, 2009	F-36
G-1	Photo Station Numbers and Compass Bearing of Fixed Station Photographs at Each Spring and Pond Site	G-1

ACRONYMS

AC	age class
BLM	Bureau of Land Management
BWG	Biological Work Group
CPUE	catch-per-unit effort
DOI	U.S. Department of the Interior
DRI	Desert Research Institute
EC	Executive Committee
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
GPS	Global Positioning System
HA	hydrographic area
HMU	hydro morphological unit
IBMA	Initial Biological Monitoring Area
JFA	Joint Funding Agreement
MCL	maximum contaminant level
NAD83	North American Datum of 1983
NDOW	Nevada Department of Wildlife
NSE	Nevada State Engineer
NTU	nephelometric turbidity units
QA	quality assurance
QC	quality control
SNWA	Southern Nevada Water Authority
TRP	Technical Review Panel
UDWR	Utah Division of Wildlife Resources
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VFRM	Valley-Floor Rocky Mountain

ABBREVIATIONS

°F	degrees Fahrenheit
afy	acre-feet per year
bgs	below ground surface
cm	centimeter

ABBREVIATIONS (CONTINUED)

ft	foot
ft^3	cubic foot
in.	inch
L	liter
m	meter
Ma	million years
mg	milligram
mi	mile
mi^2	square mile
mm	millimeter
mS	millisiemens
µg	microgram
µm	micrometer
µmho	micromho
µS	microsiemen
pmc	percent modern carbon
sec	second

1.0 INTRODUCTION

The Southern Nevada Water Authority (SNWA) prepared this first annual status and data report to satisfy a requirement of the *Biological Monitoring Plan for the Spring Valley Stipulation* (Plan) (Biological Work Group, 2009) approved by the Nevada State Engineer (NSE) on January 23, 2009, as required by NSE Ruling 5726. This report also satisfies a requirement of the Stipulation for Withdrawal of Protests signed by the U.S. Department of the Interior (DOI) and SNWA on September 8, 2006. The biological data contained in this report were also submitted to the NSE and Biological Work Group (BWG) to meet the specified requirements.

1.1 Background

SNWA holds groundwater rights in Spring Valley hydrographic area (HA) 184 for municipal and domestic purposes under permits 54003 through 54015, inclusive, as well as 54019 and 54020. These permits were granted by NSE in Ruling 5726 issued April 16, 2007, and total 60,000 afy following a staged development (NSE, 2007). The staged-development guidelines call for a minimum 10-year period during which a maximum of 40,000 afy can be pumped in any one year with a 10-consecutive-year average of at least 35,000 afy. At the end of the 10-year period and after a review of the findings of the staged-development period, SNWA may have the opportunity to develop the full 60,000 afy. Ruling 5726 required the development of biologic and hydrologic monitoring plans, which were approved in January 23, 2009.

On September 8, 2006, prior to the water-right application hearing, a Stipulation for Withdrawal of Protests (Stipulation) was established between SNWA and DOI on behalf of the Bureau of Indian Affairs, the Bureau of Land Management (BLM), the National Park Service, and the U.S. Fish and Wildlife Service (USFWS) (collectively known as the DOI Bureaus). Exhibits A and B of the Stipulation require the development of comprehensive biologic and hydrologic monitoring plans. As part of the Stipulation, an Executive Committee (EC) was established to oversee the implementation of the agreement. The BWG and hydrologic Technical Review Panel (TRP), composed of representatives of parties to the stipulation, were established to develop and oversee implementation of monitoring and mitigation plans, review program data, and modify the monitoring plans, if necessary.

1.2 Major Activities Performed in 2009

Major activities associated with the biological monitoring plan performed in 2009 were as follows:

- Submitted the *Biological Monitoring Plan for the Spring Valley Stipulation* to the NSE. The Plan was approved by the NSE on January 23, 2009.

- Established SNWA data-exchange web site accessible by the NSE, EC, TRP, and BWG. The web site contains project reports and biological data.

- Pursued property access for biological monitoring on private lands. With the exception of one spring site, access was granted for all other private lands identified in the Plan.

- Applied for and received Nevada Department of Wildlife (NDOW) Scientific Collection Permits and Utah Division of Wildlife Resources (UDWR) Certificates of Registration for Collect/Possess/Release and applied for and received Nevada BLM casual use permit.

- Designated aquatic-sampling areas in consultation with BIO-WEST, Inc.

- Established vegetation transects in consultation with KS2 Ecological Field Services, LLC.

- Established fixed photography stations and vegetation transect endpoints in the field in collaboration with the Las Vegas Valley Water District survey.

- Established a data repository and began development of a Relational Database Management System to ensure data integrity, security, and transparency.

- Began development on statistical protocols to be followed starting in 2010.

- Established standard operating procedures for collecting, maintaining, and reporting field data.

- Invited the BWG (Federal parties and State participants) to participate in field activities.

- Implemented spring, summer, and fall monitoring as required by the Plan, in conjunction with BIO-WEST, Inc., and KS2 Ecological Field Services, LLC:

    - Conducted aquatic monitoring in spring and fall 2009.
    - Conducted vegetation monitoring in summer 2009.
    - Conducted Big Springs Creek/Lake Creek monitoring in fall 2009.

- The BWG organized a workshop with a panel of modelling experts on October 29, 2009 to obtain information for the EC on utility and approaches to develop ecological modelling for implementation of the spring valley stipulation.

1.3 Purpose and Scope

This report provides the NSE, EC, and BWG with a summary of data collected in 2009 from biological monitoring locations as outlined in the Plan. The locations of the monitoring sites within the Initial Biological Monitoring Area (IBMA) are presented in Figure 1-1. Included in this report are summaries of data collection efforts focused on physical habitat mapping, site assessment, water quality, springsnail, macroinvertebrate, northern leopard frog (*Rana pipiens*), relict dace (*Relictus*

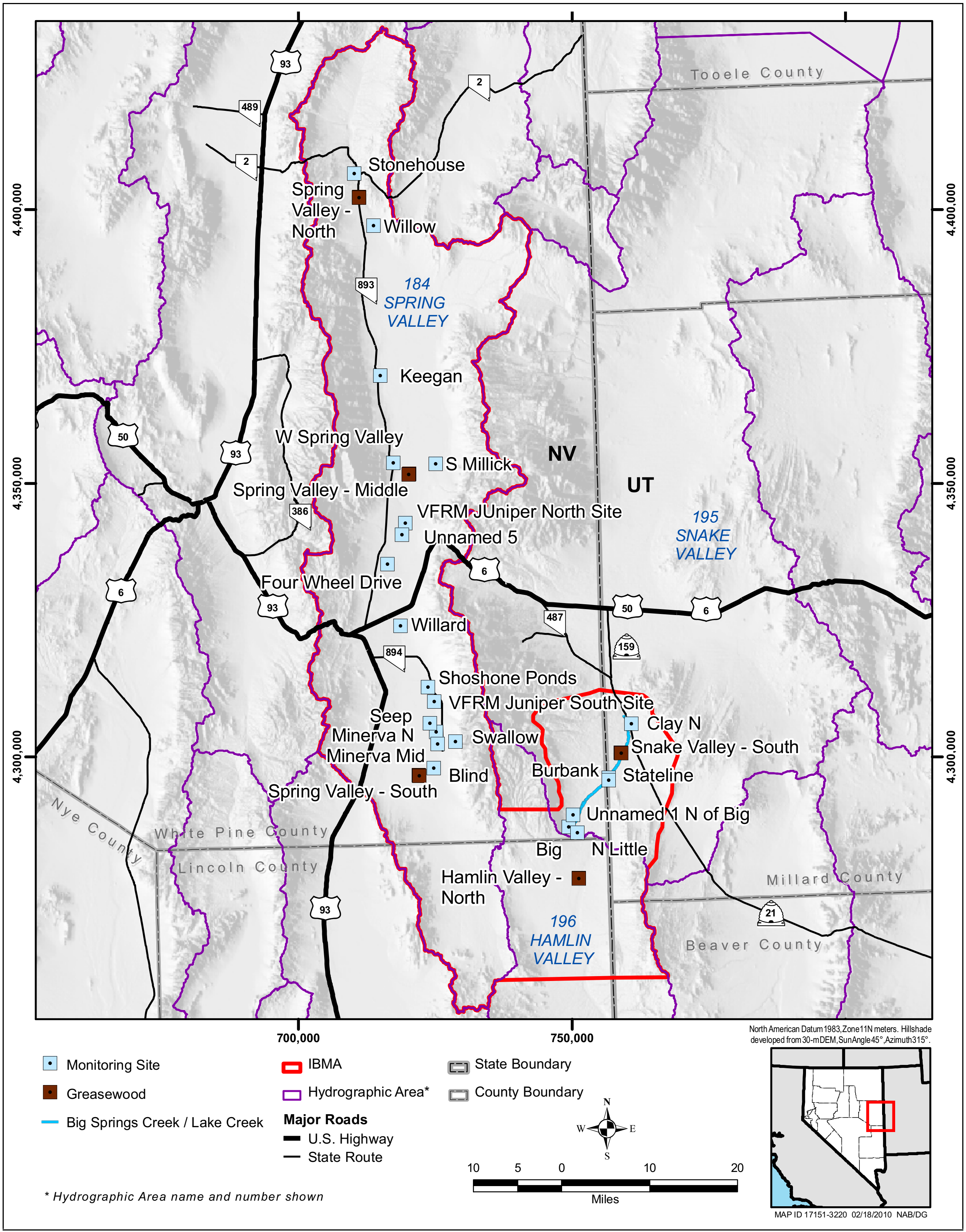


Figure 1-1
Locations of Biological Monitoring Sites within the IBMA

solitarius), Big Springs Creek/Lake Creek native fish community, Pahrump poolfish (*Empetrichthys latos*), vegetation, Valley-Floor Rocky Mountain Juniper (*Juniperus scopulorum*, VFRM Juniper), and fixed station photography survey efforts.

Section 2.0 presents the status and methods for data collected for each major parameter of the Biological Monitoring Plan, including a section on data management. More detailed documentation has been provided to the BWG via a one and a half day workshop with presentations from field leads and the data-exchange web site. Section 3.0 presents the results of the 2009 data collection. Section 4.0 discusses the planned activities for 2010, and Section 5.0 provides a list of references. Lastly, Appendix A through Appendix H present images, tables, and graphs of the various data discussed in the report.

2.0 BIOLOGICAL MONITORING PROGRAM STATUS AND METHODS

This section presents the status of each major parameter of the Biological Monitoring Program and the methods used for data collection. Survey sites and methods described in the *Biological Monitoring Plan for the Spring Valley Stipulation* (Plan) (Biological Work Group, 2009) were used during implementation of the Biological Monitoring Program. Detailed standard operating and chain-of-custody procedures were followed in the collection and maintenance of the laboratory samples and field data. Protocols were followed to prevent the translocation of hazardous nuisance and invasive species among monitoring sites.

Data were collected during the following time periods in 2009:

- May 1 through 28: Spring aquatic surveys
- June 30 through August 10: Summer vegetation cover and composition survey
- July 23 and 30: Summer NDOW relict dace and Pahrump poolfish survey at Shoshone Ponds
- August 4 through 19: Summer VFRM Juniper tree survey
- September 1 through 25: Fall aquatic surveys

2.1 Physical Habitat Mapping

Physical habitat mapping was conducted at all spring and pond sites in spring and fall 2009 and at all creek reaches in fall 2009. Physical-habitat-mapping monitoring sites are presented in Figure 2-1.

Physical habitat mapping was based on four categories that were combined to define habitat types: (1) hydro morphological unit (pool or channel); (2) depth (range); (3) velocity (range); and, (4) percent emergent vegetation (range). The perimeter of each physical habitat type was recorded using a Trimble GeoXH Global Positioning System (GPS) Unit. In an area where a distinct boundary was difficult to define, GPS points were taken to identify it as a soft boundary that may have a greater margin of error. After the initial spring 2009 survey the ranges used to define velocity and percent emergent vegetation were changed in an effort to more effectively capture biologically relevant characteristics. The emergent vegetation category was changed from presence/absence to one of 3 percent emergent vegetation categories (<30 percent, 30 percent to 90 percent, or >90 percent). An additional velocity category of <0.01 m/s was added in the fall to better characterize habitats. Because of this change, habitat types summarized for spring and fall are somewhat different and are more difficult to compare. Physical habitat data were used to create stratified random sample designs for macroinvertebrate and fish surveys, as described in the Plan.

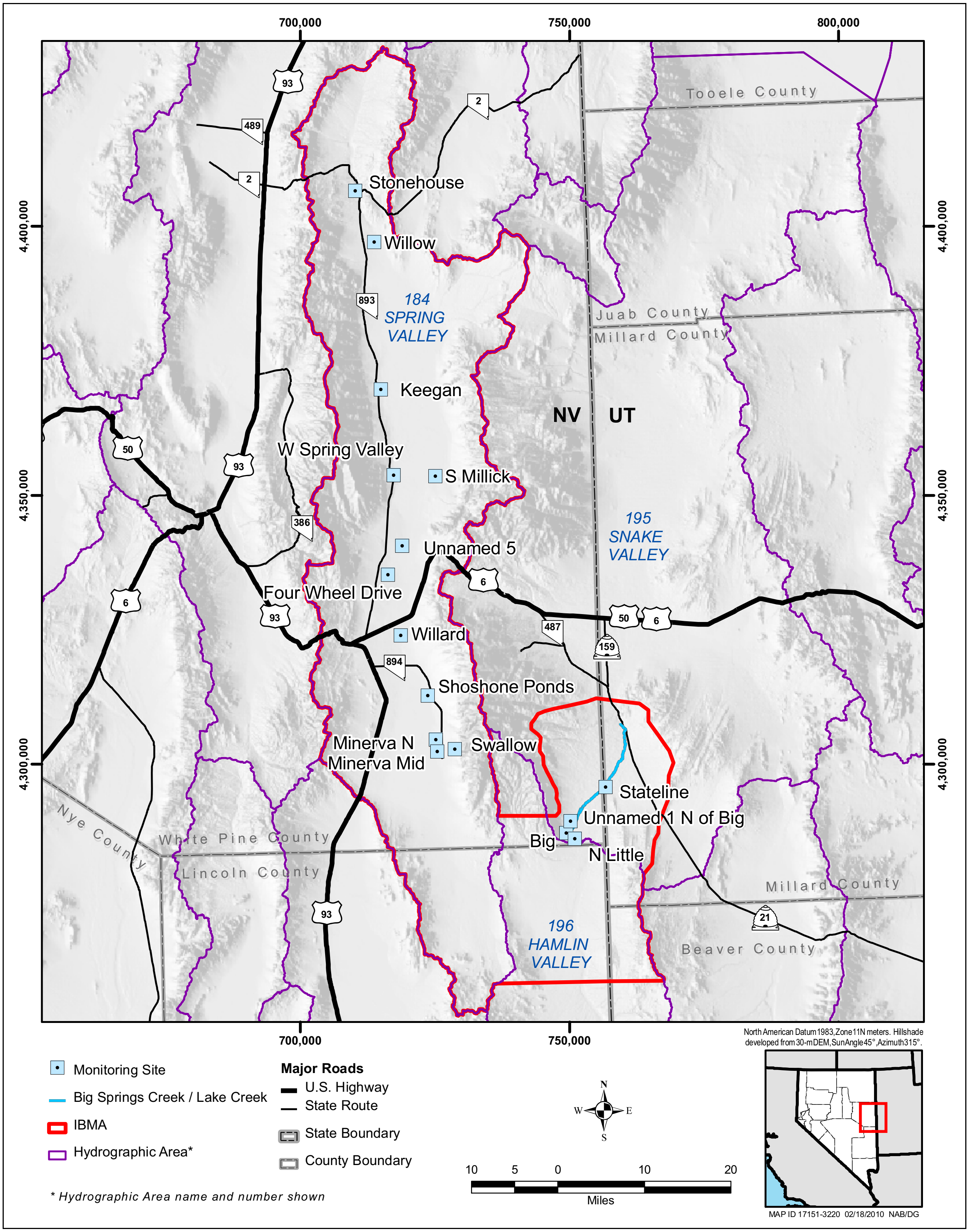


Figure 2-1
Locations of Physical-Habitat-Mapping Monitoring Sites within the IBMA

2.2 Site Assessment

Qualitative site assessments began in fall 2009 at all spring, creek, and pond sites. Site assessment monitoring sites are presented in Figure 2-2. Each site was given an overall disturbance rating of either (1) undisturbed, (2) slightly disturbed, (3) moderately disturbed, or (4) highly disturbed, as described in the *Draft U.S. National Park Service Mojave Inventory and Monitoring Network Spring Survey Protocols: Level I and Level II* (Sada and Pohlmann, 2006). Any specific disturbance factors were also recorded.

2.3 Water Quality

Water-quality measurements were made at each of the Stipulation monitoring springs during spring and fall 2009. Water-quality measurements planned at the five Big Springs Creek/Lake Creek reaches during fall fish sampling were accidently omitted in 2009. All water-quality monitoring sites are presented in Figure 2-3. Water quality measurements were made at every Stipulation spring in the springhead area, at a designated midpoint in the springbrook, and at a designated endpoint in the springbrook.

Water-quality parameters measured were temperature, specific conductivity, pH, dissolved oxygen, turbidity, and velocity. Temperature, specific conductivity, pH, and dissolved oxygen were measured using a Hydrolab MS5 Multiprobe fitted with a Hydrolab Surveyor 4a readout. Turbidity was measured using a Hach 2100P Portable Turbidimeter. Both instruments were calibrated every morning before the field survey according to manufacturer's specifications. Water velocities were measured with a Marsh-McBirney Flo-Mate 2000 Portable Flowmeter fitted with a standard wading rod.

Total nitrogen and total phosphorus samples were collected in the springhead area of each Stipulation spring. The total nitrogen and total phosphorus samples were collected in sterile containers provided by Weck Laboratories in California and stored on ice. The samples were sent via FedEx to Weck Laboratories upon return to Las Vegas from the field.

HOBO Water Temp Pro v2 temperature loggers were placed near the springheads in each of the Stipulation monitoring spring sites during the spring 2009 field survey event. Each logger was wired to a cinder half-block and placed under the block to prevent the influence of direct sunlight. GPS locations were also recorded. Each logger was programmed to record once per hour. Seven of the temperature loggers were not found during the fall 2009 survey most likely because of extensive vegetation growth, sinkage, or theft. Data from the temperature loggers were downloaded to a HOBO shuttle during the fall field 2009 surveys and then directly to a laptop computer. The logger data were transferred to the data manager upon return to Las Vegas.

2.4 Springsnails

Nine springs were surveyed for springsnails in 2009. All sites were surveyed in the spring and fall, with the exception of Minerva Spring Complex North, which was surveyed only in fall as a result of field error. Springsnail monitoring sites are presented in Figure 2-4.

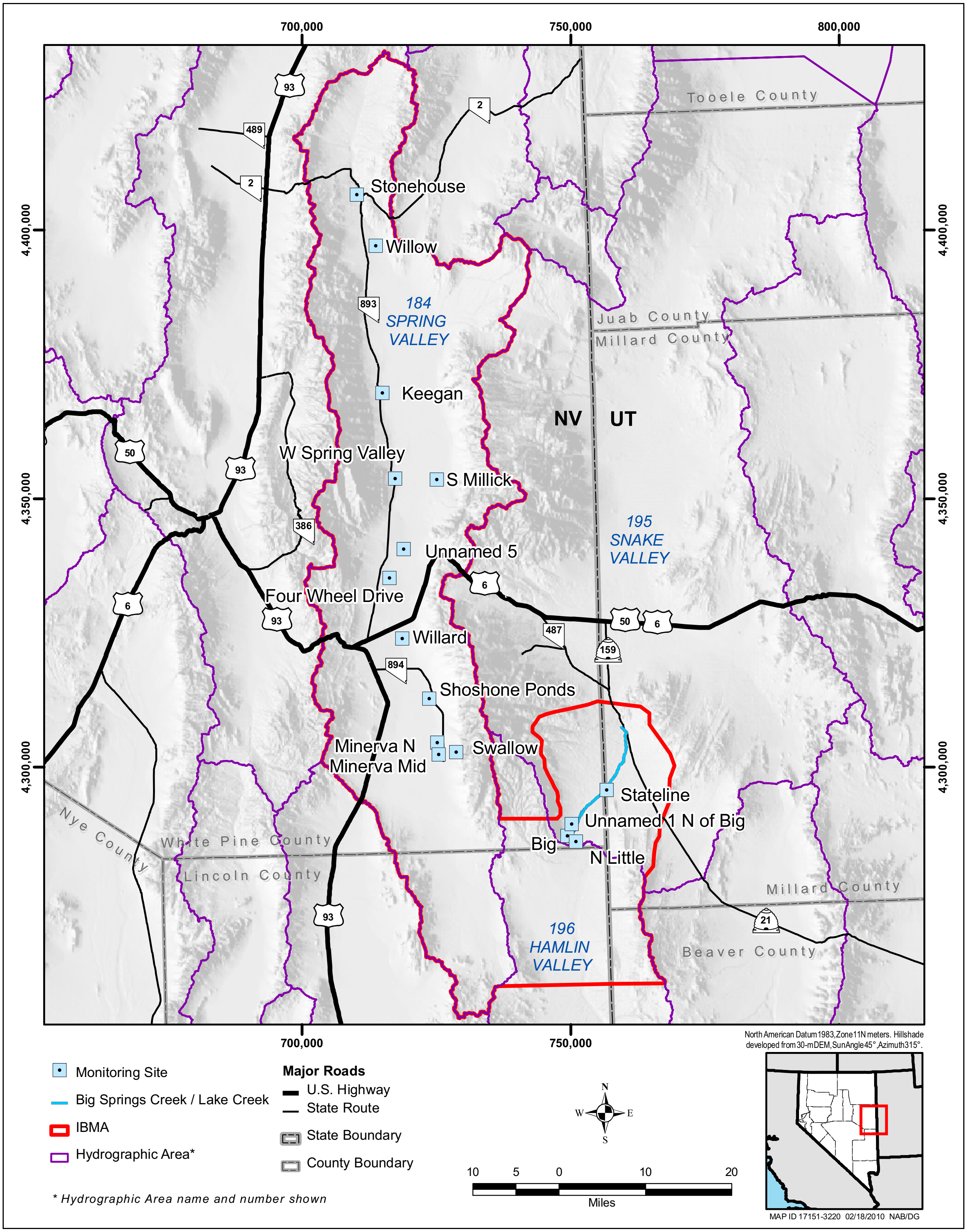


Figure 2-2
Locations of Site Assessment Monitoring Sites within the IBMA

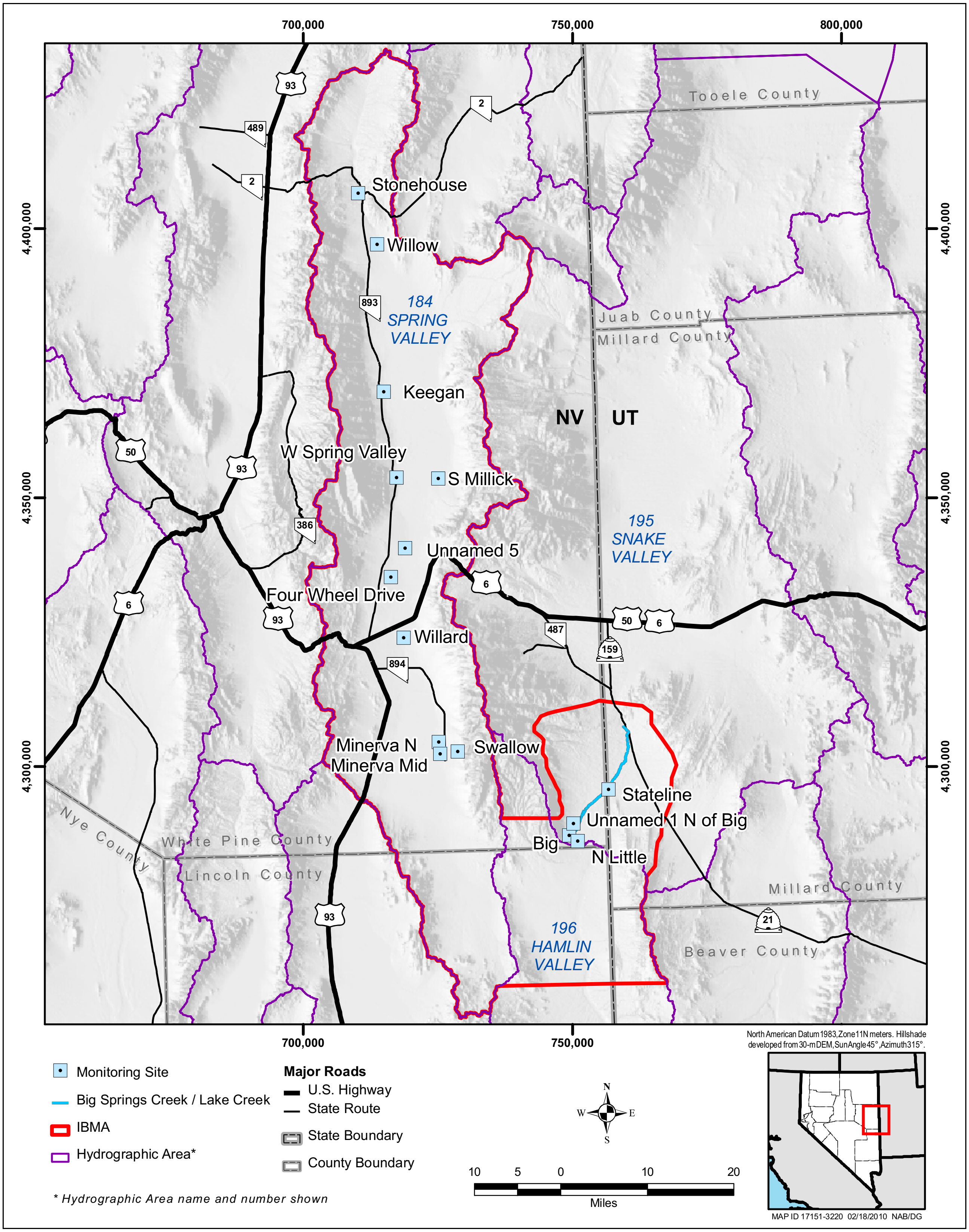


Figure 2-3
Locations of Water-Quality Monitoring Sites within the IBMA

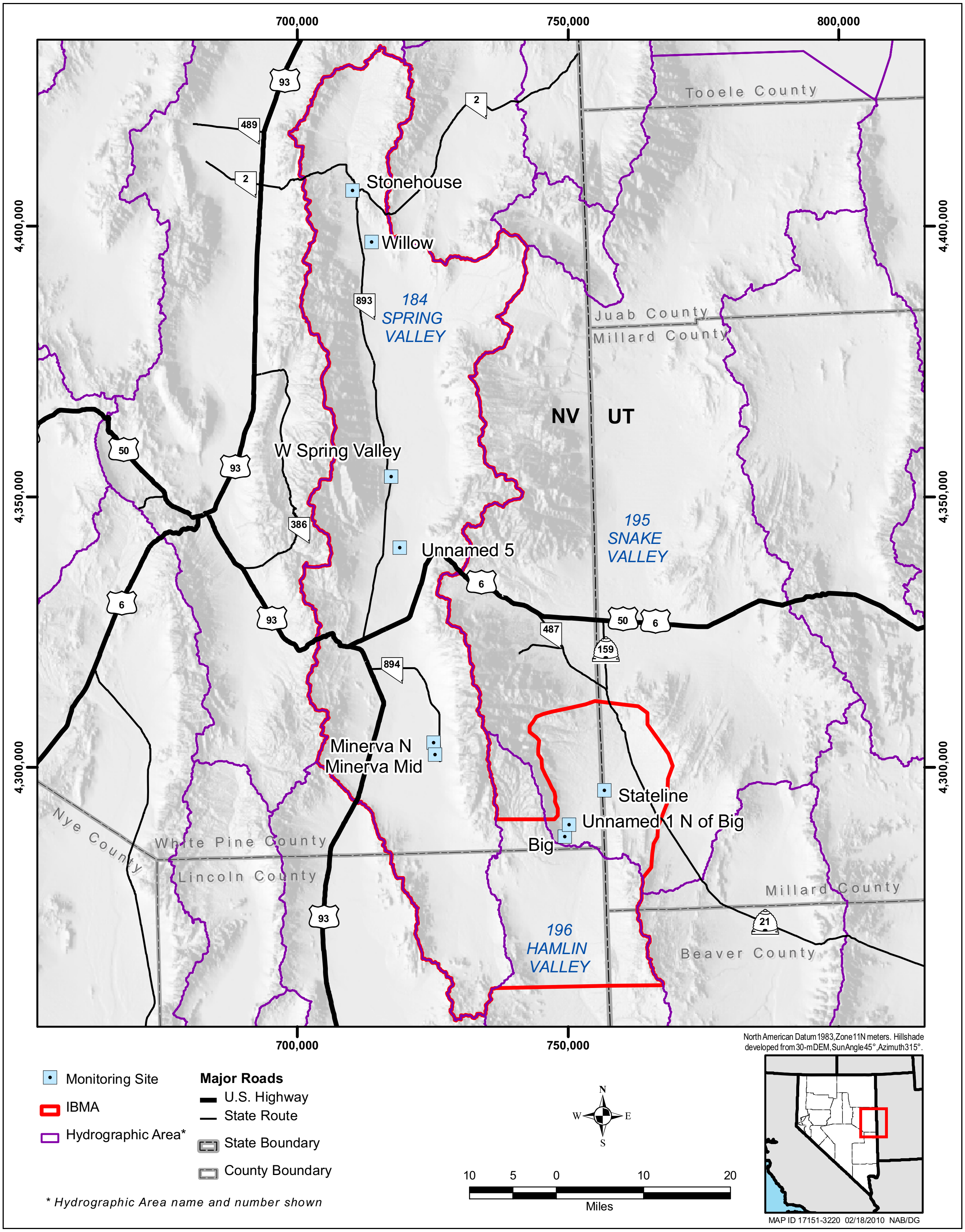


Figure 2-4
Locations of Springsnail Monitoring Sites within the IBMA

Surveys at each site began with a systematic search along the extent of spring habitat for a springsnail presence. Once the extent of the springsnails was determined, up to 20 transects (placed at a minimum distance of 2.5 m apart) were placed equidistant from the spring source to the springsnail extent. Habitat measurements and springsnail counts were made within quadrats that were placed at five evenly spaced points along each transect. In springbrooks that were too narrow to accommodate five points, a minimum of three quadrats within the narrow transect was used. A maximum of 100 habitat and population points along any given springbrook, with one to two springsnail extents sampled per site were sampled.

Starting downstream and working upstream, springsnails were counted in each 25.0 cm^2 quadrat using a modified Surber sampler with a 5.0 × 5.0 cm frame opening. Spring 2009 surveys were conducted using 250-micron mesh netting, while in the fall 700-micron mesh netting was used. Based on the recommendation of Don Sada of Desert Research Institute (DRI) (personal communication, 2009), the Surber samplers were replaced with 700-micron mesh, which allowed for easier counting of springsnails and less clogging of the netting by debris.

Habitat data (substrate type, presence/absence of algae and submerged vegetation, percent emergent vegetation cover [riparian or instream vegetation], water velocity, and water depth) were measured at each quadrat in a transect, where possible. Because of dense vegetation, muddy conditions, shallow water, and rocky substrates, velocity was not measurable at numerous quadrats. Water-quality parameters (temperature, conductivity, pH, dissolved oxygen, and turbidity) were measured at the center of each transect. Water velocity was recorded at each springsnail quadrat. Wetted width and Universal Transverse Mercator (UTM) coordinates were also recorded at each springsnail transect.

Unnamed 5 Spring, a portion of the Stonehouse Complex sampling area, and a portion of the Stateline Springs sampling area required modification of the above protocol, as was written into the Plan. Because these areas have springheads in which no linear extent of springsnails can be determined, grab samples were taken. Grab samples consisted of one or two springsnail sampling points within the springhead that were used as representative data for that springhead. To make protocol consistent across sites, sample point data were collected within transects instead of grab samples being done in the fall.

2.5 Macroinvertebrates

Thirteen springs were surveyed for macroinvertebrates during spring and fall 2009, and five Big Springs Creek/Lake Creek reaches were surveyed in fall 2009. Macroinvertebrate monitoring sites are presented in Figure 2-5.

Sampling followed the U.S. Environmental Protection Agency (EPA) rapid bioassessment protocol, which involves 20 total samples combined into one composite sample (Barbour et al., 1999), as described in the Plan. Macroinvertebrate collection began at the downstream end of the reach and proceeded upstream. Samples were collected in the form of kicks/roils, sweeps, or jabs using a D-frame net with a 250-micron mesh. Samples were collected based on characteristics found during physical habitat mapping, in which sample sites were generated and randomly assigned according to proportion of habitat, as described in the Plan. Composite samples were transferred to a sample container(s) and preserved in 95 percent ethanol.

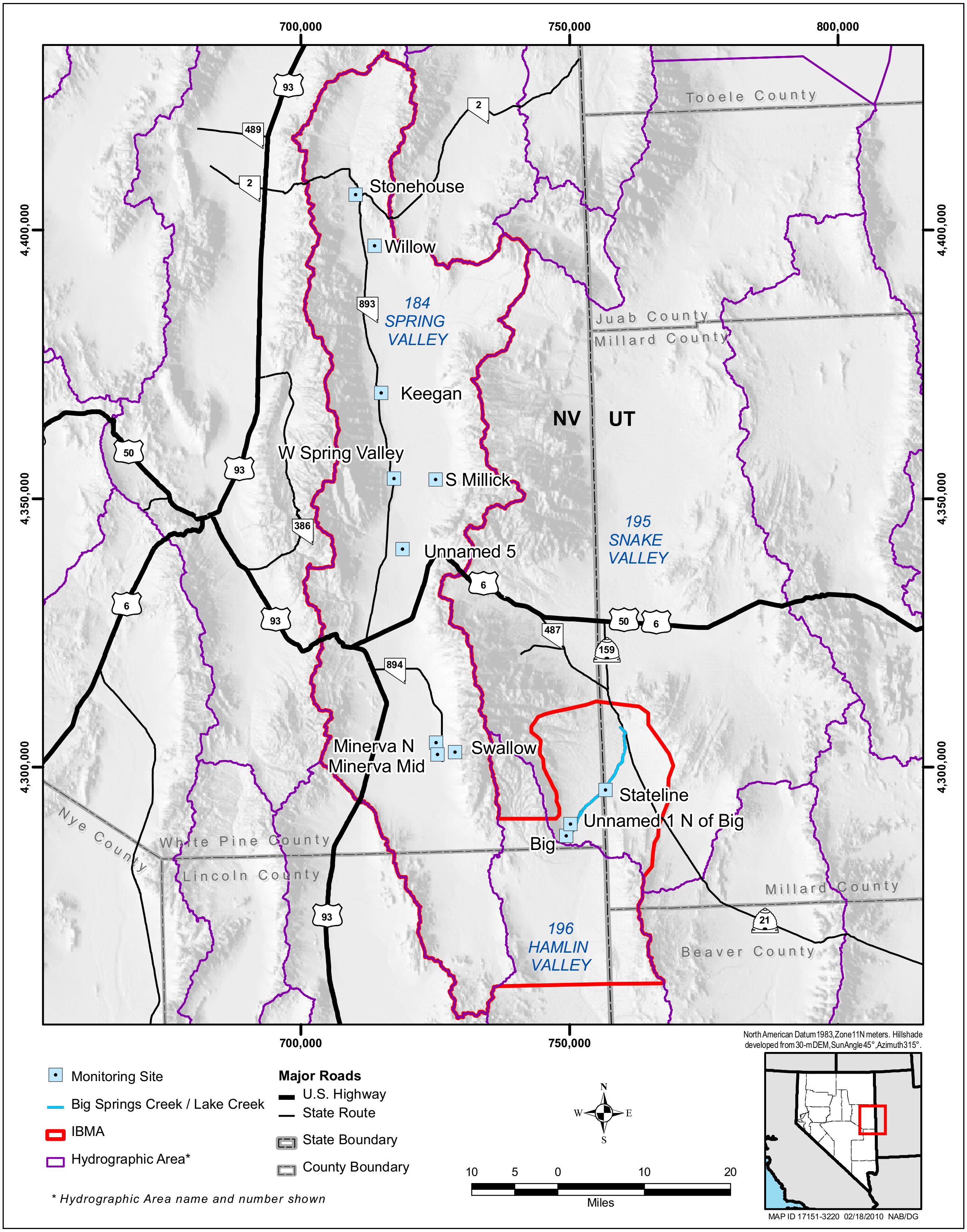


Figure 2-5
Locations of Macroinvertebrate Monitoring Sites within the IBMA

Labeled samples were shipped to Rithron Associates, Inc., of Missoula, Montana (Rhithron), for identification and analysis. At the Rhithron laboratory, standard sorting protocols were applied to achieve representative subsamples of a minimum of 300 organisms. Caton subsampling devices, divided into 30 grids each approximately 5 × 6 cm, were used. Each individual sample was thoroughly mixed in its jar, poured out, and evenly spread into the Caton tray, and individual grids were randomly selected. The contents of each grid were examined under stereoscopic microscopes. Grid selection and examination continued until at least 300 organisms were counted and identified, with the final grid counted and identified in totality.

Given the composite nature of the data collection, one set of results was provided per spring site per season as described in the Plan. Sampling was also planned to provide one set of results per Big Springs Creek/Lake Creek reach for fall, but the creek reach samples were inadvertently composited and analyzed as a single sample.

2.6 Northern Leopard Frog (Rana pipiens)

Northern leopard frog sampling was conducted at each Stipulation spring and pond site, as well as along Big Springs Creek/Lake Creek, in spring 2009 as described in the Plan. This sampling occurred in two phases. Phase one surveys were conducted to determine the presence or absence of northern leopard frogs at Stipulation sites. Phase two surveys were conducted at Stipulation sites with the confirmed presence of northern leopard frogs and focused on counting frog egg masses within a specific sampling area as defined in the Plan. Northern leopard frog presence and egg mass monitoring sites are presented in Figure 2-6.

Both phase one and phase two surveys were conducted during the northern leopard frog breeding season in Spring Valley. The onset of the breeding season was determined by monitoring a sentinel site (Stipulation Unnamed 5 spring) for the presence of egg masses. The sentinel site was visited every two weeks starting in mid-March, and once egg masses were documented, presence or absence surveys or egg mass surveys began at the other Stipulation sites.

Phase one surveys were conducted at Stipulation sites with no previous northern leopard frog documentation. Surveys consisted of two to four biologists walking at a speed no greater than 20 m per minute, around and through potential frog habitat within the Stipulation sampling area to observe northern leopard frogs, tadpoles, egg masses, or to hear calling males. The entire Stipulation sampling area of each site was surveyed, and any potential breeding habitat adjacent to the sampling area was also surveyed.

Phase two surveys consisted of two to four biologists walking around and through all aquatic habitats within the Stipulation sampling area at a speed no greater than 20 m per minute. The surveys' begin time and end time were noted. Once an egg mass was located, it was given a unique number, marked with GPS, and flagged. Based on the recommendation of Krissy Wilson of UDWR (personal communication, 2009), each egg mass was classed by age (AC 1= small, circular ova; AC 2 = kidney shaped ova; AC 3 = tailed embryos close to hatching; AC+3/hatched = hatched tadpoles; and dead = white embryos, fungus on egg mass). It was also noted if the egg mass occurred in a cluster (egg masses within one foot of each other), and measurements were taken of the water depths (inches and centimeters) and the distance from each egg mass to dry shoreline (in meters). Once an egg mass

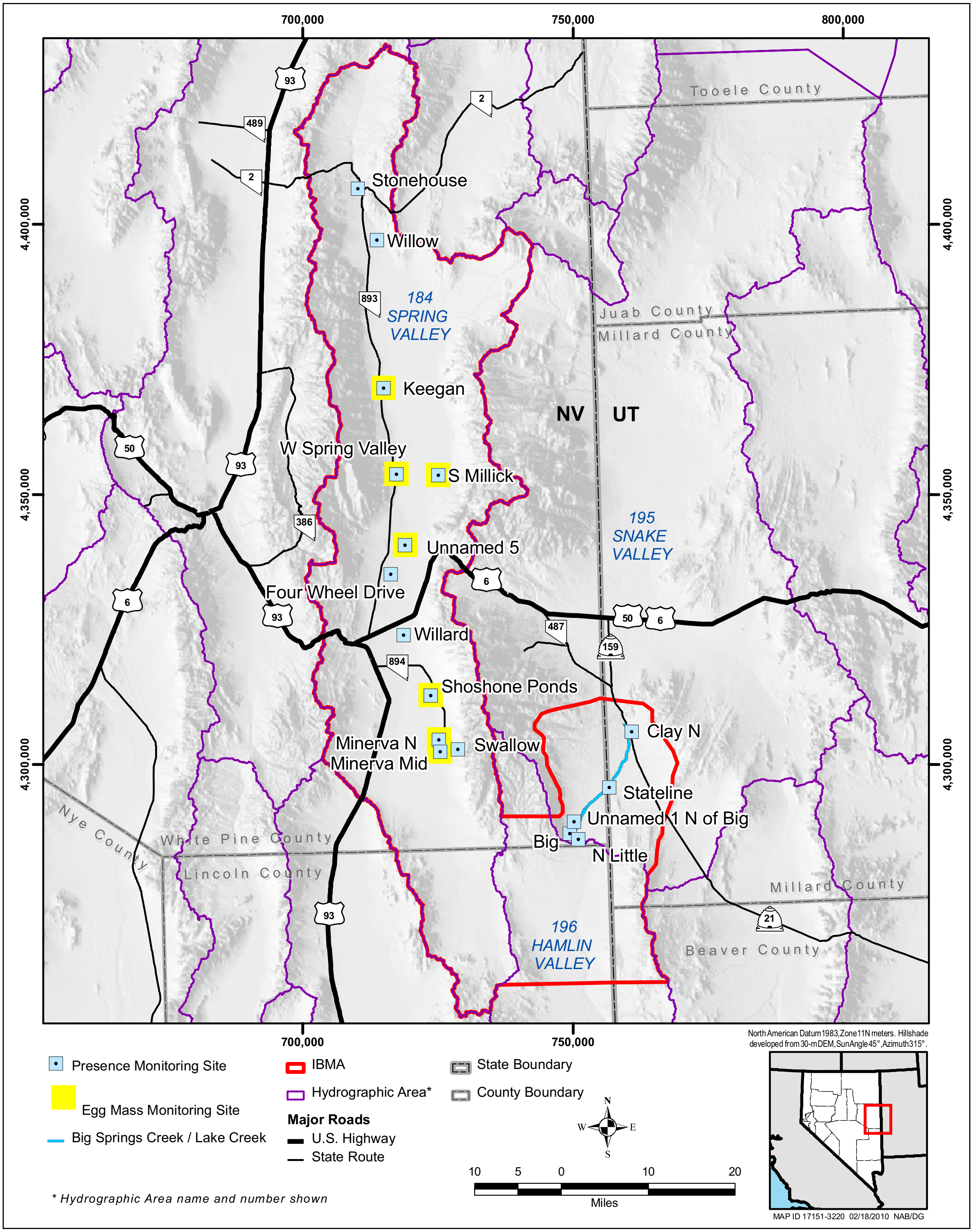


Figure 2-6
Locations of Northern Leopard Frog and Egg Mass Monitoring Sites within the IBMA

survey was conducted at a particular site, the site was visited at 2-week intervals until at least three egg mass surveys had been conducted there. At each visit, previously located egg masses were checked for development, and any new egg masses were documented.

During the final egg mass survey visit, breeding habitat line-point transects were placed through the general breeding locations at each site. A breeding location was delineated by a grouping of egg masses within a continuous breeding habitat. Transects were placed to intersect the habitat at or near as many egg masses as possible within a breeding location. Transects ranged from 2 to 6.5 m in length, depending on the distribution of egg masses at the particular breeding location. The extent of open water and the emergent vegetation cover were determined along each transect by sampling at 1-cm intervals. Water-quality data (conductivity, pH, temperature, and dissolved oxygen) were collected at each breeding pool.

2.7 Relict dace (Relictus solitarius)

Relict dace were sampled at the Stonehouse and Keegan Ranch spring complexes in spring and fall 2009. Relict dace were also sampled at Shoshone Ponds by NDOW in summer 2009. All three relict dace monitoring sites are presented in Figure 2-7.

The fish sampling areas for Stonehouse and Keegan Ranch spring complexes were designated in the Plan (p. C-12 and C-13), with modifications based on the relict dace sampling that BIO-WEST, Inc., conducted in these areas (BIO-WEST, 2009). In spring 2009, the pool and channel habitats of the sampling areas were mapped. The percent of each habitat within the site was calculated in the Geographic Information System (GIS), and this percentage was then used to determine the proportion of sampling points needed for each habitat type, as described in the Plan. Sampling points were randomly placed within each habitat type. It was originally planned to place three or six traps in each habitat, but based on previous sampling by BIO-WEST (BIO-WEST, 2009) it was decided to place more traps in each habitat to effectively sample the spring system. All sampling points were recorded by GPS. These same points were used in the fall 2009 sampling effort.

At each relict dace sampling point, a Gee minnow trap baited with dry dog food was placed in water deep enough to submerge the trap entrances. Within each habitat type, two-thirds of the minnow traps were standard 6-mm mesh (large mesh) traps and one-third were 3-mm mesh (small mesh) traps. Twenty-four large mesh and 13 small mesh traps were placed at Keegan Ranch, and 20 large mesh and 10 small mesh traps were placed at Stonehouse. The small mesh traps were used to capture a full range of fish size classes for measuring fish length as the larger mesh traps may not hold smaller fish. Traps were set in the afternoon, no later than three hours before sunset, and checked the next morning, no earlier than three hours after sunrise. The habitat, mesh size of the trap (small or large), time of trap placement and removal, and the weather conditions (cloud cover, wind, and air temperature) were recorded. Upon retrieval of a trap, captured relict dace were placed in a bucket and counted. Fish removed from small mesh traps were measured (in millimeters) for total length, with at least 25 randomly selected fish from each habitat type measured, as described in the Plan. To prevent recaptures, fish were not released until all traps in the immediate vicinity had been collected.

Relict dace seasonal distribution, length-frequency, and relative abundance (catch-per-unit effort [CPUE]) were evaluated by site and season at the Stonehouse and Keegan Ranch Stipulation

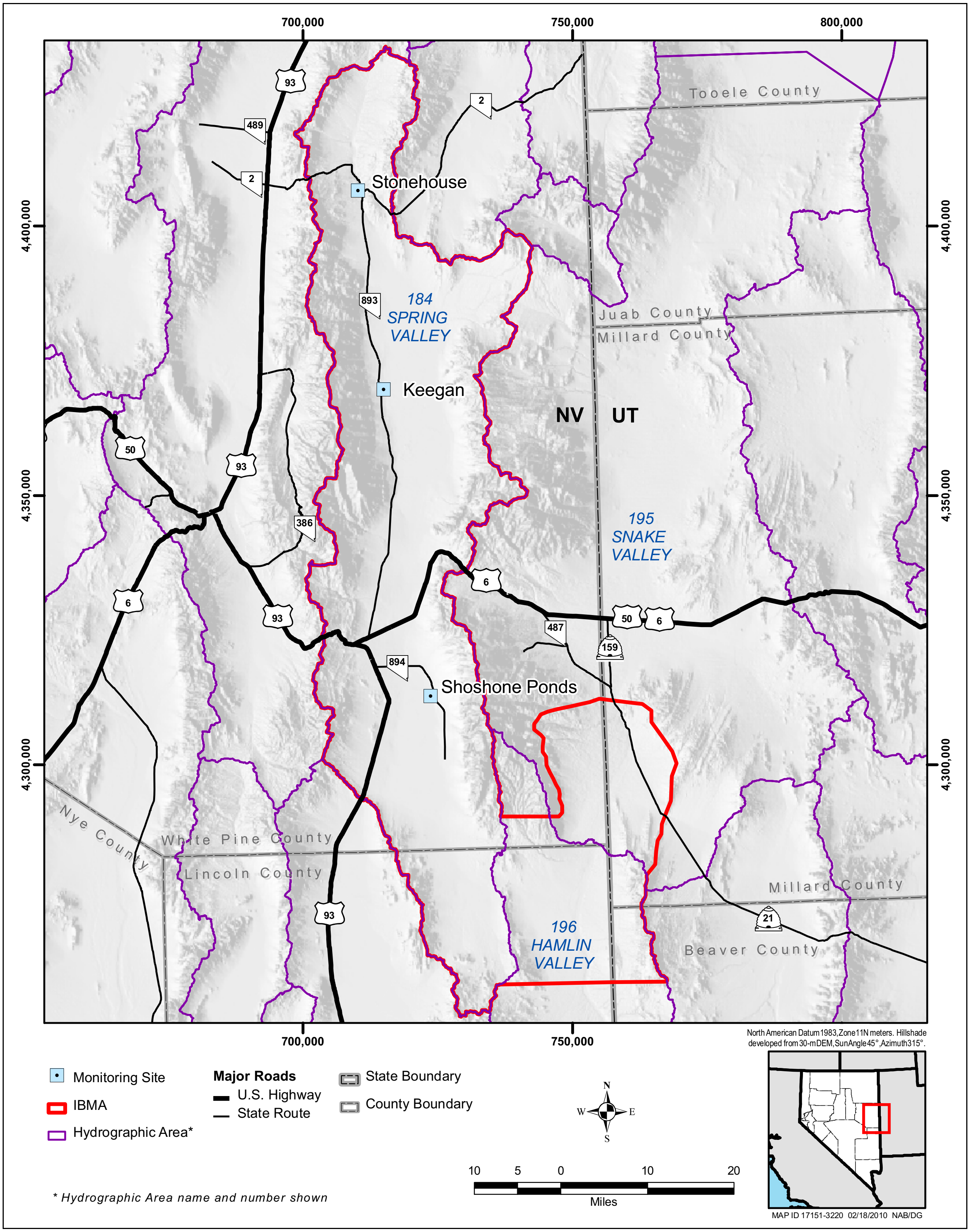


Figure 2-7
Locations of Relict Dace Monitoring Sites within the IBMA

sampling areas. To create three length classes for the length-frequency histograms, a cluster analysis (a method of K-clustering that splits a set of objects into a selected number of groups by maximizing between-cluster variation relative to the within-cluster variation) was conducted. Comparisons of CPUE by season and habitat were evaluated with a Tukey pairwise comparison test.

NDOW leads an annual sampling effort of relict dace at Shoshone Ponds. SNWA supported this effort in 2009. The sample area encompasses the Fish Refugia Pond 3 (South Pond). On July 23, 2009, relict dace were captured, measured, and marked using minnow traps (NDOW, 2009). On July 30, 2009, relict dace were again captured, and all marked and unmarked fish were counted. Using the mark-recapture data, a population estimate was derived.

For detailed methods, see the complete 2009 NDOW field trip report in Appendix H.

2.8 Pahrump Poolfish (Empetrichthys latos)

NDOW leads an annual sampling effort of Pahrump poolfish at Shoshone Ponds. SNWA supported this effort in summer 2009. The sample area includes the Fish Refugia Ponds 1 and 2 (North and Middle Ponds) and a large stock pond. The Shoshone Pahrump poolfish monitoring site is presented in Figure 2-8.

On July 23, 2009, Pahrump poolfish were captured, measured, and marked at the Shoshone Middle, North, and Stock Ponds using minnow traps (NDOW, 2009). On July 30, 2009, Pahrump poolfish were again captured at these three ponds, and all marked and unmarked fish were counted. Using the mark-recapture data, population estimates for each pond were derived. For detailed methods, see the complete 2009 NDOW field trip report in Appendix H.

2.9 Big Springs Creek/Lake Creek Native Fish Community

Fish inhabiting the Big Springs Creek/Lake Creek system were sampled along five permanent 100-m reaches in fall 2009. The reaches were chosen to include the creek outflow of Big Springs, the portion of Lake Creek along the Stateline Springs, the Lake Creek inflow to Pruess Lake, and two stretches of Big Springs Creek on BLM land.

- Reach 1 is approximately 200 m downstream from the Big Springs springhead (the Plan designated Reach 1 to originate at the springhead, but wire fencing necessitated positioning the reach 200 m downstream).
- Reach 2 is approximately 7 km downstream of Big Springs;
- Reach 3 is approximately 1.2 km upstream of Stateline Springs;
- Reach 4 is at Stateline Springs; and
- Reach 5 is approximately 800 m upstream of Pruess Reservoir.

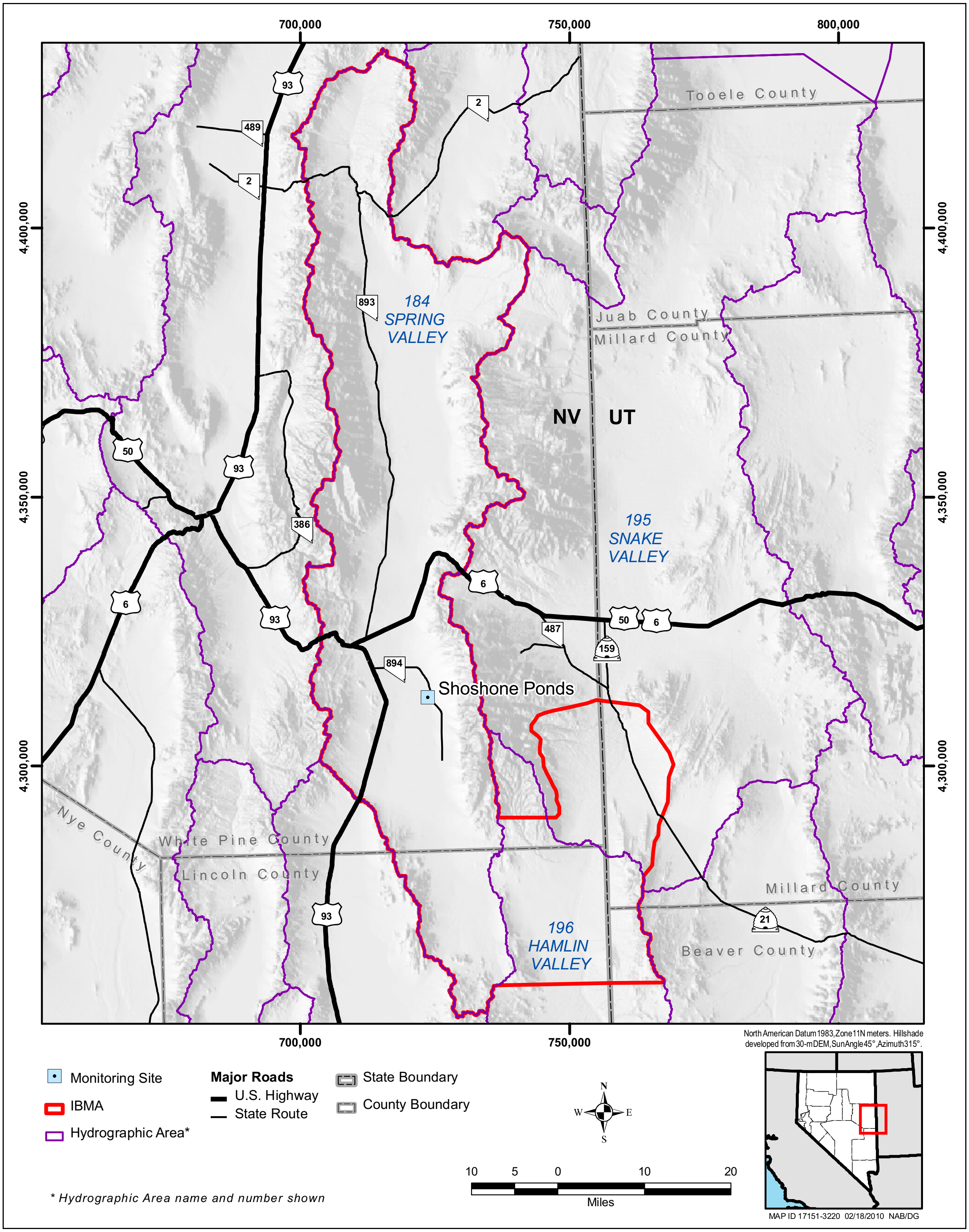


Figure 2-8
Location of Pahrump Poolfish Monitoring Site within the IBMA

The begin and endpoints of each reach were marked by GPS. Creek monitoring reaches are presented in Figure 2-9.

Fish were sampled by placing a block net at the begin and endpoints of each reach to restrict fish movements into or out of the reach. A three-pass depletion survey was conducted along each reach with a backpack electrofisher (Smith Root LR-24) while three netters captured stunned fish with dip nets. After each pass, the seconds of electrofisher use were recorded, and all captured fish were identified to species and counted. Over the course of the three passes, up to 25 individuals of each fish species were measured to total length in millimeters. The fish were released below the downstream block net immediately after counting and measuring.

For each reach, species composition was presented as the percent of each species of the total fish captured. The relative abundance of each fish species was presented as the mean CPUE, the number of fish per electrofishing second, over the three passes. The mean CPUE with standard error was calculated in SYSTAT 13.

To create five length classes for the length-frequency histograms of each species, a cluster analysis was conducted. Mean length with standard error was calculated for each species on each reach.

Upon completion of the fish sampling at each reach, habitat data were collected along five line-point transects to characterize the general habitat of the reach. The transects were placed at the 0-, 20-, 40-, 60-, and 80-m marks along the 100-m reach and ran the width of the channel. For each transect, the total length in centimeters (from bank to bank) was recorded, and the substrate was characterized by a presence of silt, sand, gravel, cobble, and boulder. At each transect centimeter mark, the habitat was classified as no vegetation, emergent vegetation, or submergent vegetation.

2.10 Vegetation

Vegetation sampling was conducted at spring, wetland/meadow, phreatophytic shrubland, and VFRM Juniper (Rocky Mountain juniper, *Juniperus scopulorum*) sites in summer 2009. Vegetation monitoring sites are presented in Figure 2-10.

Permanent vegetation transects were established in spring 2009. Goals for transect design were followed as written in the Plan, with slight modification to better allow the crossing of diverse vegetation communities and ecotones. Transect endpoints were permanently marked in the field, and locations were recorded and postprocessed using survey-grade GPS equipment (Base station receiver: Trimble 5700 with Zephyr Geo-GP antenna and Trimmark 3 radio; Rover receiver: Trimble 5800 RTK [Real-Time Kinematic]).

Vegetation data were collected along 158 line transects and 32 belt transects. Line transects include 70 aquatic transects, 63 wetland/meadow transects, and 25 phreatophytic shrubland (shrubland) transects, varying in length from 5 to 130 m, depending on the size of the monitored vegetation community. The belt transects are located within two Spring Valley valley-floor Rocky Mountain juniper populations and are 5 × 20 m.

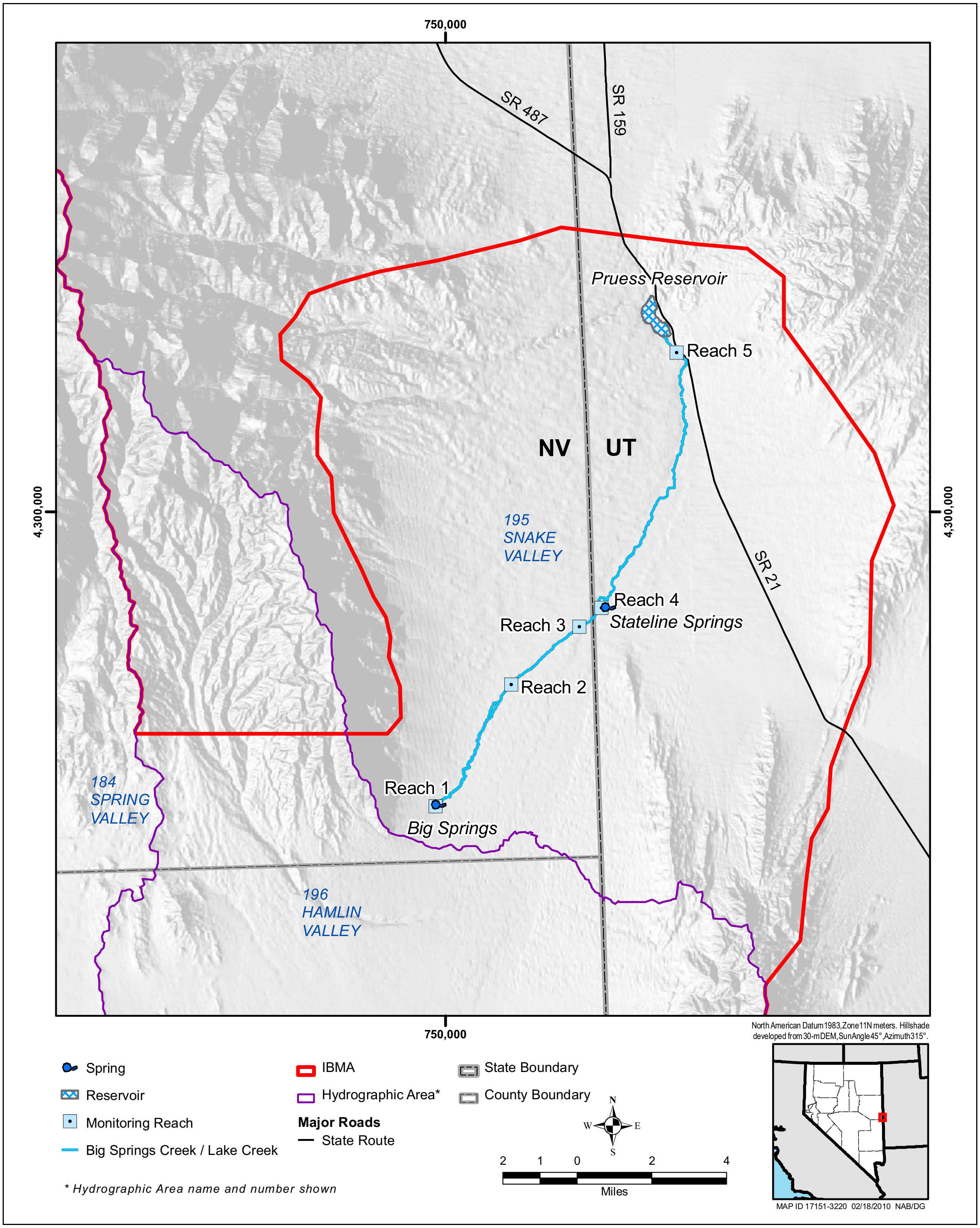


Figure 2-9
Locations of Big Springs Creek/Lake Creek Native Fish Community Monitoring Reaches within the IBMA

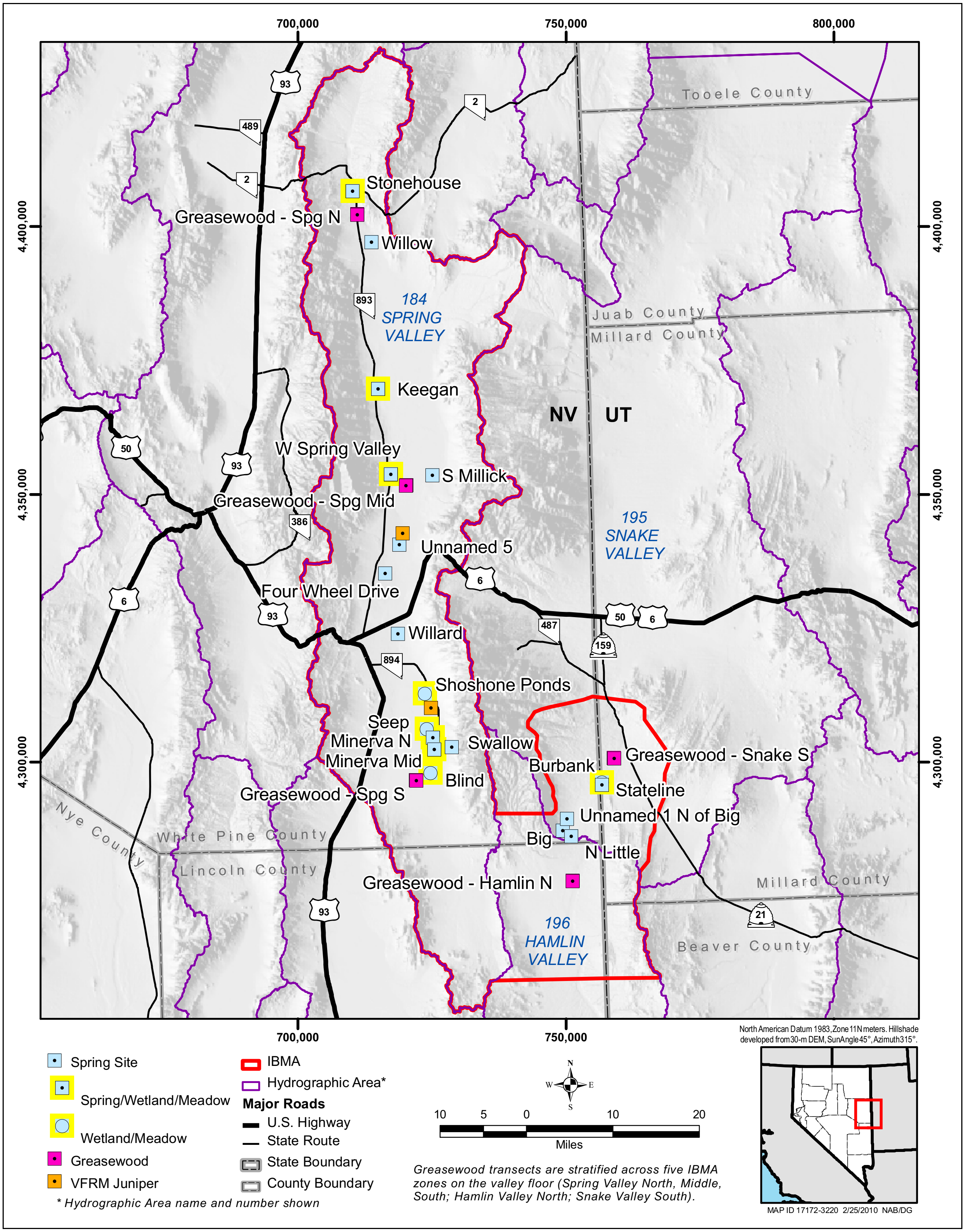


Figure 2-10
Locations of Vegetation Monitoring Sites within the IBMA

As described in the Plan, five aquatic transects were established at each of 14 spring sites (Minerva Spring Complex North and Middle treated as one large complex). Sixty-three wetland/meadow transects were placed across eight wetland/meadow sites, four of which are also spring sites (Stonehouse Complex, Keegan Ranch Spring Complex North, West Spring Valley Complex, and Minerva Spring Complex Middle/North). Four of the aquatic transects are embedded in the wetland/meadow transects, with additional wetland/meadow transects also crossing aquatic areas.

The 25 shrubland transects were stratified evenly across five IBMA zones on the valley floor (Spring Valley North, Middle, and South; Hamlin Valley North; and Snake Valley South), as designated in the Plan. All 25 transects were placed in greasewood (*Sarcobatus vermiculatus*)-dominated communities and, when possible, were positioned near basin-fill groundwater monitor wells. Twenty-one of the 25 transects are within 0.25 to 4 mi of existing or planned Spring Valley Stipulation Hydrologic Monitoring Program spring site piezometers or basin-fill monitor wells (Appendix A).

Species cover and composition data were collected at all 158 of the line transects, as well as along three line transects contained within each of the 25 belt transects. Data were collected by line-intercept method, with counts taken at each 1-cm mark along each transect and recorded, by species, at 1-m intervals. Data were taken on a multiple-hit basis where all species occurring at each 1-cm mark were counted. Multiple occurrences of the same species (i.e., different strata) at each 1-cm mark were not recorded. If no live plant material was present at a 1-cm mark, the occurrence of bare ground, litter, or open water was recorded. A qualitative measure of soil moisture was also taken at 1-m intervals along the Rocky Mountain juniper transects. Methods for collecting Rocky Mountain juniper tree data within the belt transects are discussed in Section 2.11.

2.11 Valley-Floor Rocky Mountain Juniper (*Juniperus scopulorum*) (VFRM Junipers)

Juvenile and mature VFRM Junipers were surveyed within the two Spring Valley valley-floor populations in summer 2009. VFRM Junipers monitoring sites are presented in Figure 2-11.

Tree counts, heights, basal circumferences, and stem length data were collected within 32 belt transects (16 transects per population) as described in Section 2.10. Timing of sampling was designed to correspond to the height of the growing season and the period of greatest water stress.

Counts of juvenile trees (<1 m in height) and mature trees (>1 m in height) within each of the belt transects were recorded. Heights were recorded to the nearest centimeter for up to 25 trees per age class within each transect, using either a meter stick or a leveling rod. In transects with greater than 25 trees per age class, the subsample of 25 trees was selected from trees that intersected the tape measures marking the outer boundaries of the transects. Height measurements were taken up to 950 cm, and any trees above that height were recorded as “greater than 950 cm.” In addition to height measurements, circumference measurements (basal at ground level) were taken in centimeters for the same mature trees.

Four mature juniper trees were selected from each of the belt transects for sampling of stem elongation data. The selected trees were healthy in appearance and spatially distributed within each transect. In the event that four suitable trees were not found within a transect, trees outside but very close to the transect were selected. From each tree, ten representative branches were tagged for

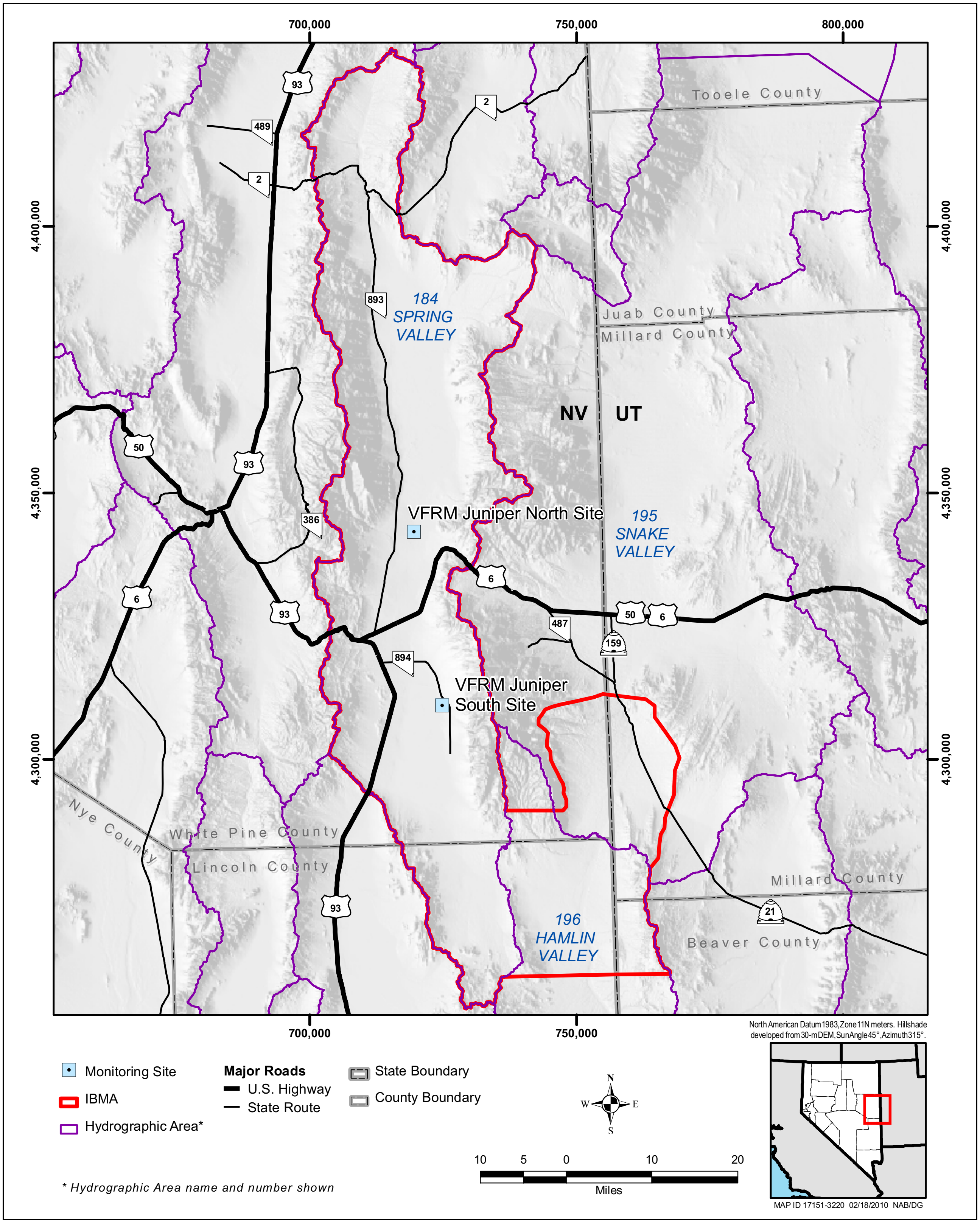


Figure 2-11
Locations of Valley-Floor Rocky Mountain Juniper VFRM Juniper Monitoring Sites within the IBMA

long-term monitoring using imprinted metal tags. Branches were selected as outlined in the plan. All tagged branches had healthy leaves and evidence of recent stem growth. The major growth point (longest stem extension on the branch) was selected for monitoring and tagged. The tag was placed at the first juncture of the longest leader to the main secondary branch. The distance from the juncture above the tag to the tip of the leader was measured to the nearest millimeter using a cloth measuring tap or a ruler. The 2009 stem-length data will provide a baseline for future elongation (growth) measurements.

2.12 Fixed Station Photography

Fixed station photography was conducted at all spring and pond sites in spring and fall 2009 and all wetland/meadow, phreatophytic shrubland, and VFRM Juniper sites in summer 2009. Fixed station photography monitoring sites are presented in Figure 2-12.

Permanent photograph stations were established in spring 2009. Stations were permanently marked in the field, and locations were recorded and postprocessed using survey-grade GPS equipment (Base station receiver: Trimble 5700 with Zephyr Geo-GP antenna and Trimmark 3 radio; Rover receiver: Trimble 5800 RTK [Real-Time Kinematic]). Station numbers and compass bearings of fixed station photographs at each spring and pond site are presented in Table G-1. At spring and pond sites, aquatic photograph stations were designed to capture representative aquatic areas where the biological surveys are being conducted. Vegetation transect endpoints described in Section 2.10 also served as photograph stations at spring, wetland/meadow, Rocky Mountain juniper (VFRM Juniper), and phreatophytic shrubland sites. To increase repeatability of photographs across seasons, compass bearings (direction of photographs) and hard copies of photographs taken in the spring at aquatic photograph stations were used as references in the fall. At vegetation transects, photographs were taken at each transect endpoint in the direction of the opposite endpoint. Photographs were taken with a digital camera at a resolution of at least 6 mega pixels.

2.13 Data Management

A data management system was developed and began to be implemented in 2009. A workflow process was designed to ensure data integrity (i.e., accuracy and consistency) from field data collection to data storage in a Relational Database Management System (Database) to data distribution. The focus was on data quality, transparency, traceability, and security.

The data management workflow is as follows:

1. Archival storage of all original data—both hardcopy data sheets and digital data files—in their original state.

2. Format all data collected in the field into standardized data sheets and GIS files.

3. Perform rigorous, multistep Quality Assurance/Quality Control (QA/QC) of all digital data.

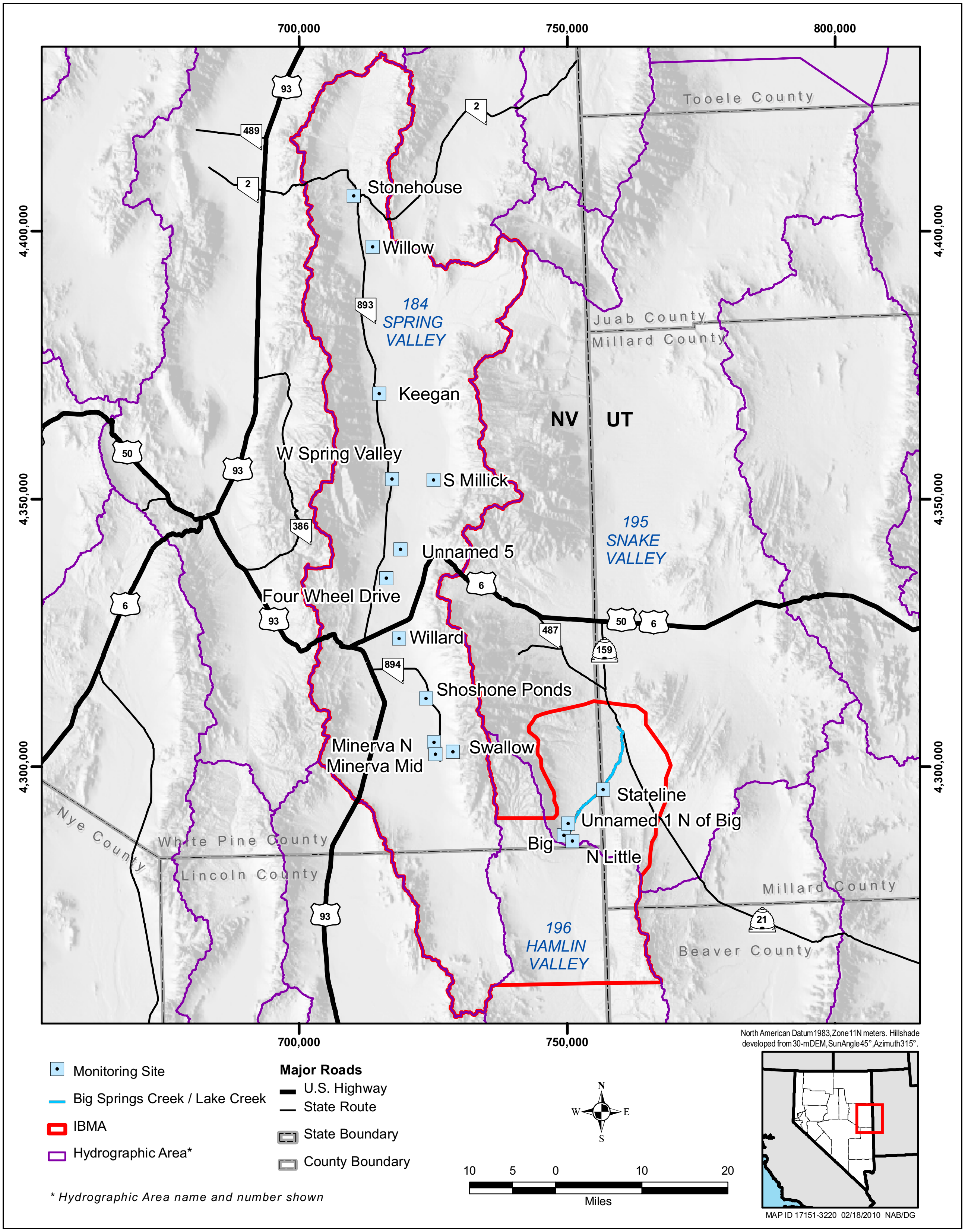


Figure 2-12
Locations of Fixed Station Photography Monitoring Sites within the IBMA

4. Use automated Database upload, which requires data to pass stringent validation rules specifically designed for each data set. (Development of Database and automated upload process are expected to be complete by May 2010).

5. Finalize data upon submission of the annual report each year, at which time final data sets will be provided to the NSE, EC, and BWG and made available to the public.

All provisional 2009 data sets were reviewed by the BWG after QA/QC (step 3) was completed. All comments received from BWG were reviewed; if any revisions to the data set were deemed clearly necessary (e.g., to correct transcription errors made when transferring raw data to digital data), comments were included in a modification justification field to ensure transparency and traceability. Time extensions for reporting data were granted by the BWG and EC to allow the development of data storage systems, format of standardized data sheets and GIS files, development and implementation of multistep QA/QC procedures, and creation of data validation rules and Database code.

Archival storage is provided for all hardcopy data sheets, original and provisional digital data sheets, and provisional and final data within the database:

- Storage with limited access provides the secure storage for all hardcopy data sheets.

- A Secure Digital Repository (Repository) on a network provides storage for all original and provisional digital data files described in the data management workflow. Repository access is limited and is backed up on a regularly scheduled basis.

- An Enterprise Oracle10g Database provides secure storage for all data loaded from digital data sheets during the automated data-loading process, as well as all final data within the Database. Database access is limited and files are backed up on a regularly scheduled basis.

3.0 BIOLOGICAL MONITORING PLAN RESULTS

This section presents summary results of the Biological Monitoring Plan 2009 field effort. Final data is available upon request.

3.1 Physical Habitat Mapping

Physical habitat maps were created at aquatic sites (springs, ponds, and creek reaches) in spring and fall 2009. Maps for individual sites are presented in Appendix B (Figure B-1 through Figure B-17).

Total area by site and by hydro morphological unit (HMU) type are summarized in Table 3-1. Habitat boundary accuracy varies based on the GPS accuracy (which varied by site) and user error associated with delineating boundaries where there was not always a clear distinction between habitat types. Analysis, interpretations, and conclusions made from these data need to take into consideration the margin of error associated with boundary delineation, particularly when comparing area measurements. Polygons created during habitat mapping are coarse characterizations that reflect the average values observed and do not attempt to capture small-scale habitat differences. In the future, these data may be used in a trend analysis.

At this time, limited data and method changes between the two data collection periods complicate the comparison of physical habitat occurring in the spring and fall seasons. However, Willard Spring, West Spring Valley Complex, Willow Spring, and Stonehouse Complex appear to have had a substantial reduction in the amount of total aquatic habitat in the fall as compared to in the spring. Although not reflected in the data because of changes in methodology (percent emergent vegetation was collected as presence/absence in the spring), there also appeared to be an increase in vegetation in the fall as compared to in the spring across all sites. Area by habitat type for each site is presented in Appendix B (Table B-1 through Table B-17).

3.2 Water-Quality

This section provides a general overview of water-quality conditions during spring and fall sampling events, including an overview of temperature regimes at the various springs during the initial year of monitoring. Water-quality data taken at springsnail transects and northern leopard frog breeding habitat transects are presented in the springsnail and northern leopard frog sections of this report, respectively.

3.2.1 Standard Water Quality Data

Temperature, conductivity, pH, dissolved oxygen, velocity, and turbidity data were taken at springheads, midpoints, and endpoints along monitored channels. Most endpoints do not represent

Table 3-1
Area Summaries for Spring Sites in Spring and Fall 2009 by HMU Type and Total Aquatic Area

Site	Spring 2009			Fall 2009		
	Channel Area[a]	Pool Area[a]	Total Aquatic Area[a]	Channel Area[a]	Pool Area[a]	Total Aquatic Area[a]
Stonehouse Complex	807	1,072	1,879	214	246	460
Willow-NV Spring	173	209	382	136	34	170
Keegan Complex North	2,600	9,584	12,184	1,804	8,598	10,402
West Spring Valley Complex 1	762	512	1,274	700	347	1,047
Shoshone Ponds	0	679	679	0	629	629
South Millick Spring	1,351	0	1,351	1,501	71	1,572
Unnamed 5 Spring	1,249	1,402	2,651	1,106	1,651	2,757
Four Wheel Drive Spring	39	179	218	101	140	241
Willard Spring	6	30	36	0	0	0
Minerva Spring Complex Middle	417	161	578	323	214	537
Minerva Spring Complex North	451	1,307	1,758	359	1,201	1,560
Swallow Spring	800	102	902	709	100	809
North Little Spring	109	74	183	40	60	100
Big Springs	410	0	410	303	0	303
Big Springs Creek/Lake Creek Reach 1	Not monitored in spring			458	0	458
Big Springs Creek/Lake Creek Reach 2	Not monitored in spring			249	0	249
Big Springs Creek/Lake Creek Reach 3	Not monitored in spring			245	0	245
Big Springs Creek/Lake Creek Reach 4	Not monitored in spring			354	0	354
Big Springs Creek/Lake Creek Reach 5	Not monitored in spring			204	0	204
Unnamed 1 Spring North of Big	197	9	206	123	7	130
Stateline Springs	131	0	131	122	9	131

[a]Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

actual endpoints of the spring systems, but instead endpoints of designated sample areas. Data for springheads are presented only in association with monitored channels, even though additional springheads may have been sampled. The tables associated with this water-quality section include results for springheads, midpoints, endpoints, and mean values for springsnail transects.

3.2.1.1 Temperature

A general, but not absolute, trend of increasing temperature was evident downstream of the springhead. Temperatures ranged from a low of 48.4°F at Swallow Spring during the spring sampling event to a high of 79.2°F at Willow-NV Spring during the fall sampling event. Water temperatures can be expected to vary with time of day, amount of shading of the springbrook, and/or measurements made in a pool or riffle area. Water temperatures for each Stipulation spring are shown in Table 3-2.

3.2.1.2 Conductivity

No obvious trends in the spatial distribution of conductivity occurred within a given spring system during either the spring or fall sampling events. Conductivity ranged from a low of 74 µS/cm at Keegan Spring Complex North during the spring sampling event to a high of 720 µS/cm at Stonehouse Complex also during the spring sampling event.

Conductivity in the springbrook is influenced by temperature and possibly by plant photosynthesis (i.e., the result nutrient uptake and carbon dioxide utilization); thus conductivity may vary throughout daylight hours, especially during the summer months.

A summary of conductivity measurements for the spring and fall 2009 monitoring program is provided in Table 3-3.

3.2.1.3 pH

A general trend toward increasing pH was observed downstream of the springhead. The pH ranged from a low of 6.25 at Keegan Spring Complex North to a high of 8.85 at Stonehouse Complex; both pH measurements occurred during the spring sampling event.

The pH will rise with the increase in solar radiation in these springs as the result of aquatic photosynthesis, which consumes carbon dioxide, resulting in an increase in pH. Thus, pH values can be expected to decrease in the late afternoon hours and remain relatively low during the night.

A summary of pH measurements for the spring and fall 2009 monitoring program is provided in Table 3-4.

3.2.1.4 Dissolved Oxygen

A general trend toward increasing dissolved oxygen concentrations is apparent downstream of the springhead. Dissolved oxygen levels ranged from a low of 2.43 mg/L in Stonehouse Complex in the fall to a high of 16.58 mg/L in the spring at Keegan Spring Complex North.

Table 3-2
Water Temperature (°F) at Springs during Spring and Fall 2009

Site	Season	Springhead[a]	Midpoint[a]	Endpoint[a]	Transect Mean	Time
Stonehouse Complex	Spring	65.3	67.2	68.6	64.7	11:29-11:35
	Fall	60.8	70.1	74.7	66.4	11:56-12:16
Willow-NV Spring	Spring	55.6	76.6	61.1	60.8	12:42-13:52
	Fall	57.4	79.2	77.8	61.9	13:42-14:07
Keegan Spring Complex North	Spring	53.8	62.4	73.7	[b]	15:22-16:01
	Fall	53.9	61.5	64.6	[b]	14:17-14:36
West Spring Valley. Complex 1	Spring	67.4	67.8	69.1	68.5	10:50-12:21
	Fall	61.7	57.9	56.8	59.1	09:33-11:58
South Millick Spring	Spring	65.4	62.4	65.3	[b]	14:51-15:18
	Fall	59.5	59.8	61.9	[b]	15:37-15:52
Unnamed 5 Spring	Spring	59.8	64.3	64.8	[b]	09:30-10:42
	Fall	56.5	59.3	58.7	[b]	13:15-13:39
Four Wheel Drive Spring	Spring	62.3	77.5	69.9	[b]	13:37-13:54
	Fall	64.9	61.2	63.8	[b]	15:31-15:44
Willard Spring	Spring	63.3	[d]	[d]	[d]	14:58
	Fall	[e]	[e]	[e]	[e]	[e]
Minerva Spring Complex Mid Channel A	Spring	53.9	57.0	58.1	54.6	12:18-13:04
	Fall	53.0	54.2	55.7	53.6	09:47-10:09
Minerva Spring Complex Mid Channel B	Spring	55.1	58.5	59.0	56.0	14:17-15;16
	Fall	55.6	56.2	56.2	55.7	10:35-10:58
Minerva Spring Complex N. Channel A	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	54.9	61.6	65.7	61.0	11:59-12:32
Minerva Spring Complex N. Channel B	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	61.3	67.7	68.2	[b]	12:42-12:54
Swallow Spring	Spring	48.4	49.3	54.7	[b]	16:25-16:55
	Fall	50.7	51.6	55.2	[b]	12:27-12:49
North Little Spring	Spring	55.9	60.8	65.4	[b]	09:31-09:47
	Fall	57.9	56.0	57.1	[b]	10:02-10:07
Big Springs Channel A	Spring	63.1	63.7	63.7	63.3	10:30-11:08
	Fall	63.1	63.9	63.9	63.3	11:57-12:37
Big Springs Channel B	Spring	63.0	63.7	63.7	63.1	10:57-11:08
	Fall	63.1	63.9	63.9	63.5	11:57-12:19
Unnamed 1 Spring N. of Big Channel A	Spring	62.1	68.0	73.6	64.9	11:35-13:01
	Fall	56.1	57.2	55.3	56.2	09:38-10:29
Unnamed 1 Spring N. of Big Channel B	Spring	68.8	68.3	71.5	62.3	14:41-15:53
	Fall	56.4	57.2	55.3	58.4	09:38-11:18
Stateline Springs Channel A	Spring	66.3	60.7	64.1	61.4	14:32-15:10
	Fall	58.3	58.3	58.7	57.6	10:34-10:41

[a]Springhead, midpoint, and endpoint data were collected along a continuous channel. At some sites, additional springheads were sampled but are not displayed.
[b]No springsnail channel surveys.
[c]Data not collected in spring 2009 (field error).
[d]Not enough water for measurements.
[e]Willard Spring was dry in fall 2009.

Table 3-3
Specific Conductivity (µS/cm) at Springs during Spring and Fall 2009

Site	Season	Springhead[a]	Midpoint[a]	Endpoint[a]	Transect Mean	Time
Stonehouse Complex	Spring	381	380	720	411	11:29-11:35
	Fall	348	347	385	333	11:56-12:16
Willow-NV Spring	Spring	433	420	440	617	12:42-13:52
	Fall	431	590	473	401	13:42-14:07
Keegan Spring Complex North	Spring	74	74	84	[b]	15:22-16:01
	Fall	79	77	90	[b]	14:17-14:36
West Spring Val. Complex 1	Spring	364	307	327	384	10:50-12:21
	Fall	155	290	290	338	09:33-11:58
South Millick Spring	Spring	511	432	430	[b]	14:51-15:18
	Fall	442	456	455	[b]	15:37-15:52
Unnamed 5 Spring	Spring	328	308	308	328	09:30-10:42
	Fall	313	300	327	313	13:15-13:39
Four Wheel Drive Spring	Spring	284	45	283	[b]	13:37-13:54
	Fall	456	333	322	[b]	15:31-15:44
Willard Spring	Spring	231	[d]	[d]	[dc]	14:58
	Fall	[d]	[d]	[d]	[d]	[d]
Minerva Spring Complex Mid Channel A	Spring	376	375	367	375	12:18-13:04
	Fall	373	391	379	367	09:47-10:09
Minerva Spring Complex Mid Channel B	Spring	404	372	367	397	14:17-15;16
	Fall	609	377	380	396	10:35-10:58
Minerva Spring Complex N. Channel A	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	373	391	379	367	11:59-12:32
Minerva Spring Complex N. Channel B	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	247	245	262	[b]	12:42-12:54
Swallow Spring	Spring	257	304	295	[b]	16:25-16:55
	Fall	317	319	308	[b]	12:27-12:49
North Little Spring	Spring	323	312	338	[b]	09:31-09:47
	Fall	388	385	463	[b]	10:02-10:07
Big Springs Channel A	Spring	360	361	361	361	10:30-11:08
	Fall	390	392	391	390	11:57-12:37
Big Springs Channel B	Spring	362	361	361	362	10:57-11:08
	Fall	391	392	391	392	11:57-12:19
Unnamed 1 Spring N. of Big Channel A	Spring	420	402	419	408	11:35-13:01
	Fall	444	478	494	455	09:38-10:29
Unnamed 1 Spring N. of Big Channel B	Spring	481	402	419	492	14:41-15:53
	Fall	456	478	494	475	09:38-11:18
Stateline Springs Channel A	Spring	363	596	360	437	14:32-15:10
	Fall	373	373	373	372	10:34-10:41

[a]Springhead, midpoint, and endpoint data were collected along a continuous channel. At some sites, additional springheads were sampled but are not displayed.
[b]No springsnail channel surveys.
[c]Data not collected in spring 2009 (field error).
[d]No standing water.

Table 3-4
pH at Springs during Spring and Fall 2009

Site	Season	Springhead[a]	Midpoint[a]	Endpoint[a]	Transect Mean	Time
Stonehouse Complex	Spring	7.63	8.30	8.85	7.60	11:29-11:35
	Fall	7.26	7.07	7.08	7.26	11:56-12:16
Willow-NV Spring	Spring	7.22	8.35	7.71	7.68	12:42-13:52
	Fall	7.33	7.32	7.64	7.61	13:42-14:07
Keegan Spring Complex North	Spring	6.63	7.38	7.49	[b]	15:22-16:01
	Fall	6.25	7.47	7.21	[b]	14:17-14:36
West Spring Val. Complex 1	Spring	7.42	8.10	8.48	7.35	10:50-12:21
	Fall	7.31	7.40	7.46	7.29	09:33-11:58
South Millick Spring	Spring	7.66	7.88	8.05	[b]	14:51-15:18
	Fall	7.50	7.62	7.75	[b]	15:37-15:52
Unnamed 5 Spring	Spring	7.30	8.24	8.27	7.30	09:30-10:42
	Fall	7.46	7.38	7.09	7.46	13:15-13:39
Four Wheel Drive Spring	Spring	8.25	8.51	7.93	[b]	13:37-13:54
	Fall	6.87	6.97	7.56	[b]	15:31-15:44
Willard Spring	Spring	8.04	[d]	[d]	[d]	14:58
	Fall	[d]	[d]	[d]	[d]	[d]
Minerva Spring Complex Mid Channel A	Spring	7.59	7.70	7.78	7.67	12:18-13:04
	Fall	8.08	7.71	8.09	8.14	09:47-10:09
Minerva Spring Complex Mid Channel B	Spring	7.64	7.66	7.42	7.71	14:17-15;16
	Fall	8.15	7.90	8.17	8.22	10:35-10:58
Minerva Spring Complex N. Channel A	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	8.45	8.54	8.57	8.57	11:59-12:32
Minerva Spring Complex N. Channel B	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	9.45	9.25	8.67	[b]	12:42-12:54
Swallow Spring	Spring	7.27	7.82	7.97	[b]	16:25-16:55
	Fall	7.19	7.95	8.28	[b]	12:27-12:49
North Little Spring	Spring	7.49	8.12	8.06	[b]	09:31-09:47
	Fall	7.43	7.76	7.31	[b]	10:02-10:07
Big Springs Channel A	Spring	7.49	7.55	7.56	7.50	10:30-11:08
	Fall	7.52	7.56	7.65	7.54	11:57-12:37
Big Springs Channel B	Spring	7.51	7.55	7.56	7.51	10:57-11:08
	Fall	7.47	7.56	7.65	7.49	11:57-12:19
Unnamed 1 Spring N. of Big Channel A	Spring	7.70	7.95	8.13	7.84	11:35-13:01
	Fall	7.59	7.77	7.80	7.76	09:38-10:29
Unnamed 1 Spring N. of Big Channel B	Spring	7.58	7.95	8.13	7.87	14:41-15:53
	Fall	7.48	7.77	8.13	7.66	09:38-11:18
Stateline Springs Channel A	Spring	7.86	8.08	8.06	[b]	14:32-15:10
	Fall	7.58	7.58	7.63	[b]	10:34-10:41

[a]Springhead, midpoint, and endpoint data were collected along a continuous channel. At some sites, additional springheads were sampled but are not displayed.
[b]No springsnail channel surveys.
[c]Data not collected in spring 2009 (field error).
[d]No standing water.

Dissolved oxygen levels in these spring systems can be affected by several factors. Turbulence at the air-water interface affects dissolved oxygen levels, especially in shallow spring systems. Aquatic plant and algae photosynthesis will increase dissolved oxygen concentrations. An increase in water temperature will reduce the amount of dissolved oxygen that can be retained in a body of water. Sediment-laden sections of springbrooks may contain low dissolved oxygen levels and may remove dissolved oxygen from the water column above.

A summary of dissolved oxygen levels for the spring and fall 2009 Stipulation monitoring program is provided in Table 3-5.

3.2.1.5 Velocity

Springbrook velocities varied between springs from a low of <0.01 ft/sec in ponded sections (e.g., Four Wheel Drive Spring, West Spring Valley Complex 1, Unnamed 5 Spring, Willow-NV Spring) to a high of 2.9 ft/sec at Swallow Spring. It was not possible to measure velocity at some sites because of extensive aquatic vegetation and/or the shallowness of the water.

A summary of velocity levels for the spring and fall 2009 Stipulation monitoring program is provided in Table 3-6.

3.2.1.6 Turbidity

No clearly definable patterns existed in the distribution of turbidity within any given spring system during either the spring or fall 2009 sampling events. Turbidity tended to be higher during the fall 2009 sampling event, but this was probably due to the difficulty in obtaining representative turbidity samples because of shallow water and/or extensive vegetation cover in many of the springbrooks at that time.

A summary of turbidity levels for the spring and fall 2009 Stipulation monitoring program is provided in Table 3-7.

3.2.2 Nitrogen and Phosphorus

Nitrogen (N) and phosphorus (P) samples were taken at one springhead per spring site. For each site, the springhead location where the nitrogen and phosphorus samples were taken coincided with one of the springheads where standard water-quality data were taken, as with well as the springhead where the temperature logger was placed.

Total N and P concentrations tended to be higher during the fall 2009 sampling event as compared to the spring 2009 sampling event. Large differences in concentrations between the spring and fall sampling events (e.g., Four Wheel Drive Spring) were due to entrainment of sediments during sample collection. As a result, these sediments provide a significant reservoir of nutrients to support aquatic plant growth.

Table 3-5
Dissolved Oxygen Levels (mg/L) at Springs during Spring and Fall 2009

Site	Season	Springhead[a]	Midpoint[a]	Endpoint[a]	Transect Mean	Time
Stonehouse Complex	Spring	6.08	11.17	14.59	7.38	11:29-11:35
	Fall	5.57	4.63	2.43	6.02	11:56-12:16
Willow-NV Spring	Spring	5.37	12.83	8.89	9.90	12:42-13:52
	Fall	3.56	6.54	4.06	6.05	13:42-14:07
Keegan Spring Complex North	Spring	11.48	16.58	13.72	[b]	15:22-16:01
	Fall	5.93	11.23	8.23	[b]	14:17-14:36
West Spring Valley Complex 1	Spring	6.13	7.84	8.88	3.72	10:50-12:21
	Fall	8.31	7.87	8.82	6.35	09:33-11:58
South Millick Spring	Spring	6.60	8.74	9.57	[b]	14:51-15:18
	Fall	6.79	7.95	8.28	[b]	15:37-15:52
Unnamed 5 Spring	Spring	9.37	14.32	15.36	[b]	09:30-10:42
	Fall	7.46	7.56	7.36	[b]	13:15-13:39
Four Wheel Drive Spring	Spring	15.75	8.78	8.50	[b]	13:37-13:54
	Fall	4.04	4.63	6.17	[b]	15:31-15:44
Willard Spring	Spring	8.04	[d]	[d]	[d]	14:58
	Fall	[d]	[d]	[d]	[d]	[d]
Minerva Spring Complex Mid Channel A	Spring	10.22	10.16	12.32	10.60	12:18-13:04
	Fall	8.04	7.15	10.35	8.41	09:47-10:09
Minerva Spring Complex Mid Channel B	Spring	8.19	8.21	7.57	8.52	14:17-15;16
	Fall	8.23	8.21	8.23	7.53	10:35-10:58
Minerva Spring Complex N. Channel A	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	8.04	7.15	10.35	8.41	11:59-12:32
Minerva Spring Complex N. Channel B	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	8.04	7.15	10.35	8.41	12:42-12:54
Swallow Spring	Spring	8.49	8.72	8.52	[b]	16:25-16:55
	Fall	7.69	8.55	8.16	[b]	12:27-12:49
North Little Spring	Spring	7.21	10.01	7.40	[b]	09:31-09:47
	Fall	6.94	7.70	7.48	[b]	10:02-10:07
Big Springs Channel A	Spring	5.05	5.42	5.52	5.21	10:30-11:08
	Fall	5.25	5.48	5.78	5.25	11:57-12:37
Big Springs Channel B	Spring	5.19	5.42	5.52	5.08	10:57-11:08
	Fall	5.19	5.42	5.52	5.16	11:57-12:19
Unnamed 1 Spring N. of Big Channel A	Spring	6.47	8.22	7.38	6.29	11:35-13:01
	Fall	6.54	7.18	7.58	6.90	09:38-10:29
Unnamed 1 Spring N. of Big Channel B	Spring	5.50	7.18	7.58	6.29	14:41-15:53
	Fall	6.86	7.18	7.58	6.56	09:38-11:18
Stateline Springs Channel A	Spring	4.49	5.87	5.88	5.83	14:32-15:10
	Fall	5.57	5.57	5.91	5.39	10:34-10:41

[a]Springhead, midpoint, and endpoint data were collected along a continuous channel. At some sites, additional springheads were sampled but are not displayed.
[b]No springsnail channel surveys.
[c]Data not collected in spring 2009 (field error).
[d]No standing water.

Table 3-6
Springbrook Velocity (ft/sec) at Springs during Spring and Fall 2009

Site	Season	Springhead[a]	Midpoint	Endpoint	Time
Stonehouse Complex	Spring	[b]	1.21	1.08	11:29-11:35
	Fall	[b]	[b]	[b]	11:56-12:16
Willow-NV Spring	Spring	[b]	[b]	<0.01	12:42-13:52
	Fall	[b]	[b]	[b]	13:42-14:07
Keegan Spring Complex North	Spring	0.78	0.75	0.03	15:22-16:01
	Fall	[b]	[b]	[b]	14:17-14:36
West Spring Val. Complex 1	Spring	<0.01	0.20	0.13	10:50-12:21
	Fall	[b]	[b]	[b]	09:33-11:58
South Millick Spring	Spring	[b]	[b]	[b]	14:51-15:18
	Fall	[b]	[b]	[b]	15:37-15:52
Unnamed 5 Spring	Spring	<0.01	<0.01	0.20	09:30-10:42
	Fall	[b]	[b]	[b]	13:15-13:39
Four Wheel Drive Spring	Spring	<0.01	<0.01	<0.01	13:37-13:54
	Fall	[b]	[b]	[b]	15:31-15:44
Willard Spring	Spring	[b]	[d]	[d]	14:58
	Fall	[d]	[d]	[d]	[d]
Minerva Spring Complex Mid Channel A	Spring	[b]	<0.01	<0.01	12:18-13:04
	Fall	[b]	[b]	[b]	09:47-10:09
Minerva Spring Complex Mid Channel B	Spring	[b]	[b]	0.03	14:17-15;16
	Fall	[b]	[b]	[b]	10:35-10:58
Minerva Spring Complex N. Channel A	Spring	[c]	[c]	[c]	[c]
	Fall	[b]	[b]	[b]	11:59-12:32
Minerva Spring Complex N. Channel B	Spring	[c]	[c]	[c]	[c]
	Fall	[b]	[b]	[b]	12:42-12:54
Swallow Spring	Spring	2.95	0.56	0.75	16:25-16:55
	Fall	[b]	[b]	[b]	12:27-12:49
North Little Spring	Spring	<0.01	0.69	[b]	09:31-09:47
	Fall	[b]	[b]	[b]	10:02-10:07
Big Springs Channel A	Spring	0.69	[b]	[b]	10:30-11:08
	Fall	[b]	[b]	[b]	11:57-12:37
Big Springs Channel B	Spring	[b]	[b]	[b]	10:57-11:08
	Fall	[b]	[b]	[b]	11:57-12:19
Unnamed 1 Spring N. of Big Channel A	Spring	[b]	[b]	[b]	11:35-13:01
	Fall	[b]	[b]	[b]	09:38-10:29
Unnamed 1 Spring N. of Big Channel B	Spring	[b]	[b]	[b]	14:41-15:53
	Fall	[b]	[b]	[b]	09:38-11:18
Stateline Springs Channel A	Spring	[b]	[b]	0.79	14:32-15:10
	Fall	[b]	[b]	[b]	10:34-10:41

[a]Springhead, midpoint, and endpoint data were collected along a continuous channel. At some sites, additional springheads were sampled but are not displayed.
[b]Unable to measure velocity because of shallow or muddy water, extensive aquatic vegetation, or wind.
[c]Data not collected in spring 2009 (field error).
[d]No standing water.

Table 3-7
Turbidity Levels (NTU) at Springs during Spring and Fall 2009

Site	Season	Springhead[ab]	Midpoint[ab]	Endpoint[ab]	Transect Mean	Time
Stonehouse Complex	Spring	51.6	7.90	7.40	20.1	11:29-11:35
	Fall	14.6	20.1	26.9	24.2	11:56-12:16
Willow-NV Spring	Spring	3.30	6.80	6.20	21.2	12:42-13:52
	Fall	21.5	40.1	65.8	36.3	13:42-14:07
Keegan Spring Complex North	Spring	1.70	6.60	9.80	[c]	15:22-16:01
	Fall	2.10	7.20	3.50	[c]	14:17-14:36
West Spring Valley Complex 1	Spring	7.00	6.00	5.00	28.7	10:50-12:21
	Fall	5.00	1.10	1.00	26.7	09:33-11:58
South Millick Spring	Spring	12.6	4.90	6.10	[c]	14:51-15:18
	Fall	2.90	8.20	10.2	[c]	15:37-15:52
Unnamed 5 Spring	Spring	78.9	6.90	3.50	[c]	09:30-10:42
	Fall	23.70	7.10	4.30	[c]	13:15-13:39
Four Wheel Drive Spring	Spring	9.70	22.7	7.00	[c]	13:37-13:54
	Fall	6.90	657	>1000	[c]	15:31-15:44
Willard Spring	Spring	1.60	[d]	[d]	[d]	14:58
	Fall	[de]	[de]	[de]	[de]	[de]
Minerva Spring Complex Mid Channel A	Spring	1.10	1.50	1.00	0.60	12:18-13:04
	Fall	0.80	1.40	7.20	2.80	09:47-10:09
Minerva Spring Complex Mid Channel B	Spring	1.20	3.20	1.20	1.75	14:17-15;16
	Fall	1.43	2.19	5.94	5.03	10:35-10:58
Minerva Spring Complex N. Channel A	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	1.08	13.9	11.2	13.9	11:59-12:32
Minerva Spring Complex N. Channel B	Spring	[c]	[c]	[c]	[c]	[c]
	Fall	6.15	23.7	8.70	[c]	12:42-12:54
Swallow Spring	Spring	0.90	0.60	1.90	[c]	16:25-16:55
	Fall	0.20	0.50	4.20	[c]	12:27-12:49
North Little Spring	Spring	4.10	2.10	34.4	[c]	09:31-09:47
	Fall	6.30	12.4	172	[c]	10:02-10:07
Big Springs Channel A	Spring	0.30	2.00	1.00	0.50	10:30-11:08
	Fall	2.00	3.20	2.50	1.70	11:57-12:37
Big Springs Channel B	Spring	0.80	2.00	1.00	0.74	10:57-11:08
	Fall	0.84	3.20	2.50	1.63	11:57-12:19
Unnamed 1 Spring N. of Big Channel A	Spring	0.50	6.00	12.1	9.80	11:35-13:01
	Fall	1.70	1.60	10.7	133	09:38-10:29
Unnamed 1 Spring N. of Big Channel B	Spring	0.90	6.00	12.1	7.88	14:41-15:53
	Fall	1.76	1.60	10.7	28.3	09:38-11:18
Stateline Springs Channel A	Spring	1.00	1.00	16.0	8.30	14:32-15:10
	Fall	3.80	3.80	5.30	4.20	10:34-10:41

[a]Springhead, midpoint, and endpoint data were collected along a continuous channel. At some sites, additional springheads were sampled but are not displayed.
[b]Some values may be a result of excess sedimentation in samples.
[c]No springsnail channel surveys.
[d] Data not collected in spring 2009 (field error).
[e]Willard Spring was dry in fall 2009.

Based on the N:P ratios near the springheads, it is evident that phosphorus would represent the limiting plant nutrient entering these spring systems. However, as noted above, the springbrook sediments store large amounts of both nitrogen and phosphorus, and it is probable that these spring systems do not experience nutrient limitation under normal circumstances.

Total N and P levels for the spring and fall 2009 Stipulation monitoring program are shown in Table 3-8.

Table 3-8
Total Nitrogen and Phosphorus Concentrations (µg/L) at Springs during Spring and Fall 2009

Site	Season	Total Nitrogen[a]	Total Phosphorus[a]
Stonehouse Complex	Spring	[b]	[b]
	Fall	3,000	69
Willow-NV Spring	Spring	<100	100
	Fall	440	78
Keegan Spring Complex North	Spring	320	28
	Fall	420	35
West Spring Valley Complex 1	Spring	[b]	[b]
	Fall	720	29
South Millick Spring	Spring	580	12
	Fall	680	16
Unnamed 5 Spring	Spring	520	100
	Fall	750	10
Four Wheel Drive Spring	Spring	230	<10
	Fall	29,000	6,200
Willard Spring	Spring	440	25
	Fall	[c]	[c]
Minerva Spring Complex Middle Springhead A	Spring	630	<10
	Fall	630	10
Minerva Spring Complex North Springhead A	Spring	[b]	[b]
	Fall	440	22
Swallow Spring	Spring	210	<10
	Fall	240	<10
North Little Spring	Spring	1,600	40
	Fall	310	270
Big Springs Springhead B	Spring	520	<10
	Fall	670	22
Unnamed 1 Spring North of Big Springhead A	Spring	1,900	61
	Fall	240	<10
Stateline Springs Springhead A	Spring	1,600	<10
	Fall	1,600	32

[a]Some values may be a result of excess sedimentation in samples.
[b]Data not collected in spring 2009 (field error).
[c]Willard Spring was dry in fall 2009.

3.2.3 Temperature Logger Data

Grand means between May and September 2009 ranged from a low of 48.6°F at Swallow Spring to a high of 63.0°F at Big Springs. Swallow Spring and Willow-NV Spring demonstrated the greatest change in temperature across monthly means (3.0°F and 3.9°F, respectively), while water temperature at Big Springs remained nearly constant during that period.

The results of the May to August 2009 temperature recordings are shown as monthly means and ranges plus a grand mean in Table 3-9.

Table 3-9
Monthly Summaries of 2009 Temperature Logger Data (Water Temperature °F) for Springs

Site		May	June	July	August	Grand Mean
Stonehouse Complex	Mean					
	Range					
Willow-NV Spring	Mean	**49.5**	**50.4**	**51.6**	**52.7**	**51.5**
	Range	49.3 - 50.0	49.3 - 51.0	50.8 - 52.5	52.2 - 53.6	49.3 - 53.7
Keegan Spring Complex North	Mean	**52.6**	**52.6**	**53.0**	**53.0**	
	Range	51.5-54.3	51.6-54.9	52.1-56.8	52.4-54.1	
West Spring Valley Complex 1	Mean	**60.1**	**60.1**	**61.7**	**61.3**	**60.8**
	Range	55.9 - 65.7	56.1 - 63.9	57.1 - 66.5	55.1 - 66.6	55.1 - 66.6
South Millick Spring	Mean	**54.0**	**54.7**	**55.7**	**56.5**	**55.7**
	Range	51.7 - 57.5	52.9 - 56.3	54.0 - 56.9	51.3 - 63.9	46.7 - 63.9
Unnamed 5 Spring	Mean					
	Range					
Four Wheel Drive Spring	Mean					
	Range					
Willard Spring	Mean					
	Range					
Minerva Spring Complex Middle Springhead A	Mean	**52.0**	**52.6**	**53.3**	**53.2**	**52.9**
	Range	50.5 - 53.7	51.1 - 54.5	51.7 - 55.9	51.9 - 54.3	50.5 - 55.9
Minerva Spring Complex North Springhead A	Mean					
	Range					
Swallow Spring	Mean	**47.4**	**47.3**	**48.3**	**49.7**	**48.6**
	Range	46.9 - 48.2	46.9 - 47.6	47.6 - 49.0	49.0 - 50.6	46.9 - 51.3
North Little Spring	Mean					
	Range					
Big Springs Springhead B	Mean	**62.9**	**62.9**	**63.0**	**63.0**	**63.0**
	Range	62.7 - 63.0	62.9 - 63.0	62.9 - 63.0	63.0 - 63.0	62.7 - 63.1
Unnamed 1 Spring North of Big Springhead A	Mean	**54.9**	**55.1**	**55.6**	**55.9**	**55.4**
	Range	49.1 - 62.2	50.5 - 58.9	54.6 - 57.3	54.2 - 58.7	49.1 - 62.2
Stateline Springs Springhead A	Mean	**57.2**	**57.3**	**57.4**	**57.5**	**57.4**
	Range	57.0 - 57.4	57.1 - 57.5	57.3 - 57.6	57.4 - 57.8	57.0 - 57.8

Note: Blanks in the table represent sites where the temperature loggers were unable to be retrieved in September 2009, no data are available for May through August 2009 for these sites.

Time-series plots of temperature logger recordings for May to August 2009 are shown in Appendix C. This figure serves mainly to demonstrate the uniqueness of springhead temperature regimes across site, and does not include all sites.

Seven temperature loggers were not found during the fall 2009 survey, most likely because of extensive vegetation growth, sinkage, or theft. In those cases, a new logger was installed, and GPS locations were recorded. Six loggers were not found in January 2010.

3.3 Springnails

Springsnail sampling was conducted at nine spring sites in 2009. Clay Spring in Snake Valley was to be an additional springsnail monitoring site, however, access was denied. While access was denied for the 2009 field season, there is potential for access to be granted in the upcoming 2010 field season. Linear springsnail extents occurred at eight of the nine sites. Four sites were sampled for springsnails along one channel (Stonehouse Complex, Willow-NV, West Spring Valley Complex, and Minerva Spring Complex North), while the remaining four sites were sampled for springsnails along two channels (Minerva Spring Complex Middle, Big Springs, Unnamed 1 Spring North of Big, and Stateline Springs). At the ninth site, Unnamed 5 Spring, springsnail sampling was conducted only at the springhead because the site lacked a linear springsnail extent. Other sites, such as Stonehouse Complex and Stateline Springs, received additional sampling at individual springheads where no linear springsnail extent occurred; these data are included in the data set but are not discussed in this report. Minerva Spring Complex North was not sampled in spring 2009 because of field error, and Stateline Channel B was not sampled in fall 2009 because no springsnails were observed.

Table 3-10 shows the following summary data: length of springsnail extent, total springsnail count, mean springsnail density (mean count per sample point), and minimum, maximum, and standard deviation counts per sample point. Minerva Spring Complex North, Unnamed 1 Spring North of Big (Channels A and B), and West Spring Valley Complex had the longest springsnail extents and the highest springsnail counts.

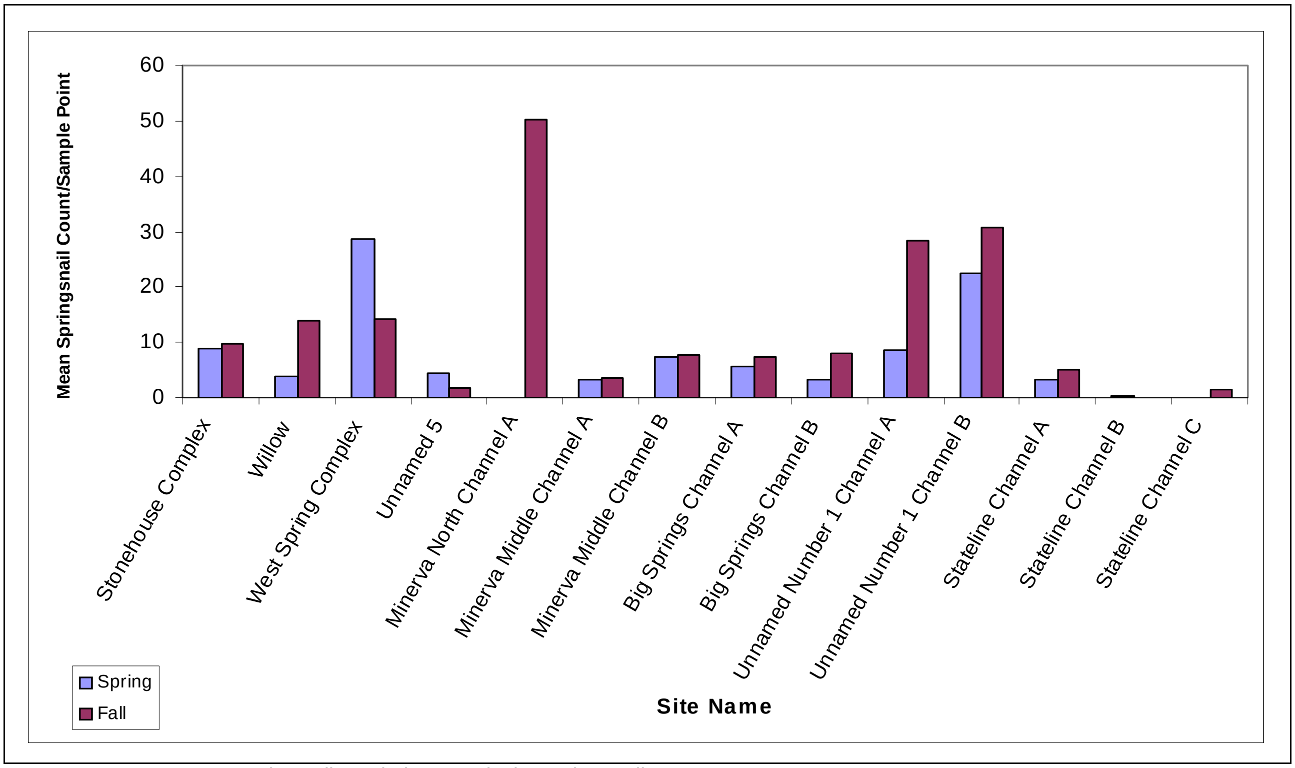
In general, springsnail extent was similar across seasons for each site. Of the 10 channels where abundance and distribution data were collected for both spring and fall 2009, six did not appear to show much seasonal difference in springsnail extent, total springsnail count, or mean springsnail density per sample point (Table 3-10 and Figure 3-1). At three channels (Unnamed 1 Spring North of Big – Channel A, Big Springs – Channel B, and Willow-NV Spring), extent remained relatively constant from spring to fall, but mean density per sample point more than doubled or tripled, suggesting that overall springsnail counts may have increased in the fall. At one channel (West Spring Valley Complex), extent nearly doubled from spring to fall, but mean density per sample point decreased by approximately half in the fall, suggesting that distribution changed but overall springsnail counts may have remained relatively constant. Distributions of springsnails, represented by charting mean density per sample point for each transect by transect distance from springhead, are presented for each site in Appendix D.

Habitat data were also collected at springsnail sampling locations. Temperature, dissolved oxygen, conductivity, pH, and turbidity were taken at the center of each springsnail transect, and water velocity, water depth, and percent emergent vegetation cover were collected at each springsnail

Table 3-10
Springsnail Counts at Spring Sites, Spring and Fall 2009

Site	Season	Extent (m)[a]	Transects [a]	Sample Points [a]	Total Springsnail Count [a]	Density (mean count/ sample point) [a]	Minimum Point	Maximum Point	Standard Error
Stonehouse Complex[b]	Spring	20.3	9	45	397	8.82	0	71	1.95
	Fall	21.3	9	45	395	9.7	0	62	1.90
Willow-NV Spring[b]	Spring	19.7	10	50	191	3.82	0	26	0.67
	Fall	22.1	10	41	566	13.8	0	62	2.35
West Spring Val. Complex 1[b]	Spring	28.6	12	37	1061	28.68	0	163	6.74
	Fall	47.6	15	68	973	14.31	0	147	3.53
Unnamed 5 Spring[b]	Spring	N/A[c]	N/A[c]	3	13	4.33	1	9	2.40
	Fall	N/A[c]	1	5	9	1.8	0	6	1.11
Minerva Spring Complex N.[b]	Spring	d	d	d	d	d	d	d	d
Channel A	Fall	98.2	20	89	4470	50.22	0	304	5.08
Minerva Spring Complex Mid.[b]	Spring	32.5	13	65	213	3.28	0	46	0.76
Channel A	Fall	30.6	14	70	245	3.5	0	19	0.57
Minerva Spring Complex Mid.[b]	Spring	31.4	14	54	358	7.33	0	74	1.94
Channel B	Fall	28.1	14	62	374	7.74	0	94	2.10
Big Springs[e]	Spring	15.7	7	35	192	5.49	0	26	1.14
Channel A	Fall	14.1	7	35	257	7.34	0	71	2.43
Big Springs[e]	Spring	13.6	10	50	165	3.3	0	15	0.54
Channel B	Fall	12.3	8	40	321	8.03	0	71	1.99
Unnamed 1 Spring N. of Big[e]	Spring	56.9	20	100	862	8.62	0	114	1.61
Channel A	Fall	58.8	20	100	2846	28.46	0	244	4.62
Unnamed 1 Spring N. of Big[e]	Spring	52.3	20	100	2235	22.35	0	167	3.67
Channel B	Fall	47.2	20	100	3085	30.85	0	227	4.13
Stateline Springs[e]	Spring	13.8	3	15	48	3.2	0	25	1.65
Channel A	Fall	12.4	3	15	77	5.13	0	21	1.79
Stateline Springs[e]	Spring	8.2	4	13	3	0.23	0	2	0.17
Channel B	Fall	f	f	f	f	f	f	f	f
Stateline Springs[g]	Spring	g	4	15	100	g	0	47	2.46
Channel C	Fall	13.2	3	19	14	29.47	0	3	0.23

[a]Data represent samples collected along a particular springsnail extent. At some sites, additional springheads were sampled but are not displayed.
[b]*Pyrgulopsis kolobensis*
[c]No linear springsnail extent. Grab samples were taken in the spring, and one transect was run in the fall.
[d]Data not collected in spring 2009 (field error).
[e]*Pyrgulopsis anguina* (*Pyrgulopsis* found at these springs is assumed to be *anguina* species based on (Bio-West, 2009)
[f]No standing water; no springsnails found.
[g]Several springheads within the complex were sampled as grab samples in the fall; one springhead and channel were sampled in the fall.



Note: Data represent samples collected along particular springsnail extent.
[a] Density (mean springsnail count/sample point) more than doubled or tripled from spring to fall, while extent remained similar, suggesting an increase in overall springsnail count in the fall in Big Springs Channel B, Unnamed 1A, and Willow.
[b] Density (mean springsnail count/sample point) decreased by approximately 50% from spring to fall, while extent nearly doubled, suggesting a change in distribution but not overall springsnail count.

Figure 3-1
Springsnail Density (Mean Springsnail Count per Sample Point), Spring and Fall 2009

sample point. The mean of each of these variables was calculated for each springsnail extent, shown in Table 3-11.

Distribution of springsnails along extents was explored by charting mean springsnail count/transect against distance from the springhead. Higher springsnail numbers often occurred just below the springhead and throughout the middle of the system, and numbers decreased toward the end of the springsnail extents in both spring and fall. Distribution graphs are provided in Appendix D.

3.4 Macroinvertebrates

Macroinvertebrate monitoring ascertains the seasonal and annual variation in macroinvertebrate assemblage composition and richness over time. Potential changes in macroinvertebrate abundance and species composition would allow for the assessment of linkages between changes in habitat and water-quality conditions (Biological Work Group, 2009).

A summary of the percentage of relative abundance (percent of the total sample count) for non-insects, insect orders, and the family Chironomidae for the spring and fall 2009 Stipulation monitoring program is shown in Table 3-12.

Table 3-11
Mean-Water Quality Data Taken at Springsnail Transects, Spring and Fall 2009

Site	Season	Time	Water Temperature (°F)[a]	Conductivity (µS/cm)[a]	pH	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Velocity (ft/sec)[a]
Stonehouse Complex[b]	Spring	11:29-11:35	64.68	410.81	7.60	7.38	20.08	N/A
	Fall	11:56-12:16	66.40	333.33	7.26	6.02	24.18	N/A
Willow-NV Spring[b]	Spring	12:42-13:52	60.82	617.24	7.68	9.90	21.23	N/A
	Fall	13:42-14:07	61.88	400.80	7.61	6.05	36.27	N/A
West Spring Valley Complex 1[b]	Spring	10:50-12:21	68.45	383.92	7.35	3.52	28.67	0.20
	Fall	09:33-11:58	59.08	337.89	7.29	6.35	26.69	N/A
Unnamed 5 Spring[b]	Spring	09:30-10:42	59.80	327.60	7.30	9.40	78.90	0.00
	Fall	13:15-13:39	56.50	313.00	7.46	7.46	23.70	0.00
Minerva Spring Complex Middle[b] Channel A	Spring	12:18-13:04	54.56	375.32	7.67	10.60	0.60	N/A
	Fall	09:47-10:09	53.58	367.29	8.14	8.41	2.81	0.23
Minerva Spring Complex Middle[b] Channel B	Spring	14:17-15;16	56.01	397.06	7.71	8.50	1.69	N/A
	Fall	10:35-10:58	56.02	398.36	8.22	7.33	4.73	N/A
Minerva Spring Complex North[b] Channel	Spring	[d]	N/A	N/A	N/A	N/A	N/A	N/A
	Fall	11:59-12:32	60.79	282.68	8.57	7.58	13.87	0.10
Big Springs[c] Channel A	Spring	10:30-11:08	63.27	361.33	7.50	5.21	0.49	1.05
	Fall	11:57-12:37	63.33	390.14	7.54	5.25	1.71	N/A
Big Springs[c] Channel B	Spring	10:57-11:08	63.12	361.70	7.51	5.08	0.74	0.36
	Fall	11:57-12:19	63.45	392.25	7.49	5.16	1.63	N/A
Unnamed 1 Spring North of Big[c] Channel A	Spring	11:35-13:01	64.92	407.95	7.84	6.29	9.83	N/A
	Fall	09:38-10:29	56.24	454.60	7.76	6.90	236.26	N/A
Unnamed 1 Spring North of Big[c] Channel B	Spring	14:41-15:53	62.26	492.28	7.87	6.29	7.88	N/A
	Fall	09:38-11:18	58.42	474.55	7.66	6.57	27.00	N/A
Stateline Springs Channel C	Spring	10:44-11:01	58.99	389.64	7.79	5.74	10.79	N/A
	Fall	10:04-10:21	56.68	373.00	7.58	5.42	3.26	N/A
Stateline Springs[c] Channel A	Spring	14:32-15:10	62.53	487.87	8.02	5.48	2.00	0.36
	Fall	10:34-10:41	57.97	370.67	7.65	5.08	2.32	N/A
Stateline Springs[c] Channel B	Spring	9:17-9:33	60.00	408.60	7.93	6.40	19.25	N/A
	Fall	[e]	[e]	[e]	[e]	[e]	[e]	[e]

[a]Unable to measure velocity at the majority of points within the transect because of shallow or muddy water, extensive aquatic vegetation, or wind.
[b]*Pyrgulopsis kolobensis*
[c]*Pyrgulopsis anguina*
[d]Data not collected in spring 2009 (field error).
[e]No springsnails found

Table 3-12
Percent Relative Abundance of Macroinvertebrates for Spring and Fall 2009 Monitoring Program

Category	Season	Big Springs	Big Spring Creek[a]	Keegan	Minerva North[a]	Minerva Middle	South Millick	Stateline	Stonehouse	Swallow	Unnamed 1 North of Big	Unnamed 5	West Spring Complex	Willow
Non-Insect	Spring	77.42		36.67		79.67	97.88	92.43	74.00	87.33	92.12	74.33	73.67	76.33
	Fall	91.50	67.31	60.60	76.64	83.33	97.43	89.29	96.27	78.39	89.88	71.67	69.40	74.67
Odonata	Spring	b		1.33		0.33	b	b	0.33	b	2.73	1.00	0.67	1.33
	Fall	0.65	4.85	10.60	11.53	0.33	0.32	b	1.55	b	3.99	10.67	0.63	1.00
Ephemeroptera	Spring	b		b		b	b	b	a	b	b	b	b	b
	Fall	0.33	13.59	6.62	5.92	b	b	1.30	a	4.19	b	10.33	b	0.33
Plecoptera	Spring	b		b		1.00	b	b	a	0.33	b	b	b	b
	Fall	b	b	b	b	b	b	b	a	0.32	b	b	b	b
Heteroptera	Spring	7.94		0.67		b	b	b	5.67	b	b	3.67	b	0.67
	Fall	b	0.97	0.66	b	b	1.29	0.32	0.31	b	b	1.67	b	b
Trichoptera	Spring	1.61		1.33		2.00	1.21	0.95	b	8.33	2.12	3.00	b	1.00
	Fall	1.31	4.85	1.66	b	1.33	0.32	2.92	b	8.71	1.53	0.33	1.26	b
Coleoptera	Spring	0.32		1.67		0.33	0.91	0.63	0.33	3.00	0.30	0.33	2.00	0.33
	Fall	b	b	0.99	b	b	0.32	0.65	0.62	1.29	0.31	0.33	4.10	b
Diptera	Spring	1.61		9.00		b	b	0.32	3.33	1.00	0.30	9.67	5.33	13.33
	Fall	b	1.29	2.65	b	b	0.32	0.97	0.93	1.29	0.92	0.33	0.95	13.00
Chironomidae	Spring	17.10		49.33		16.67	b	5.68	16.33	b	2.42	8.00	18.33	7.00
	Fall	6.21	7.12	16.23	5.92	15.00	b	4.55	0.31	5.81	3.37	4.67	23.66	11.00

[a]Not sampled during spring 2009 sampling event.
[b]Not found in composite sample.

A few generalizations can be made from the first year of monitoring. Non-insect taxa, mostly amphipods, ostracods and gastropods, make up more than 65 percent of the macroinvertebrates in all of the springs sampled during both seasons, with the exception of Keegan Spring Complex North. Chironomids tended to be the most numerous insects at most of the springs. No Ephemeroptera (mayflies) were identified at any sampled spring during the spring 2009 sampling event but were recorded at 8 of the 13 composite samples during the fall 2009 sampling event.

For the purposes of this report, macroinvertebrate "richness" in the surveyed spring systems is simply defined as the number of taxa identified in the composited sample from any given spring system. EPT richness (i.e., the sum of Ephemeroptera, Plecoptera, and Trichoptera taxa in each composite spring sample) is often used as a measure of pollution or habitat degradation as insects in these three orders are considered sensitive to changes in the aquatic environment. Taxa and EPT richness determinations for the surveyed spring systems are summarized in Table 3-13.

Table 3-13
Macroinvertebrate Taxa and EPT Richness Measures for Spring and Fall 2009 Monitoring Program

Site	Taxa Richness		EPT Richness	
	Spring	Fall	Spring	Fall
Stonehouse Complex	41	41	2	2
Willow-NV Spring	13	19	1	2
Keegan Spring Complex North	32	20	2	1
West Spring Valley Complex	11	24	2	5
South Millick Spring	18	16	0	1
Unnamed 5 Spring	12	20	2	4
Minerva Spring Complex Middle	25	21	1	2
Minerva Spring Complex North[a]	---	9	---	1
Swallow Spring	16	19	3	2
Big Springs	29	19	0	0
Big Springs Creek[a]	---	28	---	8
Unnamed 1 Spring North of Big	22	18	3	4
Stateline Springs	32	31	0	1

[a]Not sampled during spring 2009 sampling.

Taxa richness in the fall was equal to, or greater than, spring season richness in five springs and less than the spring season richness at six springs. EPT richness was typically low, ranging from zero during both the spring and fall 2009 surveys to eight in Big Springs Creek in the fall. However, the value in Big Springs Creek may be biased because the samples from the five sampled reaches were inadvertently combined into a single, composite sample.

A complete taxa listing and metrics report for each sampling event at each spring can be found in Appendix E.

3.5 Northern Leopard Frog

Northern leopard frog monitoring determines the presence of frogs at the Stipulation sites and estimates the number of breeding adults within each Stipulation monitoring area. Northern leopard frog egg-mass surveys were conducted at seven Stipulation spring sites with a documented northern leopard frog occurrence. Additionally, 13 locations were surveyed to document the presence or absence of northern leopard frogs. Table 3-14 shows all sites surveyed.

Table 3-14
Northern Leopard Frog Survey Locations with the Type of Survey Conducted in 2009

Site	Survey Type
Stonehouse Complex	Presence/Absence
Willow-NV Spring	Presence/Absence
Keegan Spring Complex North[b]	Egg Mass
West Spring Valley Complex 1[b]	Egg Mass
Shoshone Ponds[b]	Egg Mass
South Millick Spring[b]	Egg Mass
Unnamed 5 Spring[b]	Egg Mass
Four Wheel Drive Spring	Presence/Absence
Willard Spring	Presence/Absence
Minerva Spring Complex Middle[b]	Egg Mass
Minerva Spring Complex North[b]	Egg Mass
Swallow Spring	Presence/Absence
North Little Spring	Presence/Absence
Big Springs	Presence/Absence
Big Springs Creek	Presence/Absence
Unnamed 1 Spring North of Big	Presence/Absence
Stateline Springs	Presence/Absence
Clay Spring North[a]	Presence/Absence
Clay Spring South[a]	Presence/Absence
Lake Creek	Presence/Absence

[b]Access to Clay Spring North and Clay Spring South was provided by landowner during the initial northern leopard frog presence survey. Clay Spring South was not a designated monitoring site in the Biological Monitoring Plan but was visited upon request by BWG to determine if it might serve as a more desirable site than Clay Spring North (it did not, as the south spring did not harbor any nested targets).
[c]Site with previously documented as a northern leopard frog occurrence (BIO-WEST, 2007, 2009; SNWA, 2009).

Unnamed 5 Spring was chosen to be monitored as the sentinel site as it had a documented northern leopard frog occurrence, evidence of northern leopard frog breeding, and a location between the northern and southern Spring Valley survey locations. The first sentinel visit took place on March 12, and the second visit took place on March 24 with no observed northern leopard frog activity on either visit. The site was next visited on April 9 with observed northern leopard frog breeding activity (egg masses, calling male frogs, and a pair of frogs in *amplexus*). The general breeding area was located on the east side of the southern-most spring pool before the system flows into a narrow channel. This area had shallow, open water with some short emergent vegetation. After the April 9 visit (considered visit 1 egg mass survey), four additional site visits took place at 2-week intervals. A total of nine northern leopard frog egg masses were documented at this site. The egg masses were found 3.0 to 5.4 m from the dry shoreline and in 6.2-cm to 9.0-cm deep water. Table 3-15 summarizes the visits to the Unnamed 5 Spring site.

Table 3-15
Summary of Visits to Unnamed 5 Spring with the Number and Age Class (AC) of New Egg Masses Documented and Tadpoles Observed

Visit	Date	AC 1	AC 2	AC 3	AC +3/Hatched	Tadpoles
Sentinel	3/12/2009	0	0	0	0	No
Sentinel	3/24/2009	0	0	0	0	No
1	4/09/2009	5	0	0	0	No
2	4/14/2009	3	0	0	0	No
3	5/1/2009	0	0	0	1	Yes
4	5/13/2009	0	0	0	0	Yes
5	5/28/2009	0	0	0	0	Yes

No age class 1 egg masses were documented after the April 9 date, so it appears that the majority of breeding took place within the first two weeks in April. The age class +3/hatched egg mass found on May 1 was probably deposited shortly after the April 14 survey. By April 14, the class 1 egg masses documented on April 9 had already developed to age class 2 or 3. By May 1, they had all hatched with tadpoles dispersed, so it appears that northern leopard frog eggs reach the +3/hatched stage in approximately two weeks at this location.

With the confirmed breeding activity at Unnamed 5 Spring on April 9, egg mass surveys or presence/absence surveys began at the remainder of the sites the following week. The Keegan Spring Complex North was first visited on five occasions from April 14 to May 28. On May 6, it was determined that an additional portion of the system was within the Stipulation-defined area and was surveyed as visit 3. Thirteen new egg masses were documented around a shallow pool. Eight of these egg masses were class 1, five were class +3/hatched, and no dispersed tadpoles were observed. Because egg masses tale approximately two weeks to reach a +3/hatched stage, it is probable that no egg masses were missed by not surveying this area in the first two visits. Table 3-16 summarizes the visits to Keegan Spring Complex North.

Table 3-16
Summary of Visits to Keegan Spring Complex North with the Number of Age Class (AC) of New Egg Masses Documented and Tadpoles Observed

Visit	Date	AC 1	AC 2	AC 3	AC +3/Hatched	Tadpoles
1	4/14/2009	2	0	0	0	No
2	4/30/2009	1	9	4	5	Yes
3	5/06/2009	8	0	0	5	Yes
4	5/13/2009	0	0	0	0	Yes
5	5/28/2009	0	0	0	0	Yes

Egg masses at this location appear to be taken approximately two weeks to hatch, and by May 13, all egg masses were either +3/hatched or fully hatched with dispersed tadpoles.

All of the egg masses documented at this location were either in the pond separated from the main channel or in a shallow pool off of the main channel. Both locations had short emergent vegetation with calm, shallow water. Egg masses in the pond were found 0.3 to 0.9 m from the dry shoreline and in 9.5-cm to 11.5-cm deep water. Egg masses in the main channel pool were found 1.0 to 2.58 m from dry shoreline and in 7.0-cm to 14.0-cm deep water.

West Spring Valley Complex 1 was first visited every two weeks from April 14 to May 28. Only one egg mass was documented at this site. Table 3-17 summarizes the visits to West Spring Valley Complex 1.

The one egg mass documented was found in a shallow, marshy pool that borders a deeper, cattail-filled pond near the terminus of the system. The egg mass was 1.5 m from the dry shoreline and was in 8.5-cm deep water. The egg mass location appears to provide the best breeding habitat in the system as the remainder is composed of either flowing channels or deeper spring pools. Breeding is also known to occur at the nearby West Spring Valley Complex 5, where an egg mass was documented in April 2009 during an additional survey, and metamorphic frogs were documented on July 22, 2008 (SNWA, 2009).

Table 3-17
Summary of Visits to West Spring Valley Complex 1 with the Number and Age Class (AC) of New Egg Masses Documented and Tadpoles Observed.

Visit	Date	AC 1	AC 2	AC 3	AC +3/Hatched	Tadpoles
1	4/14/2009	0	0	0	0	no
2	4/30/2009	1	0	0	0	no
3	5/06/2009	0	0	0	0	no
4	5/13/2009	0	0	0	0	yes
5	5/28/2009	0	0	0	0	no

South Millick Spring was visited on April 14, April 30, May 13, and May 28 with no egg masses documented. No tadpoles were observed, but several adult northern leopard frogs were present. This portion of the system consists of spring pools and a flowing channel and does not offer the shallow, still, and lightly vegetated habitat that northern leopard frogs seem to prefer for breeding. Farther downstream in the system, there are shallow, manmade ponds and a marshy terminus where the leopard frogs probably focus their breeding activity. The terminal marsh was visited near the end of the breeding season, but no egg masses or tadpoles were documented.

Minerva Spring Complex Middle was visited on April 21, April 29, May 12, and May 29 with no egg masses documented. Minerva Spring Complex North was visited on April 14, April 29, May 12, and May 29 with no egg masses documented. Both sites had some adult northern leopard frogs present, but no tadpoles or other signs of reproduction were observed. Both sites are composed of flowing channels and spring pools. The spring pools appear to offer some possible breeding habitats. The

Minerva Spring Complexes terminate to the west in a series of seasonal, shallow, marshy lakes. This area is influenced not only by the Minerva Spring Complex Middle and North but also by seasonal run-off and a ditch that carries Swallow Spring diversion water and Minerva Spring Complex South water. This area was investigated on April 29, 2009, during Stipulation surveys and two northern leopard frog egg masses were documented along with several adult frogs. It is possible that the majority of breeding in the Minerva Spring Complex area takes place at these shallow lakes.

Shoshone Ponds was first visited on April 8. This site was visited before the sentinel site's egg masses were documented because it was thought that breeding could occur earlier there because the site is fed by thermal artesian wells. This was the case, and one +3/hatched age class egg mass was documented in the stock pond. The site was visited on April 14, May 1, May 12, and May 28 with no additional egg masses documented. Breeding habitat appears to be limited at this site as there is little shallow-water, vegetated areas at the refugia ponds or the stock pond for egg deposition. Some shallow pools and marshy areas occur in the meadow to the west of the ponds, but no egg masses or tadpoles were documented in this area. Breeding has been previously documented in the stock pond with an egg mass observed on March 9, 2006 (SNWA, 2009). No tadpoles were observed after the April 8 visit, so they may have dispersed or were predated by Pahrump poolfish.

Four Wheel Drive Spring has no northern leopard frog occurrence record, so it was surveyed for frogs on April 23. No northern leopard frog was documented. This area was previously surveyed on September 11, 2008, at 20:00 and on multiple occasions in 2005 and 2006 with no northern leopard frog documented (SNWA, 2009). Some potential northern leopard frog habitat occur at this site.

Stonehouse Complex was surveyed for the presence of northern leopard frog on April 21 with no signs of frogs documented. This area has no northern leopard frog occurrence record and was previously visited in 2006 and 2008 (SNWA, 2009). This area seems to have a potential habitat for northern leopard frog.

Swallow Spring was surveyed for the presence of leopard frogs on April 21 with no frog sign documented. This area has been previously visited with no frog documented (SNWA, 2009). This site has fast-flowing, cool water with little potential breeding habitat.

Willard Spring was surveyed for the presence of northern leopard frogs on April 21. No leopard frog were documented, and no occurrence record exists for this site. This site was dry at the time of the survey, so it probably cannot support a permanent population of leopard frogs.

Willow Spring was surveyed for the presence of northern leopard frogs on April 30 with no frog sign documented. No occurrence record exists for this site and very little potential northern leopard frog habitat exists.

The Spring Valley Stipulation monitoring sites in Snake Valley have no northern leopard frog occurrence records. Clay Spring North and South were surveyed for frog presence on March 24 and April 22 with no signs of frogs documented. Also surveyed on April 22 were Lake Creek and the adjacent wetlands between Preuss Reservoir and Clay Spring South (Moriah Ranch property and BLM land), Lake Creek in the Stateline Springs area (Dearden property), Big Springs, Big Springs Creek for about 3.5 km downstream from the Big Springs springhead, Unnamed 1 Spring North of

Big Springs, and North Little Spring. All of these areas have potential northern leopard frog habitat, but no signs of leopard frogs were documented. The landowners at Big Springs, Clay Spring North, and Clay Spring South commented that they have never seen or heard frogs on their properties. According to Kevin Wheeler of UDWR (personal communication, April 22, 2009), the landowners of the Stateline Springs property have commented that they observed some species of amphibian in the Burbank Meadows portion of Lake Creek, but this was not confirmed to be northern leopard frogs.

To assess the breeding habitat at egg mass locations, point transects were conducted at the general egg mass locations from June 16 to June 18. The percentage of emergent vegetation and open water were calculated along each transect with the percentage of emergent vegetation ranging from 9 to 57 percent and open water ranging from 43 to 91 percent along each transect. Figure 3-2 shows the percent of each habitat category by site and transect.

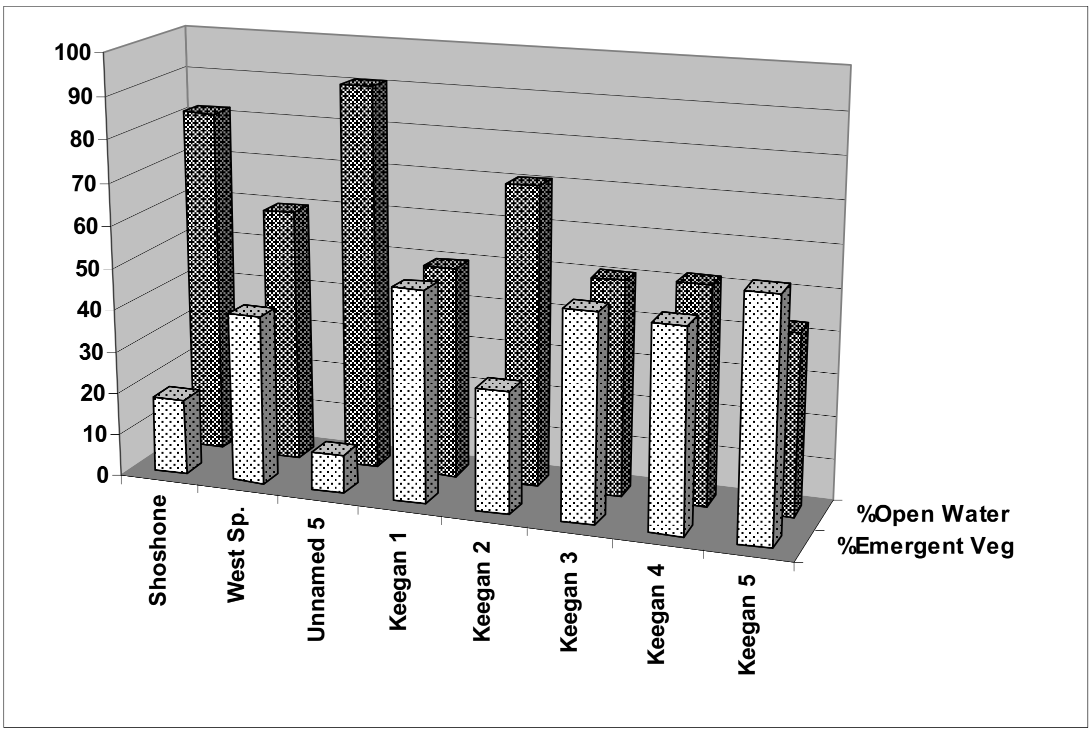


Figure 3-2
Percent of Open Water and Emergent Vegetation along each Northern Leopard Frog Breeding Habitat Transect by Site, Spring 2009

Based on the habitat transects, egg masses occurred in areas with 9 to 57 percent emergent vegetation with a mean of 38 percent (standard error = 2.50). Figure 3-3 shows the percent vegetation and number of egg masses associated with each transect. Egg masses also occurred 0.3 to 5.4 m from dry shoreline with a mean distance of 1.8 m (standard error = 0.20) and were in 6-cm to 14-cm deep water with a mean depth of 10.2 cm (standard error = 0.32). It should be noted that the habitat transect data were collected at the end of the breeding season. These data may not represent conditions occurring at the time of egg mass deposition.

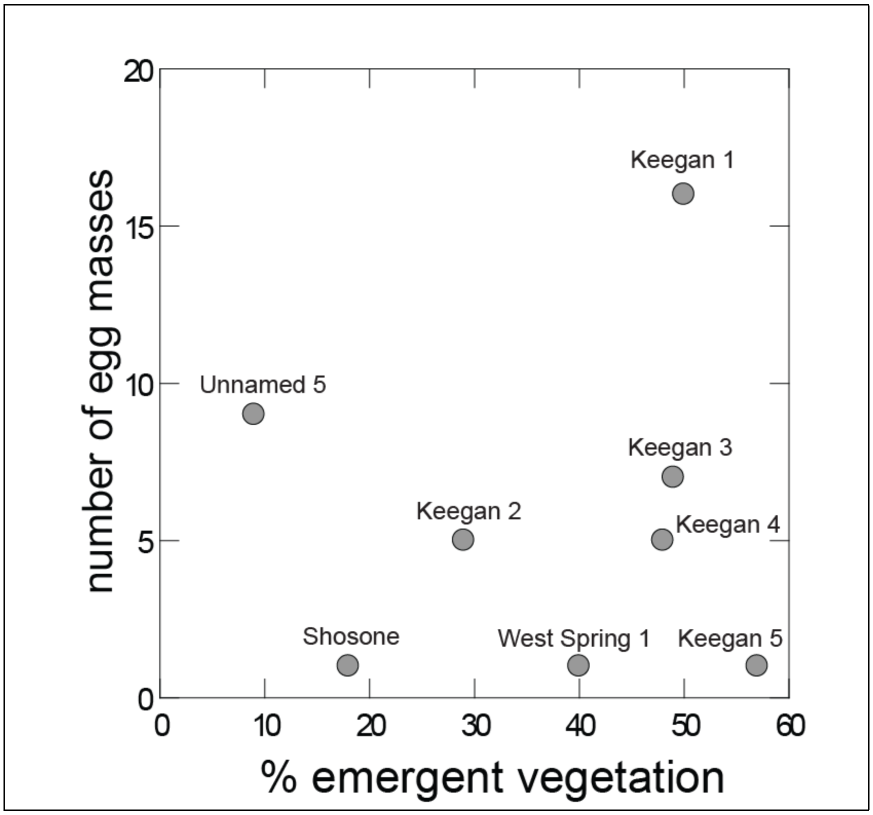


Figure 3-3
Percent Emergent Vegetation along and Number of Egg Masses Associated with each Northern Leopard Frog Breeding Habitat Transect, Spring 2009

Water-quality measurements were taken near each habitat transect (Table 3-18). Turbidity, conductivity, pH, and dissolved oxygen were lowest at the Keegan Spring Complex North transects. Temperatures over all of the transects ranged from 64°F to 76°F. Unnnamed 5 Spring had the highest pH and dissolved oxygen while West Spring Valley Complex 1 had the highest turbidity and conductivity. Keegan spring water-quality measurements were not taken until the end of the breeding season and may not represent conditions present during egg mass deposition.

3.6 Relict Dace

Relict dace monitoring determines the distribution of fish by size, season, and habitat within the designated Stipulation sample areas. Relict dace were sampled in the spring and fall 2009 at Keegan Spring Complex North and Stonehouse Complex.

3.6.1 Keegan Spring Complex North

Relict dace were sampled in the spring and fall 2009 at the Keegan Spring Complex North. Based on surveys done by BIO-WEST, Inc., at this location (BIO-WEST, 2009), the sampling area included the cattail-lined ponds, 129 m of channel above the ponds, and 54 m of channel below the ponds. On May 7, 2009 (spring sampling), 39 minnow traps were set for approximately 18 hours and collected the next morning. A total of 1,206 relict dace were captured with a CPUE of 1.76 fish per trap hour

Table 3-18
Water Quality Measurements for Each
Northern Leopard Frog Breeding Habitat Transect, June 2009

Transect	Date	Time	Water Temperature (°F)	Conductivity (µS/cm)	pH	Dissolved Oxygen (mg/L)	Velocity (m/s)	Turbidity (NTU)
Keegan 1[a]	6/17/09	12:56	65	177	6.3	2.22	0	4
Keegan 2[a]	6/17/09	12:56	65	177	6.3	2.22	0	4
Keegan 3[b]	6/17/09	13:37	75	138	7.5	9.75	0	5
Keegan 4[b]	6/17/09	13:37	75	138	7.5	9.75	0	5
Keegan 5[b]	6/17/09	13:37	75	138	7.5	9.75	0	5
Unnamed 5	5/5/09	10:28	64	308	8.2	14.32	0	6.85
West Spring Valley Complex	5/14/09	10:40	76	511	7.7	9.76	0	75.5

[a]One measurement taken for Keegan 1 and 2.
[b]One measurement taken for Keegan 3, 4, and 5.

(standard error = 0.40), a minimum CPUE of 0, and a maximum CPUE of 9.13 (Table 3-19). Fish were again sampled on September 16, 2009 (fall sampling), when 39 minnow traps were set for approximately 20 hours and collected the next morning. A total of 478 relict dace were captured with a mean CPUE of 0.60 fish per trap hour (standard error = 0.13), a minimum CPUE of 0, and a maximum CPUE of 3.48 (Table 3-19).

Table 3-19
Keegan Spring Complex North Trap CPUE Values for the Spring and Fall Sampling

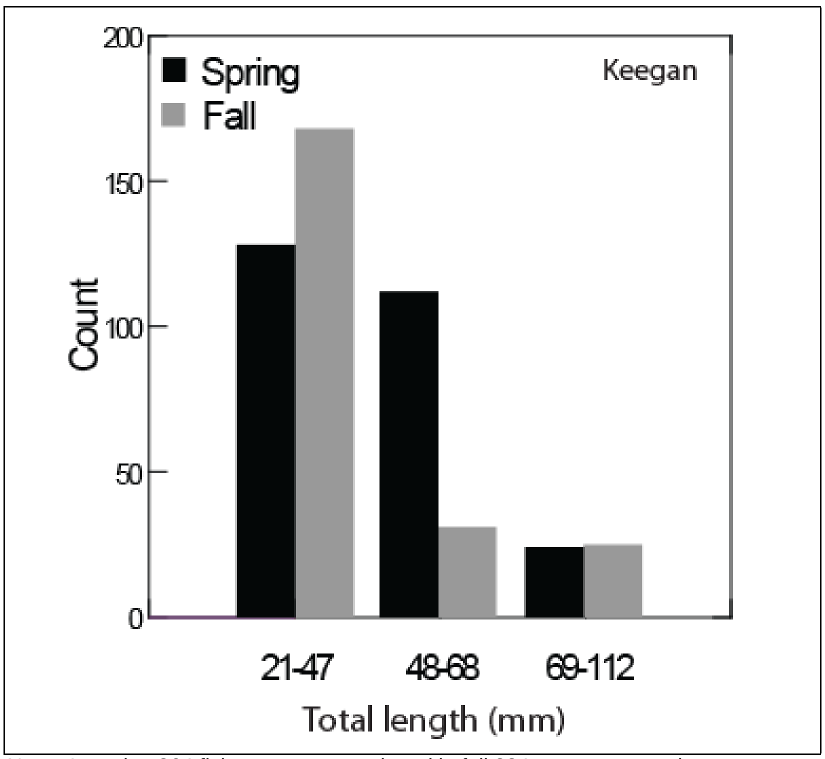
Season	Number of Traps	Total Number of Fish	Mean CPUE	Maximum CPUE	Minimum CPUE
Spring	39	1,206	1.76	9.13	0
Fall	39	478	0.60	3.48	0

In both the spring and fall sampling effort, 21 minnow traps were placed in the pool habitat, and 18 minnow traps were placed in the channel habitat. The physical habitat mapping (Section 3.1) found that pool habitat water depth ranged from 0.2 to >1.0 m, and channel habitat water depth ranged from 0.2 m to approximately 0.5 m. CPUE values for season by habitat are shown in Table 3-20,and mean CPUE by season and habitat is shown in Figure 3-4. In the spring, a total of 1,181 relict dace were captured in the pool habitat and 25 relict dace were captured in the channel habitat. The pool habitat had a mean CPUE of 3.21 fish per trap hour with a minimum CPUE of 0.06 and a maximum of 9.13 (standard error = 0.57), and channel habitat had a mean CPUE of 0.08 fish per trap hour with a minimum CPUE of 0 and a maximum of 0.44 (standard error = 0.03). In the fall, a total of 65 relict dace were captured in the pool habitat and 413 relict dace were captured in channel habitat. Pool habitat had a mean CPUE of 0.15 fish per trap hour with a minimum CPUE of 0 and a maximum of 1.03 (standard error = 0.06), and channel habitat had a mean CPUE of 1.13 fish per trap hour with a minimum CPUE of 0 and a maximum of 3.48 (standard error = 0.88).

Table 3-20
Keegan Spring Complex North Trap CPUE Values for the Spring and Fall Sampling by Habitat Type

Season	Habitat	Number of Traps	Total Number of Fish	Mean CPUE	Maximum CPUE	Minimum CPUE	Standard Error
Spring	Pool	21	1,181	3.21	9.13	0.06	0.57
Spring	Channel	18	25	0.08	0.44	0	0.03
Fall	Pool	21	65	0.15	1.03	0	0.06
Fall	Channel	18	413	1.13	3.48	0	0.88

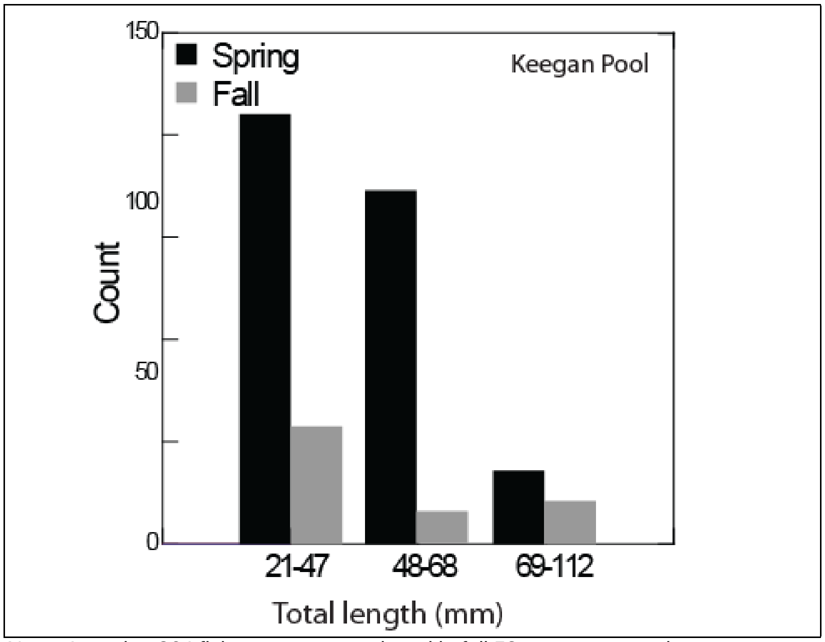
In the spring, 264 fish were measured with a total length range of 21 to 97 mm. The mean length of fish measured in spring was 48.6 mm (standard error = 0.83). In the fall, 224 fish were measured with a total length range of 21 to 111 mm. The mean length of fish measured in fall was 43.7 mm (standard error = 1.14). A length-frequency histogram for the Keegan Spring Complex North site by season is shown in Figure 3-4. Length frequencies are shown in ranges which are thought to correspond with juvenile, young adult and mature fish age classes.



Note: In spring 264 fish were measured, and in fall 224 were measured.

Figure 3-4
Relict Dace Length-Frequency Histogram for Keegan Spring Complex North

Fish length-frequency histograms are shown for habitat with season in Figure 3-5 and Figure 3-6. The cluster analysis created three size classes: 21-47, 48-68, and 69-112 mm. In the spring, 254 fish were measured from the pool habitat with a length range of 21 to 97 mm and a mean length of 48.2 mm (standard error = 0.84), and 10 fish were measured from the channel habitat with a length range of 37 to 90 mm and a mean length of 58.4 mm (standard error = 4.00). In the fall, 58 fish were measured from the pool habitat with a length range of 21 to 111 mm and a mean length of 49.0 mm (standard error = 3.04), and 166 fish were measured from the channel habitat with a length range of 25 to 104 mm and a mean length of 41.8 mm (standard error = 1.07).



Note: In spring 264 fish were measured, and in fall 58 were measured.

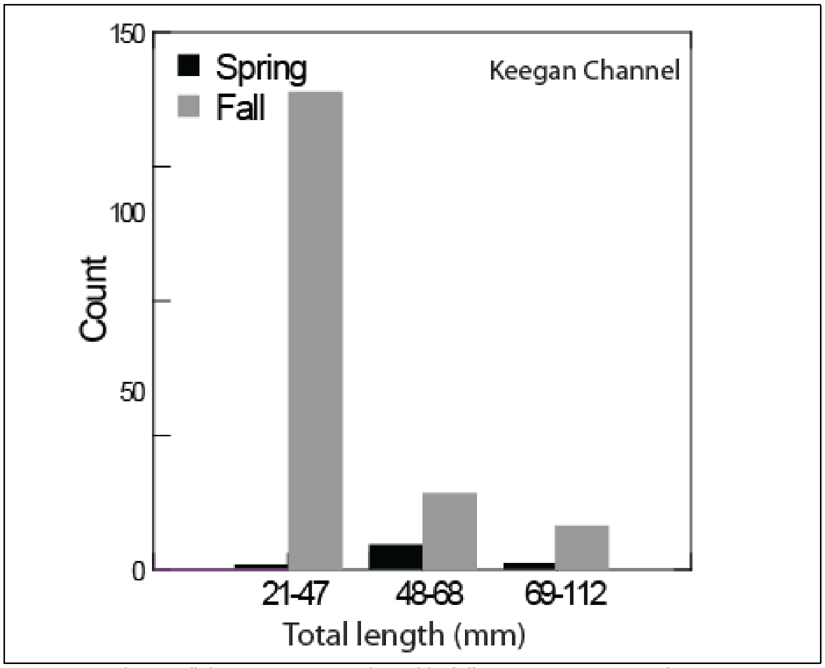
Figure 3-5
Relict Dace Length-Frequency Histogram for Pool Habitat in the Spring and Fall for Keegan Spring Complex North

Water-quality measurements were taken at Keegan Spring Complex North in the spring and fall about 352 m upstream of the first trap location and just downstream of the last trap location (Table 3-21).

3.6.2 Stonehouse Complex

Relict dace were sampled in spring and fall 2009 at the Stonehouse Complex. Relict dace are known to occur throughout the Stonehouse system, but sampling efforts focused on the areas outlined in the Biological Monitoring Plan for the Spring Valley Stipulation (Biological Work Group, 2009). On May 6, 2009 (spring sampling), 30 minnow traps were set for approximately 18 hours and collected the next morning. A total of 872 relict dace were captured with a mean CPUE of 1.64 fish per trap hour (standard error = 0.27), a minimum CPUE of 0.06, and a maximum CPUE of 5.36 (Table 3-22). Fish were again sampled on September 15, 2009 (fall sampling), when 30 minnow traps were set for approximately 20 hours and collected the next morning. A total of 847 relict dace were captured with a mean CPUE of 1.42 fish per trap hour (standard error = 0.31), a minimum CPUE of 0, and a maximum CPUE of 5.89 (Table 3-23).

In both the spring and fall sampling efforts, 12 minnow traps were placed in the pool habitat and 18 minnow traps were placed in the channel habitat. The physical habitat mapping (Section 3.1) showed that the pool habitats water depth ranged from 0.2 to >1.0 m and the channel habitats water depth



Note: In spring 10 fish were measured, and in fall 165 were measured.

Figure 3-6
Relict Dace Length-Frequency Histogram for Channel Habitat in the Spring and Fall for Keegan Spring Complex North

Table 3-21
Water-Quality Measurements Taken at Keegan Spring Complex North

Season	Point	Time	Water Temperature (°F)	Conductivity (µS/cm)	pH	Dissolved Oxygen (mg/L)	Turbidity (NTU)
Spring	1	1547	73.7	84.2	7.49	13.72	9.80
	2	1601	62.4	74.0	7.38	16.58	6.60
Fall	1	1424	61.5	77.0	7.47	11.23	7.23
	2	1436	64.6	90.0	7.21	8.23	3.54

Note: Point 1 is approximately 352 m upstream from the first fish trap, and point 2 is just downstream of the last trap.

Table 3-22
Stonehouse Complex Trap
CPUE Values for Spring and Fall Sampling

Season	Number of Traps	Total Number of Fish	Mean CPUE	Maximum CPUE	Minimum CPUE
Spring	30	872	1.64	5.36	0.06
Fall	30	847	1.42	5.89	0

Table 3-23
Stonehouse Complex Trap CPUE Values
for Spring and Fall Sampling by Habitat Type

Season	Habitat	Number of Traps	Total Number of Fish	Mean CPUE	Maximum CPUE	Minimum CPUE	Standard Error
Spring	Pool	12	359	1.66	5.36	0.06	0.44
	Channel	18	513	1.62	5.11	0.11	0.35
Fall	Pool	12	384	1.64	5.79	0	0.61
	Channel	18	463	1.28	5.89	0	0.33

ranged from 0.2 m to approximately 1.0 m. CPUE values for each season by habitat are shown in Table 3-23. CPUE by season and habitat is shown in Figure 3-8. In the spring, a total of 359 relict dace were captured in the pool habitat, and 513 relict dace were captured in the channel habitat. The pool habitat had a mean CPUE of 1.66 fish per trap hour with a minimum CPUE of 0.06 and a maximum of 5.36 (standard error = 0.44). The channel habitat had a mean CPUE of 1.62 fish per trap hour with a minimum CPUE of 0.11 and a maximum of 5.11 (standard error = 0.35). In the fall, a total of 384 relict dace were captured in the pool habitat and 463 relict dace were captured in the channel habitat. The pool habitat had a mean CPUE of 1.64 fish per trap hour with a minimum CPUE of 0 and a maximum of 5.79 (standard error = 0.61). The channel habitat had a mean CPUE of 1.28 fish per trap hour with a minimum CPUE of 0 and a maximum of 5.89 (standard error = 0.33).

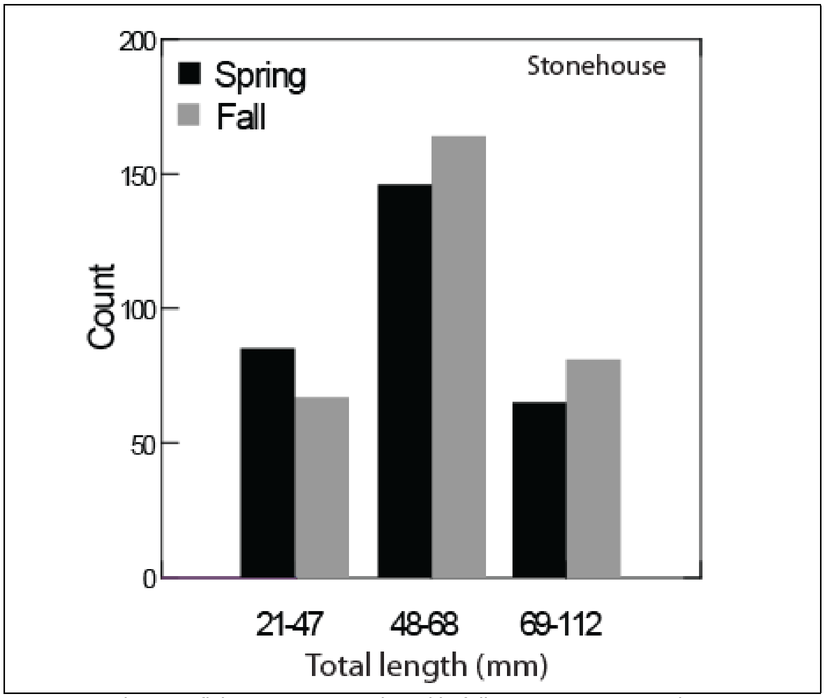
In the spring, 296 fish were measured with a total length range of 24 to 99 mm. The mean length of the fish measured in spring was 56.6 mm (standard error = 0.88). In the fall, 312 fish were measured with a total length range of 24 mm to 112 mm. The mean length of the fish measured in fall was 60.2 mm (standard error = 0.88). A length-frequency histogram by season for the Stonehouse Complex is shown in Figure 3-7.

Fish length-frequency histograms are shown for each habitat by season in Figures 3-8 and 3-9. In the spring, 125 fish were measured from the pool habitat with a length range of 26 to 92 mm and a mean length of 56.4 mm (standard error = 1.37), and 171 fish were measured from the channel habitat with a length range of 24 to 99 mm and a mean length of 56.7 mm (standard error = 1.14). In the fall, 85 fish were measured from the pool habitat with a length range of 33 to 92 mm and a mean length of 60.9 mm (standard error = 1.33), and 227 fish were measured from the channel habitat with a length range of 24 to 112 mm and a mean length of 60.0 mm (standard error = 1.10).

Water-quality measurements were not taken at the specific area that relict dace were sampled at Stonehouse Complex. These data will be collected in 2010.

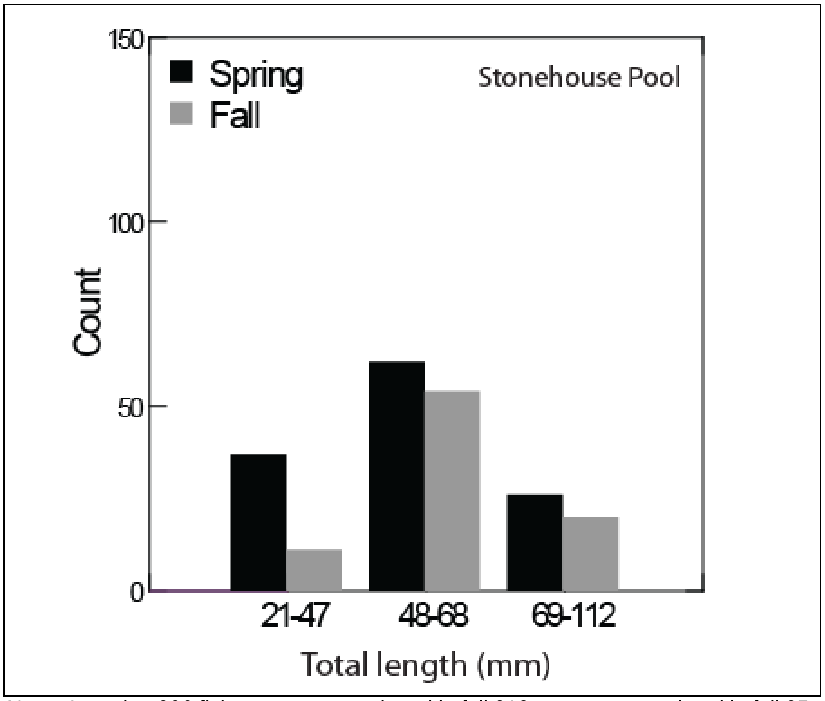
3.7 Big Springs Creek/Lake Creek Native Fish Community

Native fish community monitoring along Big Springs Creek/Lake Creek determines the distribution of fish species by reach, the length-frequency for each species by reach, and the combined species population estimate for each reach. The Big Springs Creek/Lake Creek system was sampled by



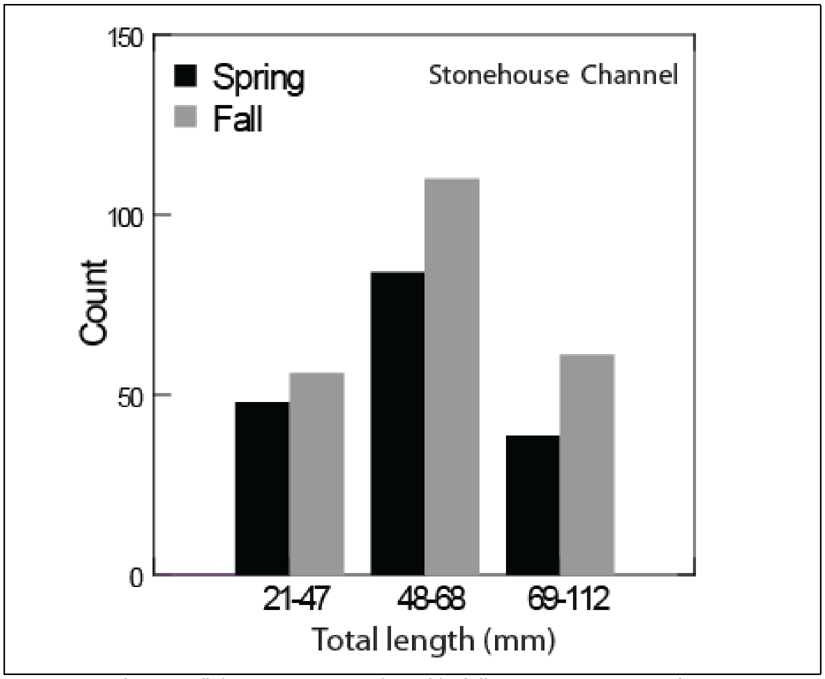
Note: In spring 296 fish were measured, and in fall 312 were measured.

Figure 3-7
Relict Dace Length-Frequency Histogram Stonehouse Complex



Note: In spring 296 fish were measured, and in fall 312 were measured and in fall 85 were measured.

Figure 3-8
Relict Dace Length-Frequency Histogram for Pool Habitat in Spring and Fall for Stonehouse Complex



Note: In spring 171 fish were measured, and in fall 227 were measured.

Figure 3-9
Relict Dace Length-Frequency Histogram for Channel Habitat in Spring and Fall for Stonehouse Complex

electrofishing on September 1 and 2, 2009. Reaches 1, 2, 3, and 5 were sampled on September 1, and Reach 4 was sampled on September 2.

3.7.1 Reach 1

Reach 1 was electrofished for a total of 2,257 seconds over the three passes. A total of 1,217 fish were captured with four native fish species documented: speckled dace, redside shiner, Utah chub, and Utah sucker. Introduced crayfish were also documented. Speckled dace were the most abundant species encountered with 914 individuals captured. Redside shiners were the next most abundant with 292 individuals captured. Ten Utah chub and one Utah sucker were also captured. Figure 3-10 shows the species composition for Reach 1.

The mean CPUE, fish per electrofishing second, for redside shiner was 0.126 (standard error = 0.015), for speckled dace was 0.395 (standard error = 0.05), for Utah chub was 0.004 (standard error = 0.002), and for Utah sucker was 0 (only one Utah sucker was captured). Figure 3-11 shows the CPUE by species for Reach 1.

3.7.2 Reach 2

Reach 2 was electrofished for a total of 1,864 seconds over the three passes. A total of 39 fish were captured with four native fish species documented: speckled dace, redside shiner, Utah chub, and Utah sucker. Introduced crayfish were also documented. Speckled dace were the most abundant species encountered with 16 individuals captured. Redside shiners were the next most abundant with

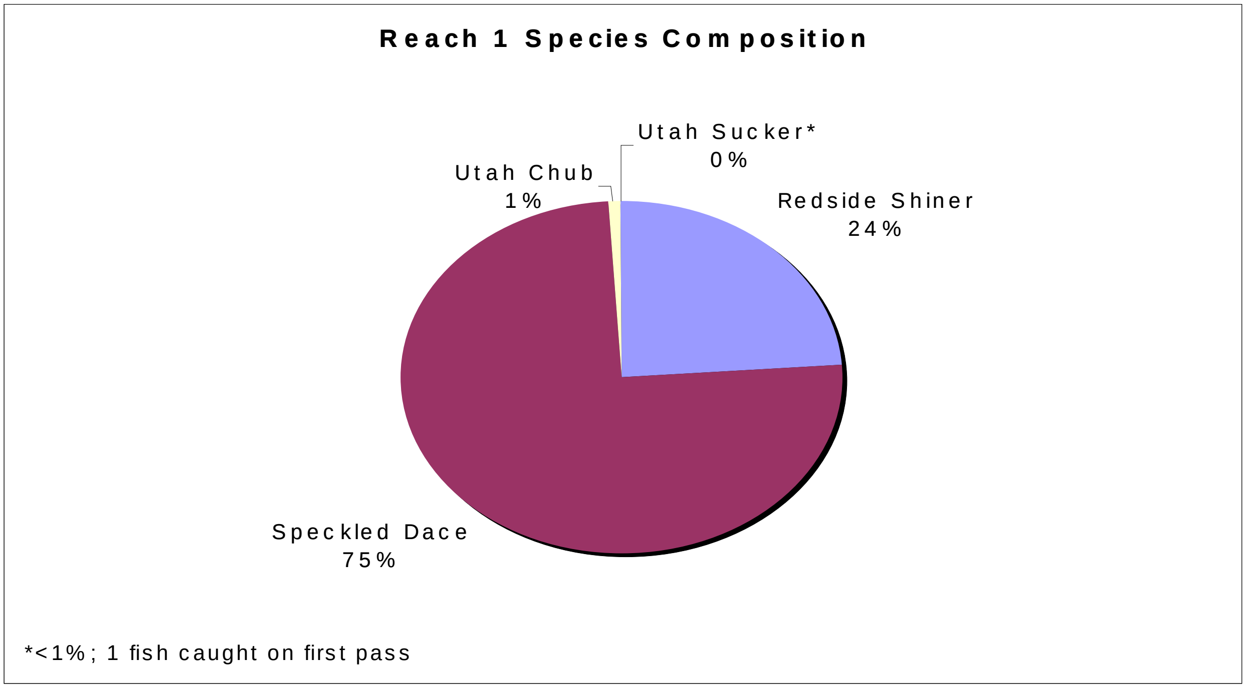
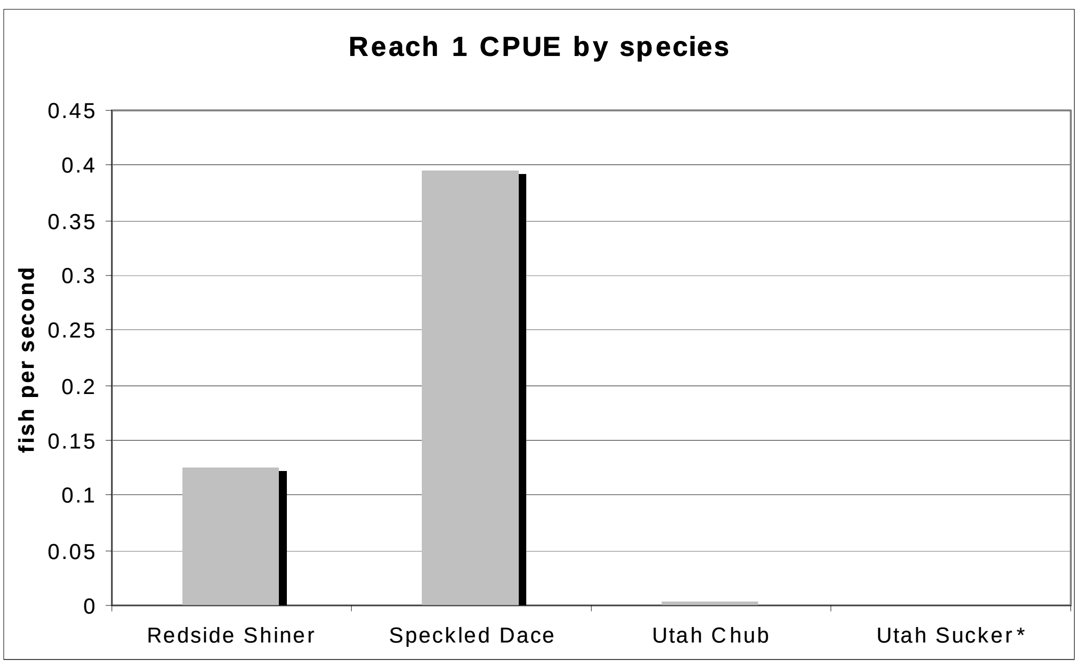


Figure 3-10
Native Fish Species Composition for
Big Springs Creek/Lake Creek Reach 1, September 2009



* One fish caught on first pass

Figure 3-11
CPUE for the Native Fish Species Documented in
Big Springs Creek/Lake Creek Reach 1, September 2009

12 individuals captured. Three Utah chub and 8 Utah sucker were also captured. Figure 3-12 shows the species composition for Reach 2.

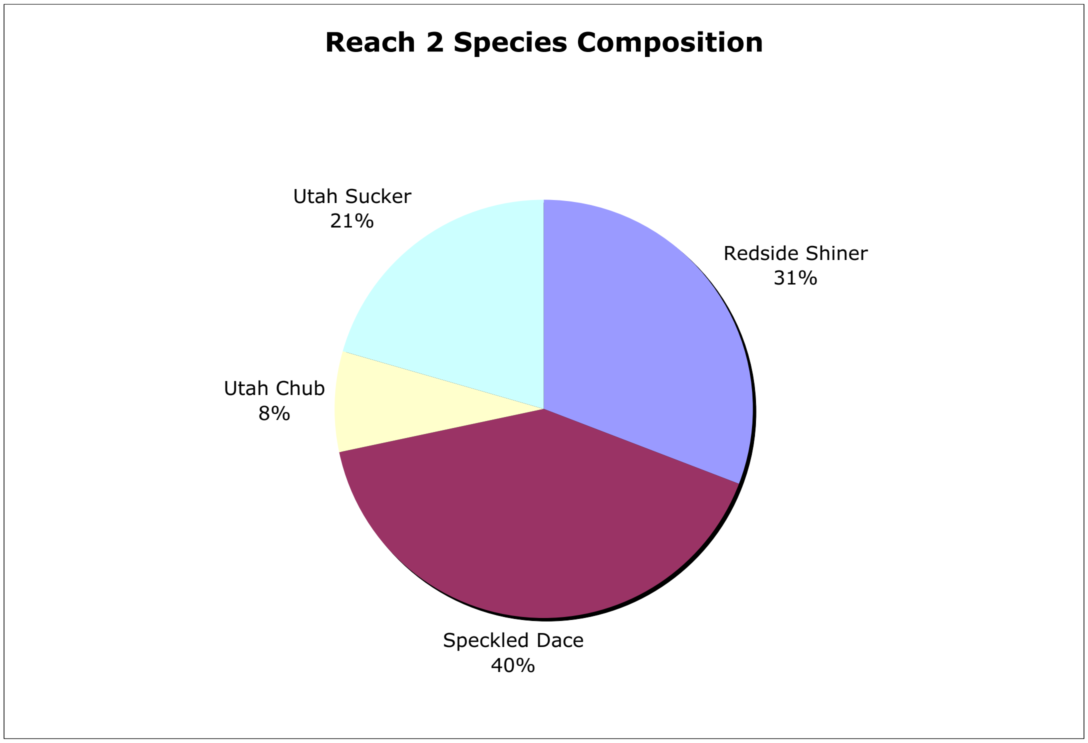


Figure 3-12
Native Fish Species Composition for
Big Springs Creek/Lake Creek Reach 2, September 2009

The mean CPUE, for redside shiner was 0.007 (standard error = 0.003), for speckled dace was 0.009 (standard error = 0.004), Utah chub 0.002 (standard error = 0.00), and Utah sucker 0.004 (standard error = 0.002). Figure 3-13 shows the CPUE by species for Reach 2.

3.7.3 Reach 3

Reach 3 was electrofished for a total of 1,696 seconds over the three passes. A total of 25 fish were captured with four native fish species documented: speckled dace, redside shiner, Utah chub, and Utah sucker. Introduced crayfish were also documented. Speckled dace were the most abundant species encountered with 10 individuals captured. Redside shiners were the next most abundant with eight individuals captured. Two Utah chub and five Utah sucker were also captured. Figure 3-14 shows the species composition for Reach 3.

The mean CPUE, for redside shiner was 0.005 (standard error = 0.003), speckled dace 0.006 (standard error = 0.002), Utah chub 0.001 (standard error = 0.001), and Utah sucker was 0.002 (standard error = 0.001). Figure 3-15 shows the CPUE by species for Reach 3.

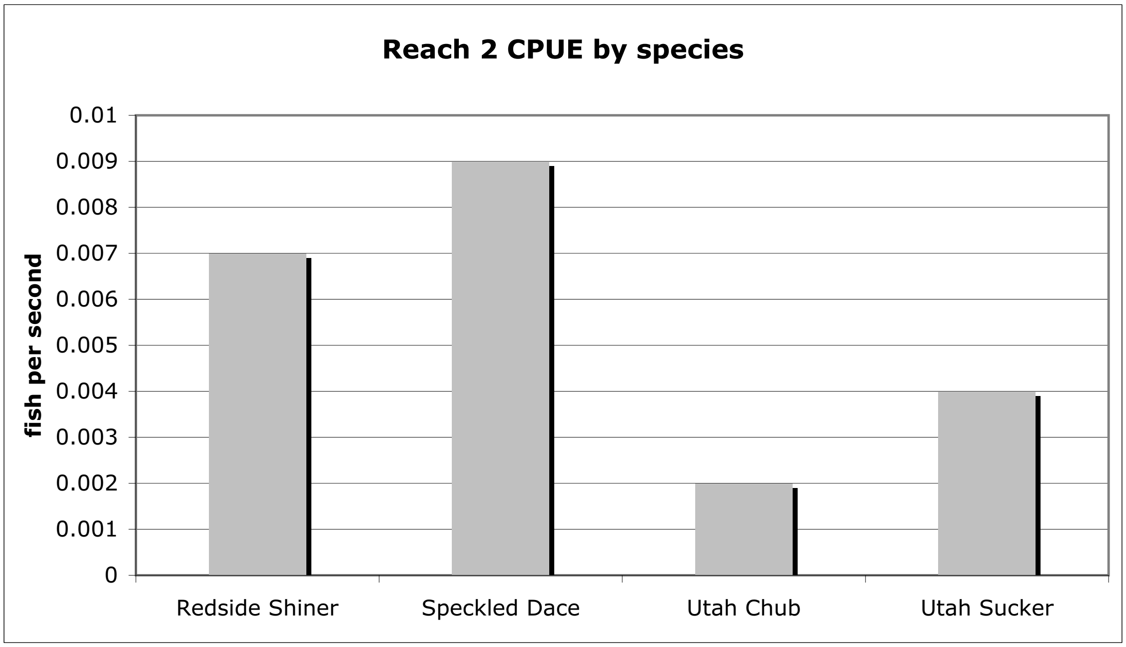


Figure 3-13
CPUE for the Native Fish Species Documented in
Big Springs Creek/Lake Creek Reach 2, September 2009

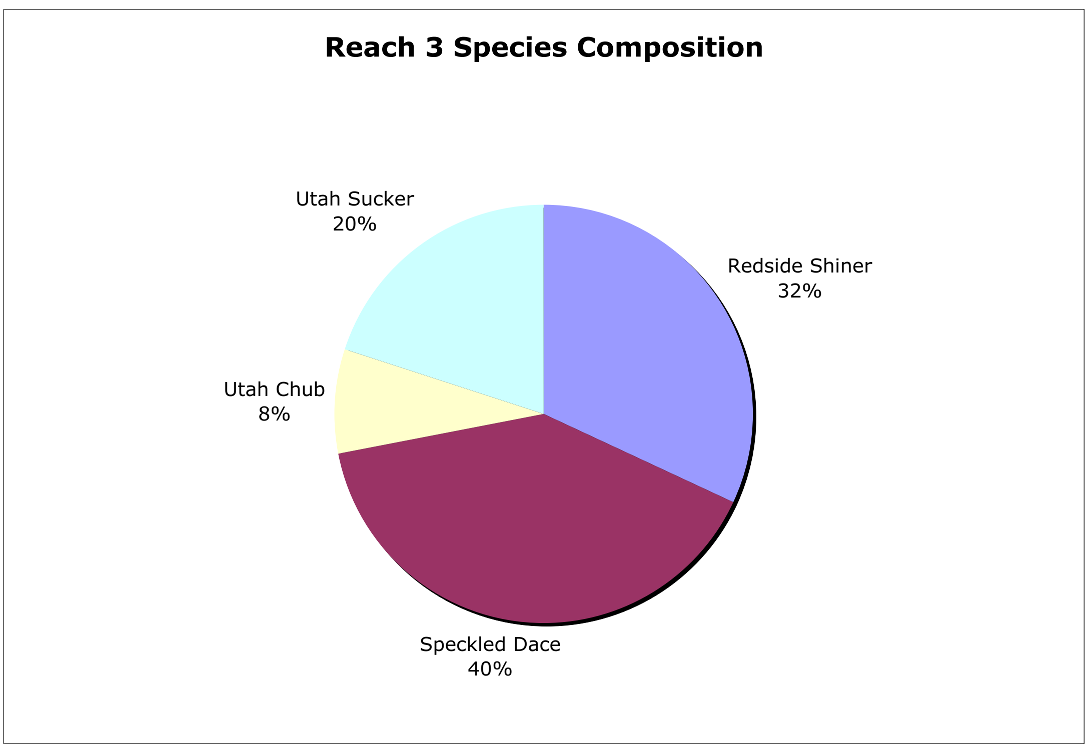


Figure 3-14
Native Fish Species Composition for
Big Springs Creek/Lake Creek Reach 3, September 2009

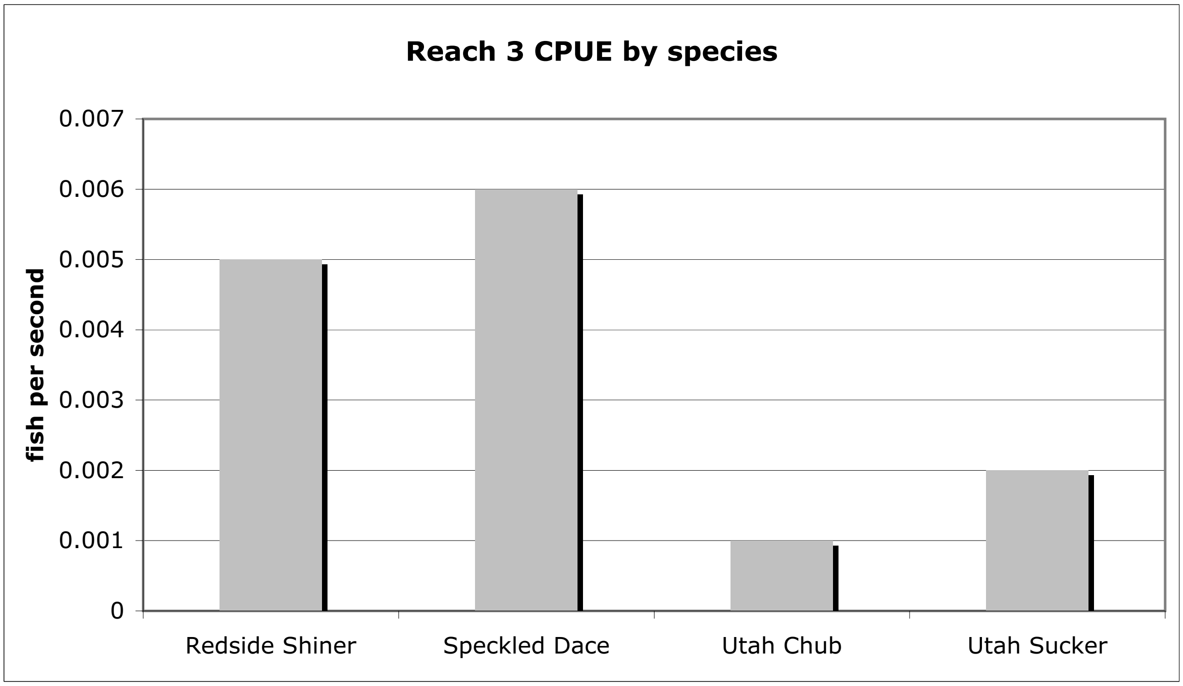


Figure 3-15
CPUE for the Native Fish Species Documented in
Big Springs Creek/Lake Creek Reach 3, September 2009

3.7.4 Reach 4

Reach 4 was electrofished for a total of 3,501 seconds over the three passes. A total of 368 fish were captured with five native fish species documented: speckled dace, redside shiner, mottled sculpin, Utah chub, and Utah sucker. Introduced crayfish were also documented. Speckled dace were the most abundant species encountered with 169 individuals captured. Mottled sculpin were the next most abundant with 89 individuals captured. Seventy-four redside shiners, 24 Utah chub, and 12 Utah sucker were also captured. Figure 3-16 shows the species composition for Reach 4.

The mean CPUE, for redside shiner was 0.019 (standard error = 0.004), speckled dace 0.049 (standard error = 0.006), mottled sculpin 0.025 (standard error = 0.002), Utah chub 0.007 (standard error = 0.001), and Utah sucker 0.003 (standard error = 0.002). Figure 3-17 shows the CPUE by species for Reach 4.

3.7.5 Reach 5

Reach 5 was electrofished for a total of 1,904 seconds over the three passes. A total of 52 fish were captured with one native fish species, Utah sucker, and one introduced fish species, Sacramento perch, documented. Introduced crayfish were also present. Thirty-three Utah suckers and 19 Sacramento perch were captured. Figure 3-18 shows the species composition for Reach 5.

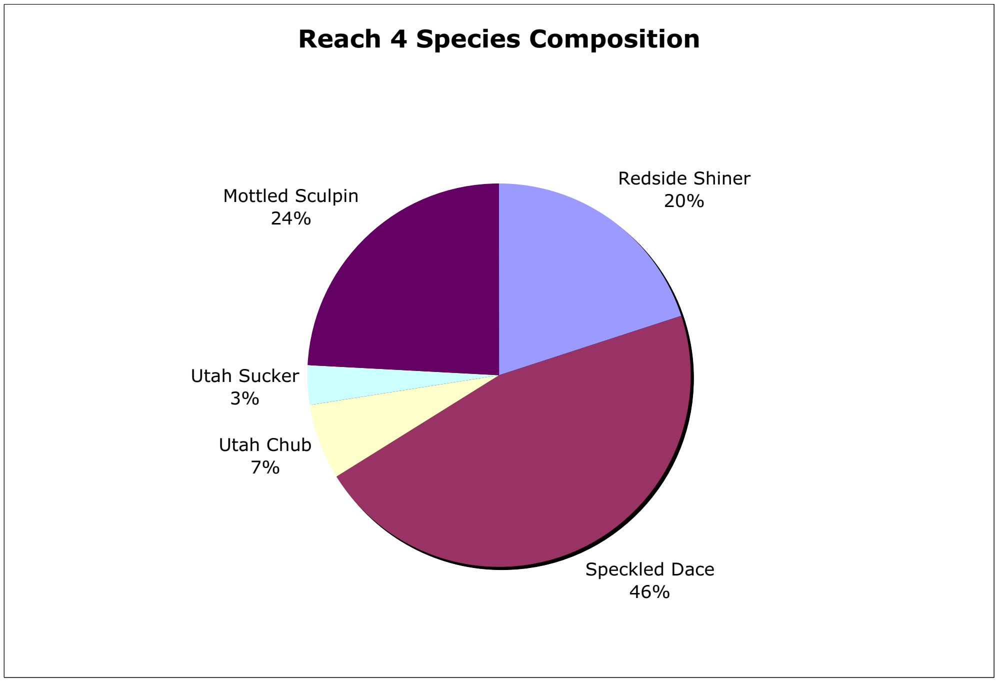


Figure 3-16
Native Fish Species Composition for
Big Springs Creek/Lake Creek Reach 4, September 2009

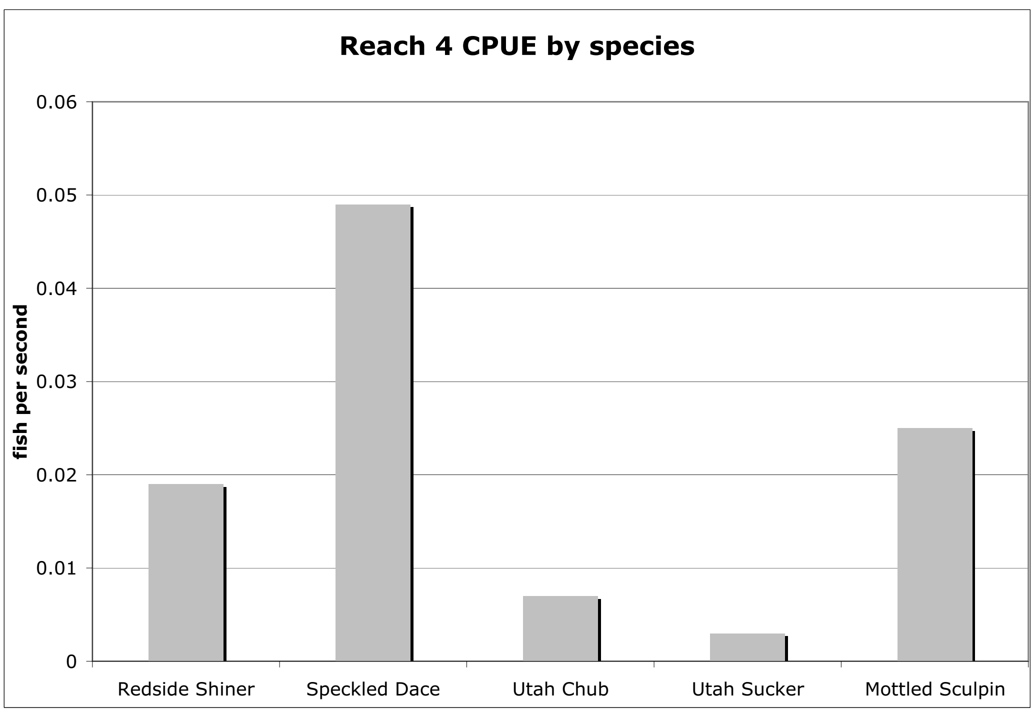


Figure 3-17
CPUE for the Native Fish Species Documented in
Big Springs Creek/Lake Creek Reach 4, September 2009

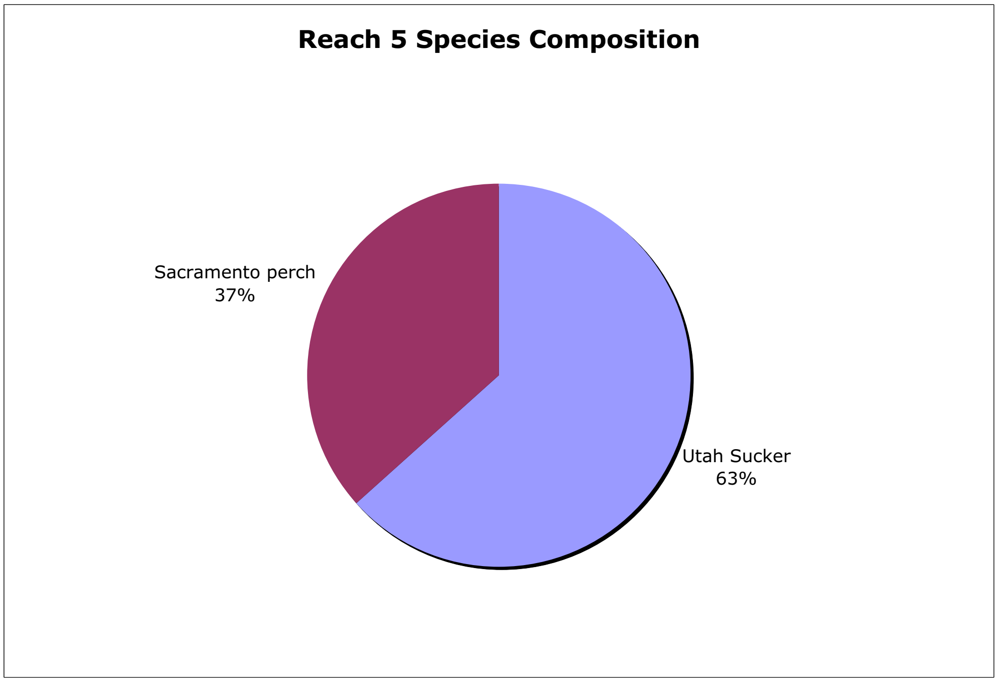


Figure 3-18
Native Fish Species Composition for
Big Springs Creek/Lake Creek Reach 5, September 2009

The mean CPUE, for Utah sucker was 0.017 (standard error = 0.004) and Sacramento perch 0.01 (standard error = 0.004). Figure 3-19 shows the CPUE by species for Reach 5.

3.7.6 Reach Comparisons

Total length data were collected at each reach for each species. Table 3-24 summarizes the length data collected for all species on all reaches. Redside shiner mean length ranged from 70.6 to 72.5 mm with the minimum length (30 mm) and the maximum length (101 mm) both recorded at Reach 2. Speckled dace mean length ranged from 60.5 to 70.4 mm with the minimum length (36 mm) recorded at Reach 4 and the maximum length (98 mm) recorded at Reach 3. Utah chub mean length ranged from 83.3 to 127.3 mm with the minimum length (51 mm) recorded at Reach 1 and the maximum length (225 mm) recorded at Reach 4. Utah sucker mean length ranged from 62.3 to 271 mm with the minimum length (46 mm) recorded at Reach 2 and the maximum length (271 mm) recorded at Reach 1. Mottled sculpin at Reach 4 had a mean length of 50.4 mm with a minimum length of 34 mm and a maximum length of 75 mm. Five transects to asses habitat parameters (open water, emergent vegetation, submergent vegetation) were completed along each of the reaches surveyed. Figure 3-20 shows mean percent vegetation points by the total number of fish captured for each reach.

A total of 1,865 habitat data points were recorded for Reach 1, and the mean percent of the points that intersected vegetation (submergent and emergent) over the five transects was 61 percent (standard error = 12.69). The substrate was characterized by sand, gravel, cobble, and a few boulders. The physical habitat mapping (Section 3.1) reflected that the average depth of the water for this reach was

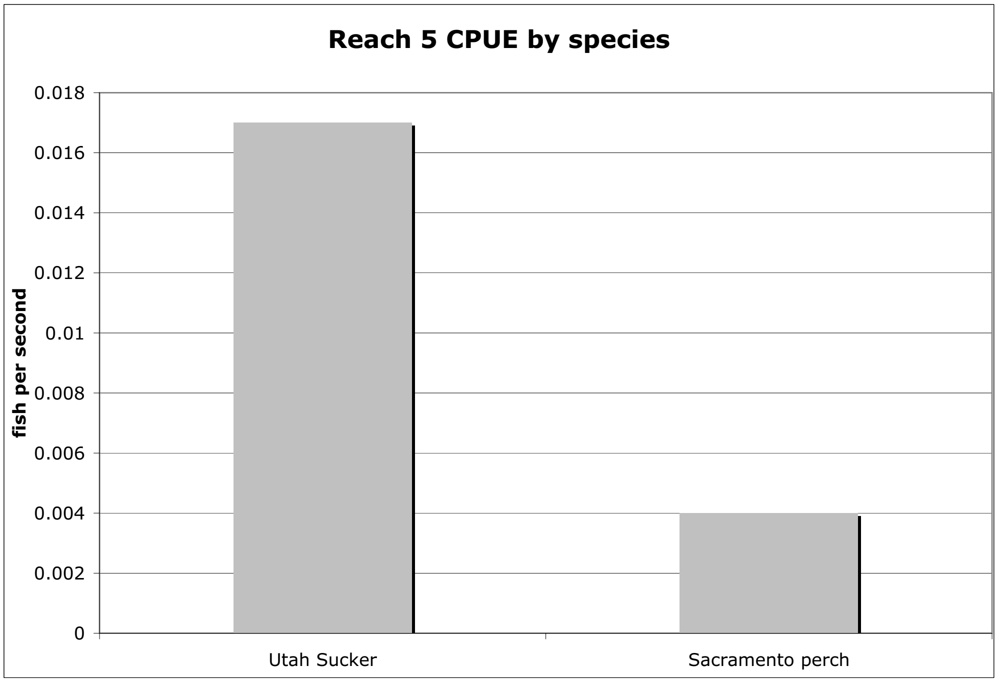


Figure 3-19
CPUE for the Native Fish Species Documented in
Big Springs Creek/Lake Creek Reach 5, September 2009

less than 0.2 m and the velocity was greater than 0.5 m/sec; however, some deeper, slower velocity pockets did occur.

At Reach 2, a total of 1,389 habitat data points were recorded, and the mean percent of the points that intersected vegetation (submergent and emergent) over the five transects was 9.6 percent (standard error = 2.98). The substrate was characterized by silt and sand. The average depth of the water for this reach ranged from 0.2 to 1.0 m, and the velocity was 0.1 to 0.5 m/sec.

At Reach 3, a total of 1,404 habitat data points were collected with a mean percent of intersected vegetation points of 6 percent (standard error = 3.72). The substrate was characterized by silt, sand, gravel, and a few boulders. Average water depth ranged from 0.2 to 1.0 m, and the velocity ranged from 0.1 to 0.5 m/sec.

At Reach 4, a total of 1,836 data points were collected with a mean percent of intersected vegetation points of 1 percent (standard error = 0.32). The substrate was characterized by sand, gravel, cobble, and boulders. Average water depth ranged from 0.2 to 1.0 m, and velocity was greater than 0.5 m/sec.

At Reach 5, a total of 1,114 data points were collected with a mean percent of intersected vegetation points of 4 percent (standard error = 1.63). The substrate was characterized by silt, sand, gravel, cobble, and some boulders. Average water depth ranged from 0.2 to 1.0 m, and velocity ranged from 0.1 to 0.5 m/sec.

Table 3-24
Length Data for Each Native Fish Species at
Big Springs Creek/Lake Creek Reaches

Species	Reach	Total Number of Fish Measured	Minimum Length (mm)	Maximum Length (mm)	Mean Length (mm)	Standard Error
Redside Shiner	1	25	60	93	71.3	1.703
	2	12	30	101	71.4	6.113
	3	8	37	92	72.5	7.813
	4	25	38	90	70.6	1.937
Speckled Dace	1	25	42	81	61.8	1.631
	2	16	46	87	69.1	2.45
	3	10	54	98	70.4	4.888
	4	25	36	83	60.5	2.662
Utah Chub	1	10	51	130	83.3	6.915
	2	3	103	144	127.3	12.441
	3	1	113	113	113	NA
	4	24	69	225	121	8.669
Utah Sucker	1	1	271	271	271	NA
	2	8	46	177	111.4	17.075
	3	5	52	190	151.4	25.563
	4	10	85	244	134.5	14.935
	5	27	51	111	62.3	2.722
Mottled Sculpin	4	25	34	75	50.4	2.202

NA - The Standard Error could not be calculated with one measurement.

3.8 Vegetation

A list of the plant taxa that occurred on the vegetation transects in 2009 is presented in Appendix F, Figure F-1.

Summaries of the 2009 vegetation data in this section are presented in order of vegetation type that the respective transects were established to monitor: aquatic (3.8.1), wetland/meadow (3.8.2), shrubland (3.8.3), and woodland (3.8.4). In each case, an overall summary is first presented that provides (1) a summary table of the sites included in the respective group with major species composition, mean overall cover, and number of species per site; (2) a list of all plant taxa that occurred on the respective transects in 2009; and (3) mean cover values for the major species in 2009, listed by site.

Following the overall summary, site-specific summaries are provided. These site-specific summaries list average cover by plant taxa overall for the site and for each transect at that site. A schematic diagram is also presented to illustrate internal spatial heterogeneity along the transects at each site.

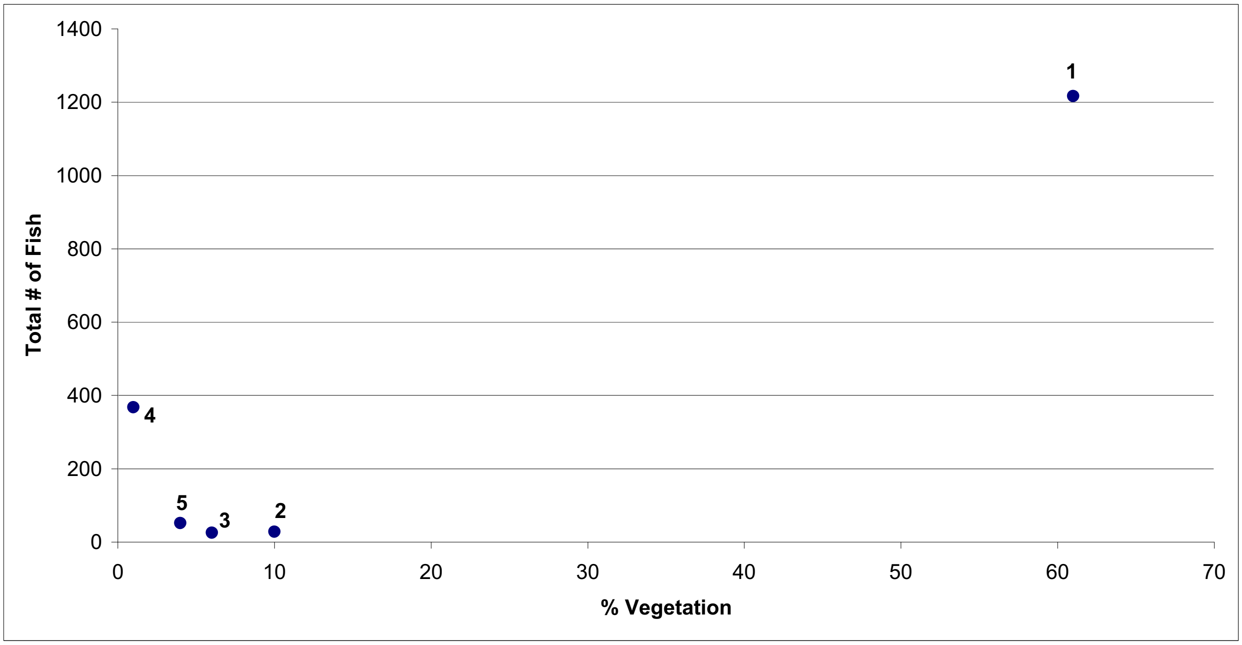


Figure 3-20
Total Number of Native Fish by Mean Percent Vegetation Points (Emergent and Submergent) for Big Springs Creek/Lake Creek Reaches (1-5)

Internal spatial heterogeneity refers to the distribution pattern of microcommunities along the transects.

Each diagram presents (1) the most abundant (i.e., dominant) species by segment (meter lengths) along each transect and (2) the distribution of the dominant species in relation to a surface hydrologic gradient. This gradient is illustrated by use of five surface moisture categories, each category representing the relative hydrologic condition of the soil surface at that point along the transect: perennial standing water (A); standing water most of the time (W); intermittently flooded, but soil saturated most of the time (S); occasionally flooded, surface soil often saturated (M); and surface soil unsaturated most of the time (D). These five categories thus represent a hydro-ecological gradient along the transect, from aquatic to relatively dry:

A ----> W ----> S ----> M ----> D

The purpose of presenting this gradient is to illustrate some of the microtopographic variability along the transect. Placement of a particular species into a respective moisture gradient category is based on the typical habitat in which that species occurs. Some species are adapted to more than one habitat type while others are always confined to one habitat type. *Juncus arcticus*, for example, typically occurs on sites that are frequently flooded, and the soil is generally saturated to the surface (S). However, this species can also occur on sites with standing water most of the time (W) and on sites where the surface soil may or may not be saturated (M or D). In contrast, *Nasturtium officinale* is an aquatic species, only occurring in perennial standing water ecosystems (A). A list of the dominant species and their associated typical moisture gradient types is presented in Appendix F, Figure F-2.

3.8.1 Aquatic Transects

3.8.1.1 Summary of Aquatic Vegetation Data Overall

Species composition varied considerably over the 14 sites containing aquatic transects (Table 3-25). Mean canopy cover was highest at Swallow Spring and the Minerva Springs Complex and was lowest at the Keegan Ranch Complex and at Willow Spring. Although average cover was low at the Keegan Ranch Complex, a large number of species were present (64), as at the Minerva Springs Complex (61). Conversely, species richness was low at North Little Spring (20), Stateline Spring (24), and Stonehouse Complex (26). Care should be taken in making direct comparisons of number of taxa between sites because the lengths of transects varied between sites (Tables F-35 to F-38). The number of taxa encountered increases as transect length increases, at least up to a point (Brown, 1954,19). The number of taxa is presented in Table 3-25 for general comparisons between sites. Mean transect length is greater at Keegan Ranch Complex (42 m; Tables F-35 to F-38) than at Stateline Springs (18 m), but mean transect length is approximately equal for Minerva Springs Complex (27 m), North Little Spring (25 m), and Stonehouse Complex (23 m).

Table 3-25
Summary of Overall Species Composition, Cover, and Number of Plant Taxa on the Aquatic Transects in 2009

Site	Composition Overall (% Cover of Major Species)						Mean Total Cover (%)	Mean Plant Coverage (%)	Number of Taxa
Stonehouse Complex	CASI	(39)	CANE	(20)	JUAR	(07)	85	75.8	26
Willow Spring	CANE	(11)	ELPA	(05)	ARAN	(05)	54.8	53.3	41
Big Springs	NAOF	(33)	ELRO	(06)	CAPR	(04)	67.7	62.3	40
Keegan Ranch Complex	CASI	(07)	THRH	(06)	CANE	(04)	53.1	51.5	64
West Spring Valley Complex	LEMI	(09)	BEER	(08)	THRH	(07)	92.6	83.5	55
South Millick Spring	BEER	(27)	SCAC	(08)	ARAN	(07)	68.6	66.5	38
Unnamed 5 Spring	CHAR	(19)	POTA	(11)	CANE	(11)	91	79	44
Four Wheel Drive Spring	CANE	(22)	JUSC	(12)	POTA	(10)	94.2	79.3	39
Willard Spring	CANE	(16)	CAPR	(09)	ARAN	(06)	76.9	70.6	47
Minerva Springs Complex	POTA	(15)	SCPR	(08)	CANE	(07)	102.3	83.1	61
Swallow Spring	POAN	(52)	ROWO	(09)	NAOF	(07)	103.6	76.4	42
North Little Spring	CANE	(46)	CASI	(17)	CHAR	(10)	94.5	91.5	20
Unnamed 1 Spring	BEER	(16)	ELRO	(13)	NAOF	(11)	69.7	67.9	44
Stateline Springs	NAOF	(38)	MOSS	(09)	JUAR	(04)	62.4	61.2	24
Overall Mean	**CANE**	**(11)**	**NAOF**	**(08)**	**CASI**	**(06)**	**79.7**	**71.6**	**42**

Note: Cover values are averages over five transects per site and number of species is the total number observed on the five transects. Numbers in parentheses following species codes are mean cover values (%) for each of the three species with the highest cover values at that site. Special codes are listed in Appendix F, Table F-2. Mean Total Cover is the mean of the cover values of all species averaged over the five transects per site, and includes multiple hits per 1-cm mark per meter. Mean Plan Coverage is the man of the percent of the length of each transect where vegetation was present (i.e., first-hit counts only).

A total of 148 plant taxa were encountered along the aquatic transects in 2009 (Table 3-26). Many (52) were infrequently encountered, occurring at only one site and usually on only one transect. Fifteen taxa occurred at 10 (71 percent) or more of the sites, and six species (*Agrostis gigantea*, *Argentina anserina*, *Berula erecta*, *Carex nebrascensis*, *Juncus arcticus*, and *Nasturtium officinale*) occurred on at least half (35) of the transects.

Table 3-26
Plant Taxa Present along Aquatic Transects in 2009
(Page 1 of 4)

Species	Mean Cover (%)	Number of Sites Where Present	Number of Transects Where Present
Achillea millefolium	0.3	5	7
Agoseris glauca	0.1	3	3
Agrostis gigantea	2.1	13	42
Algae	1.1	9	19
Alisma plantago-aquatica	0.1	1	2
Angelica sp.	t	1	1
Aqulegia formosa	0.1	3	4
Arctium minus	0.1	1	1
Argentina anserina	2.2	12	48
Artemisia tridentata	0.4	2	4
Asclepias speciosa	t	1	1
Aster sp.	0.1	2	4
Atriplex micrantha	t	1	2
Atriplex serenana	t	1	2
Bassia scoparia	0.2	6	11
Berula erecta	5.5	14	50
Bidens cernua	0.1	2	3
Bromus inermis	t	1	2
Bromus tectorum	t	4	6
Cardaria draba	t	2	2
Carex aurea	t	1	1
Carex nebrascensis	10.6	14	64
Carex praegracilis	2.1	12	34
Carex rostrata	0.5	3	5
Carex simulata	5.9	10	28
Carex sp.	0.7	9	12
Castilleja minor	t	1	1
Catabrosa aquatica	0.1	1	2
Chara sp.	2.7	7	12
Chenopodium berlandieri	0.1	1	2
Chenopodium incanum	t	1	1
Chenopodium sp.	0.1	4	4
Cirsium arvense	0.5	1	3
Cirsium scariosum	0.2	9	17

Table 3-26
Plant Taxa Present along Aquatic Transects in 2009
(Page 2 of 4)

Species	Mean Cover (%)	Number of Sites Where Present	Number of Transects Where Present
Cirsium vulgare	0.1	4	5
Clematis ligusticifolia	0.1	1	1
Convolvulus arvensis	t	2	2
Crepis runcinata	0.1	4	5
Deschampsia caespitosa	0.3	3	9
Descurainia sophia	t	3	3
Distichlis spicata	0.7	12	24
Elaeagnus angustifolia	t	1	1
Eleocharis palustris	1.8	12	31
Eleocharis rostellata	2	6	19
Eleocharis sp.	t	3	3
Elymus trachycaulus	0.3	5	7
Epilobium ciliatum	0.1	6	8
Epilobium sp.	0.1	7	16
Equisetum arvense	0.3	11	32
Ericameria nauseosa	0.1	6	7
Erigeron lonchophyllus	t	5	6
Galium trifidum	t	2	3
Gentianella amarelle	t	1	1
Glaux maritima	0.1	8	14
Grindelia squarrosa	t	1	1
Halogeton glomeratus	t	1	1
Helianthus nuttalii	t	2	3
Hippuris vulgaris	0.2	3	8
Hordeum brachyantherum	0.1	4	9
Hordeum jubatum	0.9	6	12
Hymenoxys lemmonii	0.1	3	5
Iris missouriensis	0.2	3	6
Iva axillaris	0.3	3	7
Ivesia kingii	0.1	2	3
Juncus arcticus	2.6	14	56
Juncus nevadensis	1.1	9	26
Juncus saximontanus	t	1	1
Juncus sp.	t	1	1
Juncus torreyi	t	4	4
Juniperus scopulorum	0.9	1	2
Lactuca serriola	t	1	1
Lemna minor	0.6	3	6
Lemna minuta	0.1	2	5
Lemna sp.	0.1	4	4

Table 3-26
Plant Taxa Present along Aquatic Transects in 2009
(Page 3 of 4)

Species	Mean Cover (%)	Number of Sites Where Present	Number of Transects Where Present
Lemna trisulca	t	2	3
Leymus triticoides	0.5	11	30
Lianthus pungens	t	1	1
Maianthemum racemosum	t	1	1
Medicago polymorpha	0.3	4	7
Melilotus officinalis	0.2	5	9
Mentha spicata	0.1	3	4
Mimulus guttatus	0.6	13	33
Moss	2.1	10	23
Muhlenbergia asperifolia	t	1	2
Muhlenbergia richardsonis	0.1	9	10
Myriophyllum verticillatum	t	1	1
Nasturtium officinale	8.1	12	40
Phleum pratense	t	3	4
Phragmites australis	0.2	1	1
Plantago major	0.1	2	2
Poa pratensis	1.3	12	31
Poa secunda	0.1	3	4
Poa sp.	t	1	1
Polygonum aviculare	0.2	5	8
Polypogon monspeliensis	t	4	6
Populus angustifolia	2.7	1	5
Potamogeton sp.	2.8	7	17
Potentilla gracilis	t	2	2
Potentilla hippiana	t	1	1
Potentilla pensylvanica	t	1	2
Puccinellia distans	0.1	1	3
Puccinellia lemmonii	0.1	6	14
Pyrrocoma lanceolata	0.1	5	6
Ranunculus aquatilis	t	2	2
Ranunculus cymbalaria	t	4	4
Ranunculus sceleratus	0.1	6	10
Rhus trilobata	0.4	2	3
Ribes sp.	t	1	1
Rorippa sinuata	0.5	1	2
Rosa woodsii	1.8	7	14
Rumex crispus	0.1	5	6
Sagittaria cuneata	t	1	1
Salix sp.	0.4	1	1
Salsola tragus	t	1	2

Table 3-26
Plant Taxa Present along Aquatic Transects in 2009
(Page 4 of 4)

Species	Mean Cover (%)	Number of Sites Where Present	Number of Transects Where Present
Sambucus nigra	0.1	1	1
Schedonorus pratensis	1	6	13
Schoenoplectus acutus	0.7	4	11
Schoenoplectus americanus	0.1	6	9
Schoenoplectus pungens	t	2	3
Sida neomexicana	t	1	1
Sisyrinchium halophilum	0.1	9	19
Sium suave	t	1	1
Solidago sp.	t	4	4
Sparganium eurycarpum	0.4	5	10
Spartina gracilis	0.1	3	5
Sphenopholis obtusata	0.1	3	6
Sporobolus airoides	0.1	3	8
Stuckenia filiformis	0.5	3	7
Symphyotrichum eatonii	0.2	4	12
Symphyotrichum spathulatum	t	1	4
Taraxacum officinale	0.2	8	20
Thermopsis rhombifolia	1.5	5	13
Trifolium fragiferum	t	1	1
Trifolium hybridum	t	2	2
Trifolium pratense	0.1	1	4
Trifolium repens	0.2	5	11
Trifolium sp.	t	1	1
Triglochin maritima	t	1	1
Typha latifolia	0.6	3	8
Typha sp.	0.1	1	1
Unknown t	1	1	
Urtica dioica	t	1	1
Utricularia macrorhiza	0.8	2	4
Verbascum thapsus	t	1	1
Veronica anagallis-aquatica	0.2	6	10
Viola nephrophylla	t	1	1
Xanthium strumarium	t	1	1
Zannichellia palustris	t	1	1

Mean cover = Average of the 14 site means.
Total number of sites = 14.
Total number of transects = 70.
A “t” indicates a trace amount (<0.05%).

Carex nebrascensis was the most abundant species, which had a mean cover of 10.6 percent and occurred at all 14 sites and on 64 (91 percent) of the transects (Table 3-26). The other most abundant species were *Nasturtium officinale* (8.1 percent mean cover, 12 sites, 40 transects), *Carex simulata* (5.9 percent mean cover, 10 sites, 28 transects), *Berula erecta* (5.5 percent mean cover, 14 sites, 50 transects), *Juncus arcticus* (2.6 percent mean cover, 14 sites, 56 transects), *Potamogeton sp*. (2.8 percent mean cover, 7 sites, 17 transects), and *Chara sp*. (2.7 percent mean cover, 7 sites, 12 transects).

3.8.1.2 Summary of Aquatic Transect Data by Site

Species composition along the aquatic transects varied substantially among the 14 sites (Table 3-27). Twenty-six taxa were most abundant across the 14 sites, having at least 5 percent mean cover at one or more site. Each site was dominated by 2 to 7 of these 26 species.

3.8.1.2.1 Stonehouse Complex

The major species, by overall mean cover, on the aquatic transects at the Stonehouse Complex were *Carex simulata* (39 percent), *Carex nebrascensis* (20 percent), *Juncus arcticus* (7 percent), and *Nasturtium officinale* (6 percent) (Table 3-28). A total of 26 taxa occurred on the transects in 2009; this total was relatively low compared across all sites (Table 3-25). Total overall cover averaged 85 percent; this was the average for the 14 sites.

Carex simulata was the major species along all but one of the transects 040 (Table 3-28). *Carex nebrascensis* was a major species on all five transects. *Juncus arcticus* was a major species on three transects, while *Nasturtium officinale* was a major species on two. No other species had a cover value of at least 10 percent of the total for any transect.

Internal spatial heterogeneity was considerable along the individual transects (Figure 3-21). *Carex simulata* was the most frequent dominant species, being the dominant in 10 of the 33 microcommunities along the transects, with a combined length of 59 m out of a total of 114 m included in the five transects (Figure 3-21). *Carex nebrascensis* was the second most frequent dominant, being the dominant in nine microcommunities with a combined length of 27 m. *Juncus arcticus* was the third most frequent dominant (six microcommunities and 14 m).

3.8.1.2.2 Willow Spring

Forty-one taxa were recorded along the aquatic transects at Willow Spring in 2009 (Table 3-29). This diversity was in the moderate range for the 14 sites overall (Table 3-25). The three taxa with highest overall mean cover were *Carex nebrascensis* (11 percent), *Eleocharis palustris* (5 percent), and *Argentina anserina* (6 percent). The overall aquatic plant community at this site is relatively diverse. Of the 41 plant taxa encountered, only two (*A. anserina and E. palustris*) occurred on all five transects. Total plant cover averaged 55 percent; this was the second lowest overall mean of the 14 sites (Table 3-25).

Table 3-27
Mean Percent Cover of Major Species in 2009 at the 14 Sites with Aquatic Transects
(Page 1 of 2)

Species	STON	WLLW	KGAN	WSPR	MLLK	UNM5	4WDS	WLRD	MNRV	SWAL	NLTL	BIGS	UNM1	STLN
Achillea millefolium	---	---	0.8	0.1	---	---	---	3.6	t	t	---	---	---	---
Agrostis gigantea	t	2.3	0.5	6.5	2.1	0.5	1.1	2.2	6.7	3.3	---	1.5	2.1	1
Algae	0.4	0.8	1.2	---	---	3.4	---	---	1.1	---	4.1	2.4	0.4	1.4
Alisma plantago-aquatica	---	---	---	---	---	---	1.2	---	---	---	---	---	---	---
Arctium minus	---	---	---	---	---	---	1.4	---	---	---	---	---	---	---
Argentina anserina	---	4.9	1.7	0.9	6.5	2.8	2	6.4	0.6	---	0.8	1.7	0.2	2
Artemisia tridentata	---	3.8	---	---	---	---	1.1	---	---	---	---	---	---	---
Berula erecta	1.8	0.7	0.2	8.7	27.1	6	4.6	0.4	2.8	5.3	2.8	0.1	16	0.6
Carex nebrascensis	19.7	11.2	3.9	4.6	2.8	11.1	21.9	15.8	7.2	1	46.1	0.9	1.4	0.9
Carex praegracilis	---	0.7	3	5.7	0.9	0.4	t	8.9	1.5	0.2	3.6	3.5	1.2	---
Carex rostrata	1.5	---	---	1.4	---	3.4	---	---	---	---	---	---	---	---
Carex simulata	39.3	1.7	6.9	0.7	0.5	4.4	7.9	2.9	1	---	17.1	---	---	---
Carex sp.	---	---	1.4	2.9	0.3	0.1	1.9	0.1	---	t	---	0.2	2.2	---
Catabrosa aquatica	1.2	---	---	---	---	---	---	---	---	---	---	---	---	---
Chara sp.	---	1.3	0.2	---	---	19.3	---	---	3.8	0.2	9.9	---	2.5	---
Cirsium arvense	---	---	---	7	---	---	---	---	---	---	---	---	---	---
Cirsium scariosum	---	0.1	0.2	---	0.3	0.1	---	1	0.1	---	---	0.2	0.1	0.2
Cirsium vulgare	---	1	0.3	---	0.2	---	---	---	t	---	---	---	---	---
Clematis ligusticifolia	---	---	---	---	---	---	---	---	---	1	---	---	---	---
Deschampsia caespitosa	t	---	---	---	---	---	---	3.4	---	---	---	---	0.6	---
Distichlis spicata	t	0.3	0.1	0.9	1.5	0.1	2.3	0.2	2.7	---	---	0.4	0.5	0.1
Eleocharis palustris	3.9	5.2	0.2	0.3	t	3.1	6.6	---	1.4	t	2.9	---	0.1	1.1
Eleocharis rostellata	---	---	---	3.1	---	1.1	---	---	3.7	---	---	5.7	13.4	1.2
Elymus trachycaulus	---	---	---	1.6	t	---	---	0.3	1.9	---	---	---	0.3	---
Equisetum arvense	---	0.4	t	1.2	1.5	0.2	t	0.7	0.1	---	---	t	0.1	0.2
Hippuris vulgaris	---	---	1.1	---	---	2.1	---	0.1	---	---	---	---	---	---
Hordeum brachyantherum	---	0.2	0.1	---	---	---	---	1.1	0.2	---	---	---	---	---
Hordeum jubatum	---	---	0.1	t	---	---	---	4.6	6.2	---	---	1.2	0.1	---
Iris missouriensis	0.9	1.2	0.1	---	---	---	---	---	---	---	---	---	---	---
Iva axillaris	---	2.5	---	1.5	---	---	---	---	---	0.2	---	---	---	---
Juncus arcticus	7.2	2.3	2.3	3.9	3.3	1.6	0.2	2.6	1.1	0.2	3.5	2.4	2.4	3.7
Juncus nevadensis	---	---	0.1	0.8	4.3	1.4	3.7	2.7	1.7	---	0.3	---	0.5	---
Juniperus scopulorum	---	---	---	---	---	---	12.1	---	---	---	---	---	---	---
Lemna minor	---	---	---	8.9	---	---	---	---	t	---	---	---	0.1	---
Lemna minuta	---	---	0.2	---	1.6	---	---	---	---	---	---	---	---	---
Leymus triticoides	0.1	---	2.3	0.3	0.3	0.1	0.1	2.4	1	---	---	0.8	0.2	t

Table 3-27
Mean Percent Cover of Major Species in 2009 at the 14 Sites with Aquatic Transects
(Page 2 of 2)

Species	STON	WLLW	KGAN	WSPR	MLLK	UNM5	4WDS	WLRD	MNRV	SWAL	NLTL	BIGS	UNM1	STLN
Medicago polymorpha	---	---	---	1.4	---	---	---	---	1	1.9	---	---	t	---
Melilotus officinalis	---	---	t	t	---	---	---	---	1.8	t	---	1	---	---
Mimulus guttatus	0.1	1	0.1	2.2	0.6	0.1	0.4	0.2	1.7	0.1	0.3	0.3	1	---
Moss	0.6	0.2	3.9	---	---	0.4	0.7	---	1.2	1	---	3.3	8.9	8.6
Nasturtium officinale	6.1	3.4	0.6	2.3	5.4	---	2.3	0.2	4.1	7.4	---	32.9	10.9	38.1
Phragmites australis	---	---	---	3	---	---	---	---	---	---	---	---	---	---
Poa pratensis	---	1.1	1.1	3	0.1	0.2	0.2	5	1.6	4.7	0.7	0.9	0.1	---
Poa secunda	---	---	---	t	---	t	---	---	---	1.3	---	---	---	---
Polygonum aviculare	---	t	---	t	---	t	---	0.3	2	---	---	---	---	---
Populus angustifolia	---	---	---	---	---	---	---	---	---	51.9	---	---	---	---
Potamogeton sp.	---	---	0.4	0.4	---	11.1	10.2	---	14.5	---	---	1.1	---	1.7
Ranunculus sceleratus	0.2	0.5	---	---	---	t	---	t	t	---	1	---	---	---
Rhus trilobata	---	---	---	---	---	---	0.2	---	---	4.7	---	---	---	---
Rorippa sinuata	---	---	---	---	---	---	---	6.4	---	---	---	---	---	---
Rosa woodsii	---	1.9	---	---	---	---	6	---	6.5	9	0.8	0.2	0.1	---
Salix sp.	---	---	---	---	---	---	---	---	---	5.2	---	---	---	---
Sambucus nigra	---	---	---	---	---	---	---	---	---	1.4	---	---	---	---
Schedonorus pratensis	0.1	---	0.5	1.2	---	---	---	---	7.9	---	---	3.3	1.3	---
Schoenoplectus acutus	t	---	0.8	1.1	7.8	---	---	---	---	---	---	---	---	---
Sparganium eurycarpum	---	---	0.2	0.6	---	4.4	---	---	0.1	0.1	---	---	---	---
Stuckenia filiformis	---	---	0.1	---	3.7	---	---	---	3.8	---	---	---	---	---
Symphyotrichum eatonii	---	---	---	1.7	0.2	0.3	---	---	0.1	---	---	---	---	---
Taraxacum officinale	---	t	1	0.7	---	t	---	1.3	0.1	0.2	---	---	0.1	---
Thermopsis rhombifolia	---	---	6.2	7.4	---	---	0.7	0.5	6.5	---	---	---	---	---
Trifolium pratense	---	---	---	---	---	---	---	---	1.2	---	---	---	---	---
Trifolium repens	---	---	1.1	1.3	---	0.3	---	---	t	---	---	0.3	---	---
Typha latifolia	---	3.3	3.7	---	---	---	0.9	---	---	---	---	---	---	---
Typha sp.	---	---	1.7	---	---	---	---	---	---	---	---	---	---	---
Utricularia macrorhiza	---	---	0.4	---	---	11.1	---	---	---	---	---	---	---	---

Major species = species with at least 1% mean cover at any of the 14 sites.
A “t” indicates a trace amount (<0.05%).
Dashed lines (---) indicate that the species was absent (cover = 0.0).
Sites: Stonehouse Complex (STON); Willow Spring (WLLW); Keegan Ranch Complex (KGAN); West Spring Valley Complex (WSPR); South Millick Spring (MLLK); Unnamed 5 Spring (UNM5); Four Wheel Drive Spring (4WDS); Willard Spring (WLRD); Minerva Springs Complex (MNRV); Swallow Spring (SWAL); North Little Spring (NLTL); Big Springs (BIGS); Unnamed 1 Spring (UNM1); Stateline Springs (STLN).

Table 3-28
Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the Stonehouse Complex in 2009

Species	Overall Mean	Transects				
		039	040	041	042	043
Agrostis gigantea	t	0.1	0.0	0.0	0.0	0.0
Algae	0.4	0.0	0.0	0.0	0.0	2.2
Berula erecta	1.8	0.0	4.5	0.0	0.0	4.7
Carex nebrascensis	19.7	22.0	28.9	9.8	10.2	27.6
Carex rostrata	1.5	0.0	0.0	0.0	3.8	3.7
Carex simulata	39.3	41.2	7.9	39.3	57.0	51.1
Catabrosa aquatica	1.2	0.0	4.3	1.7	0.0	0.0
Deschampsia caespitosa	t	0.2	0.0	0.0	0.0	0.0
Distichlis spicata	t	0.2	0.0	0.0	0.0	0.0
Eleocharis palustris	3.9	1.9	1.0	1.2	0.0	15.3
Iris missouriensis	0.9	2.9	1.6	0.0	0.0	0.0
Juncus arcticus	7.2	8.2	12.0	13.2	0.7	2.0
Leymus triticoides	0.1	0.0	0.3	0.0	0.0	0.0
Mimulus guttatus	0.1	0.0	0.1	0.0	0.0	0.4
Moss	0.6	0.0	3.1	0.0	0.0	0.0
Nasturtium officinale	6.1	0.0	15.6	11.9	3.0	0.0
Puccinellia distans	0.8	0.6	0.8	2.5	0.0	0.0
Pyrrocoma lanceolata	0.1	0.0	0.3	0.0	0.0	0.0
Ranunculus cymbalaria	0.2	0.0	0.0	1.1	0.0	0.0
Ranunculus sceleratus	0.2	0.5	0.5	0.0	0.0	0.0
Schedonorus pratensis	0.1	0.0	0.0	0.3	0.0	0.0
Schoenoplectus acutus	t	0.0	0.0	0.1	0.0	0.0
Schoenoplectus americanus	0.6	0.0	0.0	0.0	3.2	0.0
Solidago sp.	0.1	0.5	0.0	0.0	0.0	0.0
Veronica anagallis-aquatica	t	0.0	0.2	0.0	0.0	0.0
Zannichellia palustris	0.1	0.0	0.0	0.3	0.0	0.0
Total	**85.0**	**78.3**	**81.1**	**81.4**	**77.9**	**107.0**
Number of Species	**26**	**11**	**15**	**11**	**6**	**8**

Transect means are averages by meter, and overall mean is the average of the five transect means.
A “t” indicates a trace amount (<0.05%).

```
39   CANE         CASI        JUAR         CASI        CANE JUAR                    SPECIES
    01--03 04--------------12  13  14----------------23 24 25-26                   METERS
     S--S   W--------------W  S--S  W----------------W   S----S                    GRADIENT

40   JUAR   CANE MOSS CANE   NAOF    CANE   CASI        CANE      JUAR             SPECIES
    01--03 04--06 07 08-09 10----13 14--16 17-18 19----------25 26--28             METERS
     S---------S A--A S--S  A----A   S--S   W--W  S---------------- S              GRADIENT

41   JUAR CAAQ CASI   NAOF        CASI        CANE  JUAR                           SPECIES
    01--03 04 05--07 08-09 10------------17 18-19 20-21                            METERS
     S--S A--A W--W  A---A  W------------W   S-------S                             GRADIENT

42    CANE      CASI     CARO  OPEN SCAM              CASI                         SPECIES
    01----04 05------09 10-11 12-13 14 15----------------------------30            METERS
     S----S   W------------W  A------A  W----------------------------W             GRADIENT

43   CASI ELPA  CASI    CANE  CASI                                                 SPECIES
      01   02  03--05 06-07 08-09                                                  METERS
     W-------------W  S---S  W--W                                                  GRADIENT
```

Species codes are: CAAQ (*Catabrosa aquatic*), CANE (*Carex nebrascensis*), CARO (*Carex rostrata*), CASI (*Carex simulata*), ELPA (*Eleocharis palustris*), JUAR (*Juncus arcticus*), MOSS (moss), NAOF (*Nasturtium officinale*), OPEN (open water), and SCAM (Schoenoplectus americanus). Moisture gradient (GRADIENT) codes: S = intermittently flooded; W = mostly standing water; A = perennial standing water.

Figure 3-21
Spatial Heterogeneity (Most Abundant Species by Meter)
along the Five Aquatic Transects (39-43) at the Stonehouse Complex in 2009

Table 3-29
Mean Percent Cover, Overall and Species,
of Vegetation along Aquatic Transects at Willow Spring in 2009
(Page 1 of 2)

Species	Overall Mean	Transects				
		049	050	051	052	053
Agoseris glauca	0.1	0.3	0	0	0	0
Agrostis gigantea	2.3	6.7	3.2	1.7	0	0
Algae	0.8	3.8	0	0	0	0
Argentina anserina	4.9	6.5	8	4.7	4	1.3
Artemisia tridentata	3.8	0	14	5	0	0
Atriplex serenana	0.3	0	1	0	0.4	0
Berula erecta	0.7	3.1	0	0.6	0	0
Bidens cernua	0.6	0	0	0	2.3	0.6
Bromus tectorum	t	0	0	0	0.1	0
Carex nebrascensis	11.2	10.5	21.3	24.2	0	0.1
Carex praegracilis	0.7	3.5	0	0	0	0
Carex simulata	1.7	0	6.1	2.3	0	0
Chara sp.	1.3	0	3.4	3.3	0	0
Chenopodium berlandieri	0.9	0	0	0	1.4	3.3
Cirsium scariosum	0.1	0.5	0	0	0	0
Cirsium vulgare	1	1.4	0	3.6	0	0
Descurainia sophia	0.1	0	0	0	0.3	0
Distichlis spicata	0.3	0	1.2	0.3	0.1	0
Eleocharis palustris	5.2	2.5	4.8	17.1	0.5	1.2

Table 3-29
Mean Percent Cover, Overall and Species,
of Vegetation along Aquatic Transects at Willow Spring in 2009
(Page 2 of 2)

Species	Overall Mean	Transects				
		049	050	051	052	053
Epilobium ciliatum	t	0.2	0	0	0	0
Equisetum arvense	0.4	1	0.8	0.2	0	0
Ericameria nauseosa	0.1	0	0.4	0	0	0
Hordeum brachyantherum	0.2	0	0	0.8	0	0
Hymenoxys lemmonii	0.2	0.9	0	0	0	0
Iris missouriensis	1.2	5.5	0	0	0.6	0
Iva axillaris	2.5	0.8	0	2.2	0	9.7
Juncus arcticus	2.3	11.4	0	0.3	0	0
Lactuca serriola	t	0	0	0	0	0.1
Mentha spicata	0.1	0	0.5	0	0	0
Mimulus guttatus	1	0.8	1.9	2.4	0	0
Moss	0.2	1.2	0	0	0	0
Nasturtium officinale	3.4	7.2	8.2	1.7	0	0
Poa pratensis	1.1	5.3	0	0.1	0	0
Polygonum aviculare	t	0	0	0	0	0.2
Ranunculus scelaeratus	0.5	0	1.2	0.7	0.4	0
Rosa woodsii	1.9	2.7	2.8	3.9	0	0
Schoenoplectus americanus	t	0	0	0	0.2	0
Sisyrinchium halophilum	0.2	0.7	0	0.4	0	0
Solidago sp.	0.2	1	0	0	0	0
Taraxacum officinale	t	0.2	0	0	0	0
Typha latifolia	3.3	0	0	0	10.9	5.4
Total	**54.8**	**77.7**	**78.8**	**75.5**	**21.2**	**21.9**
Number of Species	**41**	**24**	**16**	**20**	**12**	**9**

Transect means are averages by meter, and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05%).

Carex nebrascensis had the highest cover value on two of the transects and *Iva axillaris*, *Juncus arcticus*, and *Typha latifolia* were the major species along one of each of the remaining transects. Other major species (>10 percent of the respective transect mean) were *Artemisia tridentata* (1 transect), *Bidens cernua* (1 transect), *Chenopodium berlandieri* (1 transect), and *Nasturtium officinale* (1 transect).

Internal spatial heterogeneity was considerable along the individual transects (Figure 3-22). *Carex nebrascensis* was the most frequent dominant, being the dominant species on 6 of the 36 microcommunity segments. *Nasturtium officinale* was the second most frequent, being the dominant species on four segments. However, *Typha latifolia* was dominant over the longest amount of the transects, being dominant over 22 of the 85 m of combined transects (Figure 3-22).

```
49  CANE   NAOF CANE  NAOF  ARAN   IRMI   JUAR    AGGI NAOF BEER ALGA CANE  POPR  CAPR    SPECIES
   01--03 04-05  06  07-08 09--11 12-13 14----17  18   19   20   21   22  23-24 25-26   METERS
   S---S  A--A  S--S A---A M----M S-----------S  W--W A------------A S--S M---M S---S   GRADIENT

50  ARTR  CASI  NAOF   CANE    ARAN                                                     SPECIES
   01-02   03    04  05----08 09-10                                                     METERS
   D---D W----W A--A  S----S  M---M                                                     GRADIENT

51  ARTR  CANE   CHAR  CANE  ELPA  CASI                                                 SPECIES
   01-02 03--05   06    07    08    09                                                  METERS
   D---D S----S A----A S---S W--------W                                                 GRADIENT

52  ARAN  BICE             TYLA              BRTE  BARE                                 SPECIES
   01-02 03--05 06----------------------18    19    20                                  METERS
   M---M S----S A----------------------A  D---------D                                   GRADIENT

53  IVAX          TYLA        BICE  CHBE   IVAX                                         SPECIES
   01--03 04--------------12   13  14-15 16----19                                       METERS
   S----S A---------------A   S--S  D--D  S-----S                                       GRADIENT
```

Species codes are: AGGI (*Agrostis gigantea*), ALGA (algae), ARAN (*Argentina anserina*), ARTR (*Artemisia tridentata*) BARE (bare ground), BEER (*Berula erecta*), BICE (Bidens cernua), BRTE (Bromus tectorum), CANE (*Carex nebrascensis*), CAPR (*Carex praegracilis*), CASI (*Carex simulata*), CHAR (*Chara sp.*), ELPA (*Eleocharis palustris*), IRMI (Iris missouriensis), JUAR (*Juncus arcticus*), NAOF (*Nasturtium officinale*), POPR (*Poa pratensis*), and TYLA (Typha latifolia). Moisture gradient (GRADIENT) codes: S = intermittently flooded; W = mostly standing water; A = perennial standing water.

Figure 3-22
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (49-53) at Willow Creek in 2009

3.8.1.2.3 Keegan Ranch Complex

Major taxa, by overall mean cover, on the aquatic transects at the Keegan Ranch Complex were *Carex simulata* (7 percent), *Thermopsis rhombifolia* (6 percent), *Carex nebrascensis* (4 percent), moss (4 percent), and *Typha latifolia* (4 percent) (Table 3-30). A total of 64 taxa occurred on the transects in 2009; this number was the highest of the 14 sites (Table 3-25). Total overall cover averaged 53 percent (Table 3-30); this was the lowest mean of all 14 sites (Table 3-25).

The vegetation covered by the five transects was diverse. *Carex simulata* was the only species to be a major species on more than one of the five transects (Table 3-30). It was dominant on two transects and the second most abundant on a third. *Thermopsis rhombifolia* and *Typha* (*T. latifolia and Typha sp.*) were each the most abundant on one transect and the second most abundant on a second transect. Other major taxa (10 percent or more of the total cover of a respective transect) were *Carex nebrascensis* (two transects), *Carex praegracilis* (one transect), *Leymus triticoides* (one transect), and moss (one transect).

Internal spatial heterogeneity was high along the transects (Figure 3-23). *Carex nebrascensis* was the most common dominant species, dominating 7 of the 57 microcommunity segments, with a total of 21 of the 346 m along the combined transects. *Carex simulata* and *Typha latifolia* were more dominant at slightly fewer segments (five each) than *Carex nebrascensis*; they were dominant over a longer distance (52 and 37 m, respectively). *Typha sp.* was dominant over two additional segments, covering 28 m. *Thermopsis rhombifolia* was also a common dominant, dominating six segments covering 41 m.

Table 3-30
Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the Keegan Ranch Complex in 2009
(Page 1 of 2)

Species	Overall Mean	Transects				
		021	027	080	093	150
Achillea millefolium	0.8	4	0	0	0	0
Agoseris glauca	t	0.1	0	0	0	0
Agrostis gigantea	0.5	0.8	0	0.9	0.6	0
Algae	1.2	0	0	3.2	0.3	2.7
Argentina anserina	1.7	1.3	5.8	0.2	0.6	0.7
Berula erecta	0.2	0	0	0.2	t	0.6
Bidens cernua	0.2	0	0	0	0	1.1
Carex nebrascensis	3.9	3.2	4.1	2.8	4.8	4.6
Carex praegracilis	3	6	6.3	1.2	0	1.7
Carex simulata	6.9	0	9.8	3.9	19.9	0.9
Carex sp.	1.4	4.6	0	2.3	0	0.3
Chara sp.	0.2	0	0	0.1	0	1.1
Cirsium scariosum	0.2	0	1	0	0	0
Cirsium vulgare	0.3	1.4	0	0	0	0
Crepis runcinata	0.7	0	3.6	0	0	0
Distichlis spicata	0.1	0	0	0	0.4	0
Eleocharis palustris	0.2	0.9	t	0.3	0	0
Epilobium ciliatum	0.1	0	0	0	0.4	0.1
Epilobium sp.	0.1	0.1	0	0.4	0	0.2
Equisetum arvense	t	t	0	0	0	0
Ericameria nauseosa	0.2	0	0	0	0.8	0
Erigeron lonchophyllus	t	0	0	0	0	0.1
Galium trifidum	0.3	0	0	0	0.3	1
Glaux maritima	0.1	0	0.3	0	0	0
Hippuris vulgaris	1.1	0	0	2.2	3.1	0
Hordeum brachyantherum	0.1	0.2	0.1	0	0	0
Hordeum jubatum	0.1	0.1	0.3	0	0	0
Iris missouriensis	0.1	0.1	0.5	0	0	0
Juncus arcticus	2.3	5.1	3.1	1.1	1.1	0.9
Juncus nevadensis	0.1	0	0	0	0.2	0.4
Lemna minuta	0.2	0	0	0	1.2	0
Lemna trisulca	0.4	0	0	0	0.9	1.1
Lemna sp.	0.1	0	0	0.6	0	0
Leymus triticoides	2.3	4.9	6.2	0.2	0	0.2

Table 3-30
Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the Keegan Ranch Complex in 2009
(Page 2 of 2)

Species	Overall Mean	Transects				
		021	027	080	093	150
Melilotus officinalis	t	t	0	0	0	0
Mimulus guttatus	0.1	0	0	0	0	0.6
Moss	3.9	16.9	0	2.4	0	0
Muhlenbergia richardsonis	0.1	0.2	0.3	0	0	0
Nasturtium officinale	0.6	3.1	0	0	0	0
Phleum pratense	0.1	0.5	0	t	0	0
Poa pratensis	1.1	4.7	0.5	0.5	0	0
Potamogeton sp.	0.4	0	0	0.7	1.1	0.2
Potentilla pensylvanica	0.1	0	0	0.2	0	0.5
Puccinellia lemmonii	0.2	0.2	0.3	0	0.3	0
Ranunculus aquatilis	t	0	0	0	0.1	0
Ranunculus cymbalaria	t	0	0	0	0	0.1
Rumex crispus	0.1	0.4	0	0	0	0
Schedonorus pratensis	0.5	2.4	0	0	0	0
Schoenoplectus acutus	0.8	0	0.1	3.3	0.1	0.5
Schoenoplectus americanus	0.4	0	0	0	0	2.1
Sida neomexicana	0.1	0.3	0	0	0	0
Sisyrinchium halophilum	0.1	0.2	0	0.3	0	0
Sium suave	t	0	0	0	0	0.2
Solidago sp.	0.1	0.6	0	0	0	0
Sparganium eurycarpum	0.2	0	0	0.2	0.7	0
Sporobolus airoides	t	0	0	0	0	0.1
Stuckenia filiformis	0.1	0	0	0	0.6	0
Taraxacum officinale	1	3	1.8	0.1	0	0
Thermopsis rhombifolia	6.2	14.5	14.8	1.9	0	0
Trifolium repens	1.1	0.4	0.2	1.5	1	2.4
Typha latifolia	3.7	0	0.8	1.5	8.2	8
Typha sp.	1.7	0	0	0	0	8.5
Utricularia macrorhiza	0.4	0	0	2.2	0	0
Veronica anagallis-aquatica	0.9	4.5	0	0	0	0
Total	**53.1**	**84.6**	**59.9**	**34.4**	**46.7**	**40.9**
Number of Species	**64**	**32**	**21**	**28**	**23**	**28**

Transect means are averages by meter, and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05%).

```
021   SCPR  AGGI  THRH  CAPR  POPR  THRH  CAPR  MOSS  LETR  THRH  LETR  THRH  CARX       SPECIES
     01-04 05-06 07-08 09-15 16-17 18-20 21-23 24-56 57-72 73-76 77-81 82-88 89-100      METERS
     S--------S  M---M S---S M--------M  S---S A---A S---S M---M S---S M---------M       GRADIENT

027      CAPR        THRH       ARAN   CRRU      CASI      CANE  TYLA  CAPR  CANE  ARAN      SPECIES
     01-------22 23-------46 47--54 55-58 59-------84 85-88 89-95 96-98   99    100      METERS
     S---------S M---------------M  S---S W--------W  S---S A---A S---------S M----M      GRADIENT

080   TRRE  CANE  CASI  ALGA  CARX  MOSS  POTA  TYPH  SCAC  UTMA  SCAC  CANE  THRH       SPECIES
     01-02 03-04 05-09 10-13 13-17 18-19 20-23 24-30 31-32 33-34 34-41 42-46   47        METERS
     M---M S---S W---W A---A W---W A-------------------------------A S---S  M--M        GRADIENT

093   CANE       CASI      TYLA  LETR    HIVU    STFI     TYLA        CASI      JUAR       SPECIES
     01--03 04--------13 14--16  17   18-----23 24-25 26-------33 34--------42  43       METERS
     S----S W----------W A---A  S--S  W------W A---------------A W---------W S---S       GRADIENT

150   POPR  CANE  TYLA  SCAM   TYLA     TYPH    LETR  CHAR  CASI  CANE  TRRE  ARAN       SPECIES
       01  02-04 05-11 12-13 14---25 26-----46 47-48   49  50-51 52-54   55    56        METERS
      M--M S---S A---------------------------A S---S A----A W--W S---S  M--------M       GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (021-150) at Keegan Ranch Complex in 2009. Species codes are: AGGI (*Agrostis gigantea*), ALGA (algae), ARAN (*Argentina anserina*), CANE (*Carex nebrascensis*), CAPR (*Carex praegracilis*), CARX (*Carex sp.*), CASI (*Carex simulata*), CHAR (*Chara sp.*), CRRU (*Crepis runcinata*), HIVU (*Hippuris vulgaris*), JUAR (*Juncus arcticus*), LETR (*Leymus triticoides*), MOSS (*moss*), POPR (*Poa pratensis*), POTA (*Potamogeton sp.*), SCAC (*Schoenoplectus acutus*), SCAM (*Schoenoplectus americanus*), SCPR (*Schedonorus pratensis*), STFI (*Stuckenia filiformis*), THRH (*Thermopsis rhombifolia*), TRRE (*Trifolium repens*), TYLA (*Typha latifolia*), TYPH (*Typha sp.*), and UTMA (*Utricularia macrorhiza*). Moisture gradient (GRADIENT) codes: S = intermittently flooded; W = mostly standing water; A = perennial standing water.

Figure 3-23
Spatial Heterogeneity (most abundant species by meter)
along the Five Aquatic Transects (021-150) at Keegan Ranch Complex in 2009

3.8.1.2.4 West Spring Valley Complex

The major species, by overall mean cover, on the aquatic transects at the West Spring Valley Complex were *Lemna minor* (9 percent), *Berula erecta* (9 percent), *Thermopsis rhombifolia* (7 percent), *Cirsium arvense* (7 percent), *Agrostis gigantea* (7 percent), and *Carex praegracilis* (6 percent) (Table 3-31). A total of 55 taxa occurred on the transects in 2009; this was a relatively high diversity in comparison with the other sites (Table 3-25). Total overall cover averaged 93; and was above the average of the 14 sites.

No species was the most abundant on more than one transect (Table 3-31). *Berula erecta* and *Cirsium arvense* were each the most abundant species on one transect and second most abundant on a second transect. *Carex praegracilis*, *Lemna minor*, and *Thermopsis rhombifolia* were the most abundant species on one transect each, and *Agrostis gigantea* and *Nasturtium officinale* were the second most abundant species on one transect each.

Internal spatial heterogeneity was substantial along the transects (Figure 3-24). *Thermopsis rhombifolia* was the most frequent dominant species, dominating 5 of the 39 microcommunity segments along the transects, but with a combined length of only 13 out of 79 m. Five other species were the dominant species on three to four segments each: *Agrostis gigantea*, *Berula erecta*, *Carex praegracilis*, *Cirsium arvense*, and *Lemna minor.*

Table 3-31
Mean Percent Cover, Overall and Species, of Vegetation a long Aquatic Transects at the West Spring Valley Complex in 2009
(Page 1 of 2)

Species	Overall Mean	Transects				
		086	088	094	095	096
Argentina anserina	0.9	0.4	3	0	0.4	0.8
Atriplex micrantha	0.2	0.5	0.4	0	0	0
Berula erecta	8.7	3.9	16.8	19.8	2.8	0.4
Bromus inermis	0.2	0	0.8	0	0.4	0
Bromus tectorum	0.1	0	0.6	0	0	0
Cardaria draba	0.2	0	0.9	0	0	0
Carex nebrascensis	4.6	0.4	6.6	6.2	4.4	5.6
Carex praegracilis	5.7	10.5	1.2	0	16.4	0.4
Carex rostrata	1.4	4.9	2.3	0	0	0
Carex simulata	0.7	3.1	0.4	0	0	0
Carex sp.	2.9	0	0	14.6	0	0
Castilleja minor	0.6	0	0	2.8	0	0
Cirsium arvense	7	12.5	20.8	1.8	0	0
Convolvulus arvensis	0.1	0	0.5	0	0	0
Distichlis spicata	0.9	0	0	0	0	4.6
Elaeagnus angustifolia	0.6	0	0	0	0	2.8
Eleocharis palustris	0.3	0	0	0	1.4	0
Eleocharis rostellata	3.1	8.2	0	0	0	7.4
Elymus trachycaulus	1.6	0	0	0	0	8.2
Epilobium sp.	0.5	1.9	0.5	0	0	0
Equisetum arvense	1.2	4.2	0.9	0.4	0.4	0
Ericameria nauseosa	0.7	0	3.4	0	0	0
Galium trifidum	t	0	0.1	0	0	0
Hordeum jubatum	t	0	0.1	0	0	0
Iva axillaris	1.5	0	0	0	0.6	7
Juncus arcticus	3.9	8.4	3.2	2.2	5	0.8
Juncus nevadensis	0.8	1	0	0	2.6	0.4
Juncus sp.	0.1	0	0	0.6	0	0
Lemna minor	8.9	10.4	6.3	0	6.8	20.8
Lemna sp.	0.9	0	0	4.6	0	0
Leymus triticoides	0.3	1	0	0	0	0.4
Medicago polymorpha	1.4	0	0.1	7	0	0
Melilotus officinalis	t	0	0.2	0	0	0
Mimulus guttatus	2.2	0.4	1.6	1.4	4	3.6
Muhlenbergia richardsonis	0.1	0	0	0	0.4	0

Table 3-31
Mean Percent Cover, Overall and Species, of Vegetation a long Aquatic Transects at the West Spring Valley Complex in 2009
(Page 2 of 2)

Species	Overall Mean	Transects				
		086	088	094	095	096
Nasturtium officinale	2.3	0.2	0	0	11.4	0
Phleum pratense	t	0.1	0	0	0	0
Phragmites australis	3	0	15.1	0	0	0
Poa pratensis	3	8.2	2	3	1.6	0
Poa secunda	t	t	0	0	0	0
Polygonum aviculare	t	0.2	0	0	0	0
Potamogeton sp.	0.4	0	0	0	1.8	0
Puccinellia lemmonii	0.5	0	0	0	2.6	0
Pyrrocoma lanceolata	0.2	0	0	0	1.2	0
Rumex crispus	0.2	0.2	0	0	1	0
Schedonorus pratensis	1.2	1	1.6	3.6	0	0
Schoenoplectus acutus	1.1	0	4.7	0.6	0	0
Sparganium eurycarpum	0.6	0	0	0	0	3.2
Symphyotrichum eatonii	1.7	0	1.8	0	0	6.8
Taraxacum officinale	0.7	0	0.2	0	3.2	0
Thermopsis rhombifolia	7.4	23	9.8	2.4	2	0
Trifolium repens	1.3	0	0	0	6.4	0
Viola nephrophylla	0.1	0.7	0	0	0	0
Total	**92.6**	**114.0**	**112.0**	**77.2**	**79.4**	**82.6**
Number of Species	**55**	**26**	**31**	**16**	**23**	**17**

Transect means are averages by meter, and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05%).

3.8.1.2.5 South Millick Spring

The major species, by overall mean cover, on the aquatic transects at South Millick Spring were *Berula erecta* (27 percent), *Argentina anserina* (7 percent), *Nasturtium officinale* (5 percent), *Juncus nevadensis* (4 percent), *Stuckenia filiformis* (4 percent), and *Juncus arcticus* (3 percent) (Table 3-32). A total of 38 taxa occurred on the transects in 2009; which was a moderate diversity in comparison with the other sites (Table 3-25). Total overall cover averaged 69 percent also moderate in comparison with the other sites.

Berula erecta was the most abundant species on four of the transects, and *Nasturtium officinale* was the most abundant species on one transect (Table 3-32). *Agrostis gigantea*, *Argentina anserina*, *Juncus nevadensis*, *Lemna minuta*, and *Nasturtium officinale* were the second most abundant species on one transect each.

```
86   JUAR THRH  ELRO CARO LEMI BEER CASI AGGI THRH CAPR CIAR POPR CAPR EQAR CAPR THRH   SPECIES
      01 02-03 04-05  06 07-13  14   15 16-17  18   19   20 21-22  23   24   25   26    METERS
     S--S M--M W-------W A--------A W-------W M--------------------M W---W M-------M   GRADIENT

88   SCPR POPR THRH AGGI CIAR    PHAU     CIAR    THRH       BEER     CANE     CIAR    SPECIES
      01   02   03   04 05-06 07------13  14   15------22 23------29 30--32 33------38 METERS
     S--S M-------M W--W M-----------------------------M  A-------A  S----S  M------M  GRADIENT

94   SCPR   BEER   CARX                                                                SPECIES
      01   02-03  04-05                                                                METERS
     S---S A---A  S----S                                                               GRADIENT

95   CAPR  LEMI  NAOF  TRRE  JUAR                                                      SPECIES
      01    02    03    04    05                                                       METERS
     S--S A---------A  S--------S                                                      GRADIENT

96   AGGI   LEMI  SYEA  DISP                                                           SPECIES
      01   02-03   04    05                                                            METERS
     W---W A---A W---W M----M                                                          GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (86, 88, 94-96) at West Spring Valley Complex in 2009. Species codes are: AGGI (*Agrostis gigantea*), BEER (*Berula erecta*), CANE (*Carex nebrascensis*), CAPR (*Carex praegracilis*), CARO (*Carex rostrata*), CARX (*Carex sp.*), CASI (*Carex simulata*), CIAR (Cirsium arvense), DISP (*Distichlis spicata*), ELRO (*Eleocharis rostellata*), EQAR (*Equisetum arvense*), JUAR (*Juncus arcticus*), LEMI (Lemna minor), NAOF (*Nasturtium officinale*), PHAU (Phragmites australis), POPR (*Poa pratensis*), SCPR (*Schedonorus pratensis*), SYEA (Symphyotrichum eatonii), THRH (*Thermopsis rhombifolia*), and TRRE (Trifolium repens). Moisture gradient (GRADIENT) codes: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-24
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (86, 88, 94-96) at West Spring Valley Complex in 2009

Internal spatial heterogeneity was substantial along the transects (Figure 3-25). *Berula erecta* was the most frequent dominant species, dominating seven of the 40 microcommunity segments along the transects with a combined length of 38 out of 111 m for the five transects combined. *Argentina anserina* was the second most frequent dominant species, dominating six segments with a combined length of 14 m.

3.8.1.2.6 Unnamed 5 Spring

The major species, by overall mean cover, on the aquatic transects at Unnamed 5 Spring were *Chara sp*. (19 percent), *Carex nebrascensis* (11 percent), *Potamogeton sp*. (11 percent), *Utricularia macrorhiza* (11 percent), *Berula erecta* (6 percent), *Carex simulata* (4 percent), and *Sparganium eurycarpum* (4 percent) (Table 3-33). A total of 44 taxa occurred on the transects in 2009; a moderate diversity compared to that of the other transects (Table 3-25). Total overall mean cover was 91 percent, which was a moderately high value.

Carex nebrascensis and *Utricularia macrorhiza* were the most abundant species on two transects each, and *Chara sp*. was the most abundant on one transect (Table 3-33). *Carex nebrascensis*, *Carex rostrata*, *Polygonum aviculare*, *Potamogeton sp*., and *Sparganium eurycarpum* were the second most abundant on one transect each.

Internal spatial heterogeneity along was substantial the five transects (Figure 3-26). *Carex nebrascensis* was the most frequent dominant species, dominating 10 of the 63 microcommunity segments along the transects, with a combined length of 38 out of 229 m. *Chara sp*. was the second most abundant dominant taxa, dominating species on seven segments with a combined length of

Table 3-32
Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the South Millick Spring in 2009

Species	Overall Mean	Transects				
		016	017	018	019	020
Agrostis gigantea	2.1	4.8	3.7	0.9	1.2	0
Argentina anserina	6.5	4.3	0.5	1.8	22.0	3.8
Berula erecta	27.1	2.0	54.8	31.4	22.7	24.5
Carex nebrascensis	2.8	3.5	7.7	0.5	2.2	0.1
Carex praegracilis	0.9	0	0	0.1	4.1	0.5
Carex simulata	0.5	1.6	0.8	0	0	0
Carex sp.	0.3	1.3	0	0	0	0
Cirsium scariosum	0.3	0.1	0	0.4	0	0.8
Cirsium vulgare	0.2	0.9	0	0	0	0
Crepis runcinata	0.2	0	0	0	0.7	0.2
Distichlis spicata	1.5	0	0	0	3.4	4.1
Eleocharis palustris	t	0.2	0	0	0	0
Eleocharis sp.	0.1	0.4	0	0	0	0
Elymus trachycaulus	t	0.2	0	0	0	0
Equisetum arvense	1.5	0.1	0.8	2.8	2.1	1.6
Erigeron lonchophylla	0.2	0.1	0	0	1.0	0
Glaux maritima	0.1	0	0	0	0.6	0.1
Hymenoxys lemmonii	0.4	0	0	0.5	0.9	0.5
Ivesia kingii	0.7	0	0	0	0.4	3.3
Juncus arcticus	3.3	4.1	3.2	0.4	5.5	3.4
Juncus nevadensis	4.3	1.0	5.4	1.8	0	13.2
Juncus torreyi	t	0.2	0	0	0	0
Lemna minuta	1.6	0	5.6	0.2	1.4	0.9
Lemna sp.	0.1	0.3	0	0	0	0
Leymus triticoides	0.3	0	0	0.7	0.5	0.3
Mimulus guttatus	0.6	0	0	0	0	3.1
Muhlenbergia richardsonis	0.1	0	0	0	0.4	0
Nasturtium officinale	5.4	21.2	0.4	5.6	0	0
Poa pratensis	0.1	0	0.6	0	0	0
Polypogon monspeliensis	t	t	0	t	0	0
Puccinellia lemmonii	0.4	0	0	0	0.6	1.4
Ranunculus cymbalaria	0.1	0.3	0	0	0	0
Schoenoplectus acutus	1.6	0.1	3.1	1.0	3.6	0
Sisyrinchium halophilum	0.2	0.5	0.3	0.1	0	0
Spartina gracilis	0.9	0	0	0	2.7	1.6
Sphenopholis obtusata	0.3	1.3	0.1	0	0.2	0
Stuckenia filiformis	3.7	2.5	0.9	8.0	2.9	4.0
Symphyotrichum eatonii	0.2	0.1	0.7	0.4	0	0
Total	**68.6**	**51.1**	**88.6**	**56.6**	**79.1**	**67.4**
Number of Species	**38**	**25**	**16**	**18**	**21**	**19**

Transect means are averages by meter and overall mean is the average of the five transects.
A "t" indicates a trace amount (<0.05)

```
16   ARAN BEER    NAOF      AGGI  STFI   ARAN   JUAR    OPEN     NAOF   CASI  AGGI       SPECIES
    01-02  03  04------08 09-10 11--13 14--16 17-18 19------23 24--26   27  28-29       METERS
    M---M A------------A  W---W A---A  M---M  S---S  A--------------A  W--------W       GRADIENT

17   AGGI  CANE   BEER    LEMI  CANE LEMI   BEER    SCAC  JUNE        BEER       CANE   SPECIES
      01  02-03 04----07 08-09 10-11  12  13----16 17-18 19-20 21-------------29  30    METERS
    W---W S---S A------------A S---S A-----------------A W---W A--------------A S---S   GRADIENT

18   AGGI        BEER        NAOF        STFI        JUNE  EQAR                         SPECIES
      01  02------------09 10-11 12--------------20  21  22-23                          METERS
    W---W A---------------------------------------A W---------W                         GRADIENT

19      ARAN      BEER    ARAN  DISP                                                    SPECIES
     01------05 06----09   10    11                                                     METERS
    M--------M  A-----A  M---------M                                                    GRADIENT

20   HYLE  ARAN  JUNE       BEER       STFI ARAN IVKI  DISP                             SPECIES
      01  02-03 04-05 06------------13  14   15   16  17-18                             METERS
    D---D M---M W---W A--------------------A M-------------M                            GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (16-20) at South Millick Spring in 2009. Species codes are: AGGI (*Agrostis gigantea*), ARAN (*Argentina anserina*), BEER (*Berula erecta*), CANE (*Carex nebrascensis*), CASI (*Carex simulata*), DISP (*Distichlis spicata*), EQAR (*Equisetum arvense*), HYLE (*Hymenoxys lemmonii*), IVKI (*Ivesia kingii*), JUAR (*Juncus arcticus*), JUNE (*Juncus nevadensis*), LEMI (*Lemna minuta*), NAOF (*Nasturtium officinale*), OPEN (open water), SCAC (*Schoenoplectus acutus*), and STFI (*Stuckenia filiformis*). Moisture gradient (GRADIENT) codes: S = intermittently flooded; W = mostly standing water; A = perennial standing water.

Figure 3-25
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (16-20) at South Millick Spring in 2009

Table 3-33
Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the Unnamed 5 Spring in 2009
(Page 1 of 2)

Species	Overall Mean	Transects				
		054	055	056	057	058
Agrostis gigantea	0.5	0	0.8	0.8	0	1.0
Algae	3.4	2.5	2.5	0.5	11.2	0.3
Argentina anserina	2.8	6.1	1.7	0.7	3.5	2
Berula erecta	6.0	7.1	2.0	2.6	10.4	8
Carex nebrascensis	11.1	29	12.4	9.2	0	5
Carex praegracilis	0.4	1.1	0	0.2	0.8	0
Carex rostrata	3.4	0	0	0	16.9	0
Carex simulata	4.4	19.7	0	0	2.1	0
Carex sp.	0.1	0	0.5	0	0	0
Chara sp.	19.3	12.4	39.6	43.4	1.3	0
Cirsium scariosum	0.1	0	0.1	0	0.4	0
Distichlis spicata	0.1	0.2	0	t	0.1	0.4
Eleocharis palustris	3.1	2.3	0.1	7.0	5.9	0
Eleocharis rostellata	1.1	0.6	2.6	0	1.3	1.2
Eleocharis sp.	0.1	0	0	0	0	0.5

Table 3-33
Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at the Unnamed 5 Spring in 2009
(Page 2 of 2)

Species	Overall Mean	Transects 054	055	056	057	058
Epilobium sp.	t	t	0	0	0	0.1
Equisetum arvense	0.2	0.5	0.1	0.1	0.1	0
Ericameria nauseosa	t	0	0	0	t	t
Gentianella amarella	0.1	0	0	0	0	0.3
Glaux maritima	t	0.1	0	0	0	0
Hippuris vulgaris	2.1	0.3	0.1	0.7	4.2	5.2
Ivesia kingii	t	0	t	0	0	0
Juncus arcticus	1.6	1.7	0.3	0.8	2.1	3.2
Juncus nevadensis	1.4	3.5	0	1.3	2.0	0
Leymus triticoides	0.1	0.1	0.1	0	t	0.4
Mimulus guttatus	0.1	0.1	0	0.2	0.1	0
Moss	0.4	2.2	0	0	0	0
Muhlenbergia richardsonis	t	0	0	0.1	0	0
Plantago major	0.2	0	0	0	0	0.9
Poa pratensis	0.2	0.1	0.6	0	0.1	0
Poa secunda	t	0	0	0	t	0
Polygonum aviculare	t	0	0.2	0	0	0
Potamogeton sp.	11.1	25.1	2.1	24.3	3.6	0.5
Puccinellia lemmonii	0.2	0	0.4	0.1	0.3	0
Ranunculus scelaeratus	t	0.1	0	0	0	0
Sisyrinchium halophilum	0.1	0.1	0	0	0	0.3
Sparganium eurycarpum	4.4	1.1	1.0	0.2	5.6	13.9
Spartina gracilis	t	0	0	t	0.1	0
Sphenopholis obtusata	0.5	1.0	0	0	1.3	0
Sporobolus airoides	0.7	1.1	0.8	0	0.9	0.6
Symphyotrichum eatonii	0.3	0.1	0.2	0.2	0.1	1.0
Taraxacum officinale	t	0	0	0	0.1	0
Trifolium repens	0.3	0	0	0	0.7	0.9
Utricularia macrorhiza	11.1	0	2.2	0	32.8	20.6
Total	**91**	**118.2**	**70.4**	**92.4**	**108**	**66.3**
Number of Species	**44**	**27**	**23**	**20**	**30**	**22**

Transect means are averages by meter, and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05)

```
54   SPAI  ARAN  CANE    CASI  CANE CHAR  POTA   CHAR BEER  CHAR  POTA  JUNE  CANE ARAN  SPECIES
      01   02-03 04--08 09---14 15-16 17   18---25  26    27  28-30 31---35 36  37--41 42   METERS
   M---------M S----S W-----W S--S A---------------------------------A W--W S---S M--M  GRADIENT

55   POPR ARAN CANE POTA SPEU      CHAR       ELRO  ALGA       CANE      ARAN SPAI PULE  SPECIES
      01   02   03   04   05 06-------------24  25  26--28 29---------42  43   44   45   METERS
     M-------M S--S A------------------------S W--W A----A S-----------S M-----------M  GRADIENT

56   JUAR ARAN CANE  POTA CHAR CANE  ELPA  CHAR  CANE POTA  CANE  POTA  CANE ELPA AGGI  SPECIES
      01   02   03  04-06  07   08  09-10 11---38 39 40-43 44-45 46--56 57-62  63   64   METERS
     S--S M--M S--S A--------A S--S W---W A----A S--S A--A S---S A----A S---S W-------W  GRADIENT

57   SPAI  SPOB  ELPA   UTMA   BEER  ALGA CHAR  UTMA  CARO  SPEU  UTMA ALGA ELRO  JUAR  SPECIES
      01  02-03 04-05 06----20 21-24 25-29  30  31-37 38-40 41-44 45-46  47   48  49-50  METERS
     M--M W---------W A-----------------------------------------------------A W--W S---S  GRADIENT

58   SPAI JUAR PLMA  UTMA         SPEU                UTMA      JUAR AGGI            SPECIES
      01   02   03  04----07 08----------------17 18--------------26  27   28         METERS
     M--M S--S M--M  A--------------------------------------------A S--S W--W         GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (54-58) at Unnamed 5 Spring in 2009. Species codes are: AGGI (*Agrostis gigantea*), ALGA (algae), ARAN (*Argentina anserina*), BEER (*Berula erecta*), CANE (*Carex nebrascensis*), CARO (*Carex rostrata*), CASI (*Carex simulata*), CHAR (*Chara sp.*), ELPA (*Eleocharis palustris*), ELRO (*Eleocharis rostellata*), JUAR (*Juncus arcticus*), JUNE (*Juncus nevadensis*), PLMA (*Plantago major*), POPR (*Poa pratensis*), POTA (*Potamogeton sp.*), PULE (*Puccinellia lemmonii*), SPAI (*Sporobolus airoides*), SPEU (*Sparganium eurycarpum*), SPOB (*Sphenopholis obtusata*), and UTMA (*Utricularia macrorhiza*). Moisture gradient (GRADIENT) codes: S = intermittently flooded; W = mostly standing water; A = perennial standing water.

Figure 3-26
Spatial Heterogeneity (Most Abundant Species by Meter)
along the Five Aquatic Transects (54-58) at Unnamed 5 Spring in 2009

54 m. *Utricularia macrorhiza* was also a common dominant species, dominating five segments with a combined length of 37 m.

3.8.1.2.7 Four Wheel Drive Spring

The major taxa, by overall mean cover, on the aquatic transects at Four Wheel Drive Spring were *Carex nebrascensis* (22 percent), *Juniperus scopulorum* (12 percent), *Potamogeton sp*. (10 percent), *Carex simulata* (8 percent), *Eleocharis palustris* (7 percent), and *Rosa woodsii* (6 percent) (Table 3-34). A total of 39 taxa occurred on the transects in 2009, which was an average number compared with the other sites (Table 3-25). Total overall cover averaged 94 percent which was above average for the sites overall.

Carex nebrascensis was the most abundant species on three transects and *Potamogeton sp*. was the most abundant on two transects (Table 3-34). *Eleocharis palustris* was the second most abundant species on the two transects where *Potamogeton sp*. was the most abundant. *Carex simulata*, *Carex sp*., and *Juniperus scopulorum* were each the second most abundant taxa on the transects where *Carex nebrascensis* was most abundant.

Internal spatial heterogeneity was less along the aquatic transects at Four Wheel Drive Spring than at most other sites, in part because the transects at Four Wheel Drive Spring were relatively short. *Carex nebrascensis* was the most frequent dominant species, dominating five of the 31 microcommunity segments along the transects, with a combined length of 18 out of 71 m (Figure 3-27). *Potamogeton sp*. was dominant on only two segments, but these two segments covered 14 m.

Table 3-34
Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at Four Wheel Drive Spring in 2009

Species	Overall Mean	Transects				
		059	060	061	062	063
Agrostis gigantea	1.1	1.6	0	3.7	0	0
Alisma plantago-aquatica	1.2	3.5	2.4	0	0	0
Arctium minus	1.4	0	0	0	0	7.1
Argentina anserina	2.0	0	0	9.8	0	0
Artemisia tridentata	1.1	0	0	0	2.1	3.6
Bassia scoparia	0.7	2.4	0.1	0	0	0.8
Berula erecta	4.6	8.5	3.6	8.7	2.4	0
Carex nebrascensis	21.9	2.1	6.4	40.2	42.8	18.1
Carex praegracilis	t	0	0	0	0.2	0
Carex simulata	7.9	0	0	6.5	28.5	4.3
Carex sp.	1.9	0	0	0	0	9.5
Chenopodium incanum	0.1	0	0	0	0	0.7
Chenopodium sp.	0.3	0	0	1.5	0	0
Distichlis spicata	2.3	2.6	2.3	6.4	0	0.1
Eleocharis palustris	6.6	19.6	13.6	0	0	0
Epilobium ciliatum	0.2	0	0.8	0	0	0.2
Epilobium sp.	0.9	0	0	0.5	2.7	1.5
Equisetum arvense	t	0.2	0	0	0	0
Ericameria nauseosa	0.1	0.7	0	0	0	0
Halogeton glomeratus	0.1	0.6	0	0	0	0
Juncus arcticus	0.2	0.9	0	0	0	0
Juncus nevadensis	3.7	14.6	2.1	0	1.7	0
Juniperus scopulorum	12.1	0	0	34.0	26.5	0
Leymus triticoides	0.1	0	0	0.5	0	0
Mentha arvensis	0.5	0	1.5	1.1	0	0
Mimulus guttatus	0.4	0.6	1.1	0	0.2	0
Moss	0.7	3.6	0	0	0	0
Muhlenbergia richardsonis	0.4	0	0	0	2.2	0
Nasturtium officinale	2.3	7.8	0.1	0	3.5	0
Poa pratensis	t	0	0	0	0	0.1
Potamogeton sp.	10.2	31.9	19.1	0	0	0
Ranunculus cymbalaria	t	0	0.1	0	0	0
Rhus trilobata	0.2	0	0	0	0	0.9
Ribes sp.	0.4	0	0	0	1.9	0
Rosa woodsii	6	6.4	0	2.8	16.8	4.1
Sagittaria cuneata	0.1	0.4	0	0	0	0
Sporobolus airoides	0.9	2.3	0.6	1.4	0	0
Thermopsis rhombifolia	0.7	3.6	0	0	0	0
Typha latifolia	0.9	0	0	2.2	2.4	0
Total	**94.2**	**113.9**	**53.8**	**119.3**	**133.9**	**51**
Number of Species	**39**	**20**	**14**	**14**	**14**	**13**

Transect means are averages by meter, and overall mean is the average of the five transects.
A "t" indicates trace amount (<0.05%)

```
59   DISP BASC     POTA      NAOF  JUNE  ELPA ROWO SPAI                         SPECIES
      01   02  03--------08   09  10-11   12   13   14                          METERS
    M--------M A----------------A W---------W M-------M                         GRADIENT

60   MEAR  CANE       POTA       ALPL JUNE DISP                                 SPECIES
      01  02-03 04------------11  12   13   14                                  METERS
    M---M S---S A------------------A W---W M--M                                 GRADIENT

61   JUSC     CANE      ARAN ROWO                                               SPECIES
    01--03 04------08    09   10                                                METERS
    D----D S--------S M--------M                                                GRADIENT

62   ROWO   CANE      CASI     CANE    JUSC                                     SPECIES
    01-02 03----06 07------11 12-13 14----17                                    METERS
    M---M S------S W--------W S---S D------D                                    GRADIENT

63   BARE CHIN  BASC  ARMI  ROWO    CANE     CARX  ARTR                         SPECIES
      01   02  03-04 05-06   07  08------12 13-14 15-16                         METERS
    M--------------------------M S--------S M---M D---D                         GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (59-63) at Four Wheel Drive Spring in 2009. Species codes are: ALPL (*Alisma plantago-aquatica*), ARAN (*Argentina anserina*), ARMI (*Arctium minus*), ARTR (*Artemisia tridentata*), BASC (*Bassia scoparia*), CANE (*Carex nebrascensis*), CARX (*Carex sp.*), CASI (*Carex simulata*), CHIN (Chenopodium incanum), DISP (*Distichlis spicata*), ELPA (*Eleocharis palustris*), JUNE (*Juncus nevadensis*), JUSC (*Juniperus scopulorum*), MEAR (*Mentha arvensis*), NAOF (*Nasturtium officinale*), POTA (*Potamogeton sp.*), ROWO (*Rosa woodsii*), SPAI (*Sporobolus airoides*). Moisture gradient (GRADIENT) codes: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-27
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (59-63) at Four Wheel Drive Spring in 2009

3.8.1.2.8 Willard Spring

The major taxa, by overall mean cover, on the aquatic transects at Willard Spring in 2009 were *Carex nebrascensis* (16 percent), *Carex praegracilis* (9 percent), *Argentina anserina* (6 percent), and *Rorippa sinuata* (6 percent) (Table 3-35). Willard Spring was the only site where *Rorippa sinuata* was found on the transects and was a major species. A total of 47 taxa occurred on the transects, which was above average compared to the other sites (Table 3-25). Total overall cover averaged 77 percent which was about average for the 14 sites.

Carex nebrascensis was the most abundant species on three of the transects. *Achillea millefolium* and *Carex praegracilis* were the most abundant on one transect each (Table 3-35). The second most abundant species were *Carex nebrascensis*, *Carex praegracilis*, *Hordeum jubatum*, *Poa pratensis*, and *Rorippa sinuata* on one transect each.

Internal spatial heterogeneity was substantial along two transects (64 and 65) at Willard Spring and less so along the other three transects (Figure 3-28). *Carex nebrascensis* was the most frequent dominant species, dominating nine of the 45 microcommunity segments along the transects, with a combined length of 40 out of 172 m (Figure 3-28). *Carex praegracilis* was the second most frequent dominant species, the most abundant species on eight of the segments with a combined length of 38 m. *Rorippa sinuata* was the dominant species on only two segments, but these had a combined length of 26 m. Willard Spring was the only site at which this species occurred on the aquatic transects in 2009.

Table 3-35
Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at Willard Spring in 2009
(Page 1 of 2)

Species	Overall Mean	Transects				
		064	065	066	067	068
Achillea millefolium	3.6	14.4	3.4	0.3	0	0
Agoseris glauca	0.9	0	0	0	0	4.7
Agrostis gigantea	2.2	7.5	0.6	2.7	0	0
Argentina anserina	6.4	11.4	15.2	4.9	0.5	0
Bassia scoparia	0.3	0.5	0.2	0.8	0	0
Berula erecta	0.4	1.9	0	0.2	0	0
Cardaria draba	t	0.1	0	0	0	0
Carex nebrascensis	15.8	4.4	18.0	5.6	30.4	20.7
Carex praegracilis	8.9	0.3	16.6	16.9	0.2	10.3
Carex simulata	2.9	0	14.7	0	0	0
Carex sp.	0.1	0	0	0.3	0	0
Cirsium scariosum	1.0	3.2	1.3	0	0.3	0
Deschampsia caespitosa	3.4	4.9	8.1	2.1	2.0	0
Descurainia sophia	t	0	0	0	0.1	0
Distichlis spicata	0.2	1.0	0.1	0.1	0	0
Eleocharis sp.	t	0	0	0.1	0	0
Elymus trachycaulus	0.3	0	0	1.3	0	0
Epilobium ciliatum	t	0	0	0.2	0	0
Epilobium sp.	0.3	0.8	0.1	0	0.4	0.3
Equisetum arvense	0.7	2.0	1.1	0.3	0	0
Erigeron lonchophyllus	t	0	0.1	0	0	0
Glaux maritima	t	0	0.1	0.1	0	0
Helianthus nuttalii	t	0	0	0.1	0	0
Hippuris vulgaris	0.1	0	0	0	0.4	0
Hordeum brachyantherum	1.1	0.1	0.8	0.4	2.7	1.4
Hordeum jubatum	4.6	0	1.2	0	19.1	2.5
Hymenoxys lemmonii	0.1	0	0	0	0	0.4
Juncus arcticus	2.6	1.1	4.4	0.9	0.9	5.6
Juncus nevadensis	2.7	8.4	3.7	1.4	0	0
Leymus triticoides	2.4	7.2	3.7	0.3	0.1	0.8
Mimulus guttatus	0.2	0.6	0.2	0	0	0
Muhlenbergia asperifolia	0.3	0	1.2	0.2	0	0
Muhlenbergia richardsonis	t	0.2	0	0	0	0
Nasturtium officinale	0.2	0	1.1	0	0	0
Poa pratensis	5	14.3	8.0	0.3	2.4	0
Polygonum aviculare	0.3	0	0	0	0.4	0.9

Table 3-35
Mean Percent Cover, Overall and Species, of Vegetation along Aquatic Transects at Willard Spring in 2009
(Page 2 of 2)

Species	Overall Mean	Transects				
		064	065	066	067	068
Puccinellia lemmonii	0.6	0.2	0.2	0	0.3	2.2
Pyrrocoma lanceolata	0.2	0	0	0	0	0.9
Ranunculus scelaeratus	t	0	0	0	0.2	0
Rorippa sinuata	6.4	0	0	0	17.7	14.5
Salsola tragus	0.5	1.6	0	0.7	0	0
Schoenoplectus americanus	t	0	t	0	0	0
Sisyrinchium halophilum	0.1	0.1	0.1	0.2	0	0
Solidago sp.	t	0	0.1	0	0	0
Sphenopholis obtusata	0.3	0	1.3	0	0	0
Taraxacum officinale	1.3	1.8	3.9	0.7	0.1	0.2
Thermopsis rhombifolia	0.5	2	0.1	0.3	0	0
Total	**76.9**	**90**	**109.6**	**41.4**	**78.2**	**65.4**
Number of Species	**47**	**25**	**30**	**26**	**18**	**14**

Transect means are averages by meter, and overall mean is the average of the five transects.
A "t" indicates a trace amount (<0.05%)

```
064   ARAN   ACMI     POPR  LETR CISC  JUNE  AGGI  POPR  DISP                                   SPECIES
       01  02----05 06--08  09    10  11--13  14  15-16 17-18                                   METERS
     M-----------------M S--------S W---------W M---------M                                     GRADIENT

065   CAPR NAOF JUNE  CAPR  ARAN  CAPR  CASI  JUAR  CANE  CASI  ARAN  CAPR  POPR  CANE          SPECIES
     01-03  04   05  06-09 10-13 14-15 16-19 20-21 22-23 24-25 26-28 29-30 31-32 33-36          METERS
     M---M A--A W--W M---------------M W---W S---------S W---W M--------------M S----S          GRADIENT

066   CAPR  CANE  CAPR ARAN   CANE            CAPR                AGGI     ARAN   SATR          SPECIES
     01-03 04-05 06-08  09   10---13 14---------------------28 29-------34  35   36---38        METERS
     M---M S---S M--------M S-----S M----------------------M  W--------W  M--M D-----D          GRADIENT

067         CANE              HOJU              ROSI          RASC     CANE     POPR  CANE      SPECIES
     01--------------13 14-----------26 27--------------41 42-43 44-----50 51--53  54           METERS
     S---------------S  M-------------M  A---------------------A S-------S M---M S---S          GRADIENT

068   ARAN JUAR  CANE            ROSI               CANE          CAPR                          SPECIES
       01   02  03-04 05----------------------15 16--------20 21-----------26                   METERS
      M--M S--------S A-----------------------A S---------S  M------------M                     GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (64-68) at Willard Spring in 2009. Species codes are: ACMI (*Achillea millefolium*), AGGI (*Agrostis gigantea*), ARAN (*Argentina anserina*), CANE (*Carex nebrascensis*), CAPR (*Carex praegracilis*), CASI (*Carex simulata*), CISC (*Cirsium scariosum*), DISP (*Distichlis spicata*), HOJU (*Hordeum jubatum*), JUAR (*Juncus arcticus*), JUNE (*Juncus nevadensis*), LETR (*Leymus triticoides*), NAOF (*Nasturtium officinale*), POPR (*Poa pratensis*), RASC (*Ranunculus scelaeratus*), ROSI (*Rorippa sinuata*), and SATR (*Salsola tragus*). Moisture gradient (GRADIENT) codes: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-28
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (64-68) at Willard Spring in 2009

3.8.1.2.9 Minerva Spring Complex

The major taxa, by overall mean cover, on the aquatic transects at the Minerva Springs Complex in 2009 were *Potamogeton sp*. (15 percent), *Schedonorus pratensis* (8 percent), *Carex nebrascensis* (7 percent), *Carex nebrascensis* (7 percent), *Rosa woodsii* (7 percent), *Thermopsis rhombifolia* (6 percent), and *Hordeum jubatum* (6 percent) (Table 3-36). A total of 61 taxa occurred on the transects; this was the second highest number among the 14 sites (Table 3-25). This site also had the second highest mean cover (102 percent) of the sampled sites.

Potamogeton sp. was the most abundant taxa on two transects but was absent or nearly absent from the other three transects (Table 3-36). *Carex nebrascensis*, *Eleocharis rostellata*, and *Rosa woodsii* were the most abundant species on one transect each. *Chara sp*., *Hordeum jubatum*, *Nasturtium officinale*, *Schedonorus pratensis*, and *Stuckenia filiformis* were the second most abundant species on one transect each.

Table 3-36
Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Minerva Springs Complex in 2009
(Page 1 of 2)

Species	Overall Mean	Transects				
		001	004	006	007	010
Achillea millefolium	t	0	0	0	0.1	0
Agrostis gigantea	6.7	0.8	10.8	17.4	2.5	2.0
Algae	1.1	0	0	1.3	4.0	0
Aqulegia formosa	0.2	0	0	1.1	0	0.1
Argentina anserina	0.6	0	0.3	2.1	0.4	0.2
Bassia scoparia	0.1	0.7	0	0	0	0
Berula erecta	2.8	4.2	0	7.8	1.9	0.2
Bromus tectorum	t	0	0.2	0	0	0
Carex nebrascensis	7.2	5.1	3.2	3.7	22.7	1.0
Carex praegracilis	1.5	0	0.4	0	0.2	6.9
Carex simulata	1.0	1.2	0	3.7	0	0.2
Chara sp.	3.8	18.8	0	0	0	0
Chenopodium sp.	0.2	0	0.8	0	0	0
Cirsium scariosum	0.1	0	0.6	0	0.1	0
Cirsium vulgare	t	0	0.1	0	0	0
Descurainia sophia	0.1	0	0.3	0	0	0
Distichlis spicata	2.7	13.6	0	0	0	0
Eleocharis palustris	1.4	4.2	0.7	1.9	0	0
Eleocharis rostellata	3.7	0	0	1.4	0	17.1
Elymus trachycaulis	1.9	0	6.8	0	2.8	0
Equisetum arvense	0.1	0	0.1	0.3	0.1	0.1
Ericameria nauseosa	t	0.2	0	0	0	0
Erigeron lonchophyllus	0.1	0	0	0	0.4	0
Helianthus nuttallii	0.3	0	0	1.5	0.1	0
Hordeum brachyantherum	0.2	0	1.2	0	0	0

Table 3-36
Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Minerva Springs Complex in 2009
(Page 2 of 2)

Species	Overall Mean	Transects				
		001	004	006	007	010
Hordeum jubatum	6.2	4.9	25.8	0.3	0	0
Juncus arcticus	1.1	2.1	0.5	0.8	1.9	0
Juncus nevadensis	1.7	0	0	1.3	5.8	1.6
Lemna minor	t	0	0	0	0.2	0
Leymus triticoides	1.0	0	0.4	4.4	0	0.3
Lianthus pungens	0.1	0	0	0	0.3	0
Medicago polymorpha	1.0	0	0	5.2	0	0
Melilotus officinalis	1.8	0	7.5	0.4	0.7	0.2
Mentha arvensis	0.2	0	0	0	0.9	0
Mimulus guttatus	1.7	0.5	0.1	0	8.1	0
Moss	1.2	0	0	0.8	0	5.4
Muhlenbergia richardsonis	0.2	0	0	0	0	0.9
Myriophyllum verticillatum	0.1	0	0.6	0	0	0
Nasturtium officinale	4.1	1.5	0	1.8	3.6	13.6
Poa pratensis	1.6	0	6.7	0.2	1.2	0
Polygonum aviculare	2.0	0.3	9.0	0	0.5	0
Potamogeton sp.	14.5	44.9	27.3	0	0.2	0
Potentilla hippiana	t	0	0.2	0	0	0
Puccinellia lemmonii	0.1	0	0.4	0	0	0
Ranunculus aquatilus	0.3	1.3	0	0	0	0
Ranunculus sceleratus	t	0	0.1	0	0	0
Rosa woodsii	6.5	0	0	32.3	0	0
Rumex crispus	0.3	0	1.3	0	0	0
Schedonorus pratensis	7.9	1.4	11.4	26.8	0	0
Sparganium eurycarpum	0.1	0	0	0	0.3	0
Stuckenia filiformis	3.8	0	0	0	19.2	0
Symphyotrichum eatonii	0.1	0	0.1	0.6	0	0
Taraxacum officinale	0.1	0	0.2	0.1	0	0
Thermopsis rhombifolia	6.5	0	10.9	21.6	0	0
Trifolium fragiferum	0.1	0	0.3	0	0	0
Trifolium hybridum	t	0	0.2	0	0	0
Trifolium pratense	1.2	0	1.0	3.7	0.2	1.3
Trifolium repens	t	0.1	0.1	0	0	0
Triglochin maritima	t	0	0	0	0	0.1
Veronica anagallis-aquatica	0.8	1.4	0.5	0	1.6	0.7
Xanthium strumarium	0.2	0	0	0	1.1	0
Total	**102.3**	**107.2**	**130.1**	**142.5**	**81.1**	**51.9**
Number of Species	**61**	**19**	**35**	**26**	**28**	**18**

Transect means are averages by meter, and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05%).

Internal spatial heterogeneity at the Minerva Springs Complex varied considerably among the five transects (Figure 3-29). Transects 04 and 06 were relatively complex, with 13 and 11 microcommunity segments, respectively. In contrast, the other three transects had five to seven segments each. *Carex nebrascensis*, *Chara sp*., *Eleocharis rostellata*, *Elymus trachycaulis*, *Hordeum jubatum*, moss, *Nasturtium officinale*, *Potamogeton sp*., *Rosa woodsii*, *Schedonorus pratensis*, *Stuckenia filiformis*, and *Thermopsis rhombifolia* each dominated substantial portions of at least one transect.

```
01   DISP      POTA       CHAR      POTA     ELPA HOJU DISP                           SPECIES
    01-02 03--------08 09----12 13------17  18   19   20                              METERS
    M---M A-----------------------------A W---W M-------M                             GRADIENT

04   HOJU SCPR    POTA      POPR  POAV   HOJU    SCPR AGGI  POPR  AGGI THRH  MEOF   ELTR   SPECIES
    01-02  03  04------20 21-23 24-28 29----40  41   42  43-44 45-48  49  50-52 53---60  METERS
    M---M S--S A-------A  M-----------------M S---S W--W M---M W---W M--------M S-----S  GRADIENT

06    THRH      SCPR      AGGI   ROWO  ARAN CASI AGGI CANE NAOF  BEER       ROWO       SPECIES
    01----04 05------09 10--12 13--15  16   17   18   19   20  21-22 23----------28    METERS
    M------M S--------S W----W M---------M W-------W S--S A--------A M------------M    GRADIENT

07   CANE       STFI       CANE     MIGU  CANE   AGGI                                 SPECIES
    01-02 03----------09 10----13 14-15 16--18 19-20                                  METERS
    S---S A------------A S--------S W---W S----S W---W                                GRADIENT

10   ELRO    NAOF      MOSS          ELRO                                             SPECIES
    01-02 03------07 08----11 12----------------21                                    METERS
    W---W A-----------------A W------------------W                                    GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (01, 04, 06,07, 10) at the Minerva Spring Complex in 2009. Species codes are: AGGI (*Agrostis gigantea*), ARAN (*Argentina anserina*), BEER (*Berula erecta*), CANE (*Carex nebrascensis*), CASI (*Carex simulata*), CHAR (*Chara sp.*), DISP (*Distichlis spicata*), ELPA (*Eleocharis palustris*), ELRO (*Eleocharis rostellata*), ELTR (*Elymus trachycaulis*), HOJU (*Hordeum jubatum*), MEOF (*Melilotus officinalis*), MIGU (*Mimulus guttatus*), MOSS (moss), NAOF (*Nasturtium officinale*), POAV (*Polygonum aviculare*), POPR (*Poa pratensis*), POTA (*Potamogeton sp.*), ROWO (*Rosa woodsii*), SCPR (*Schedonorus pratensis*), STFI (*Stuckenia filiformis*), and THRH (*Thermopsis rhombifolia*). Moisture gradient (GRADIENT) codes: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-29
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (01, 04, 06, 07, 10) at the Minerva Spring Complex in 2009

3.8.1.2.10 Swallow Spring

Swallow Spring was the only one of the 14 aquatic transect sites that was dominated by trees in 2009. *Populus angustifolia* (52 percent mean cover) and *Salix sp*. (5 percent mean cover) were the two tree species that occurred along the aquatic transects (Table 3-37). Other major species were *Rosa woodsii* (9 percent), *Nasturtium officinale* (7 percent), *Berula erecta* (5 percent), *Poa pratensis* (5 percent), and *Rhus trilobata* (5 percent). A total of 42 taxa occurred on the aquatic transects, which was about average for the 14 sites (Table 3-25). Total mean cover at Swallow Spring was 104 percent, the highest value for the 14 sites.

The high cover value was the result, in large part, to the dominance of *Populus angustifolia* on all five transects (Table 3-37). *Rosa woodsii* was the second most abundant species on two transects, and *Berula erecta*, *Nasturtium officinale*, and *Salix sp*. were the second most abundant taxa on one transect each.

Table 3-37
Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Swallow Spring in 2009

Species	Overall Mean	Transects				
		044	045	046	047	048
Achillea millefolium	t	0	0	0	0	0.1
Agrostis gigantea	3.3	0	1.9	7.6	0	7.2
Angelica sp.	0.1	0	0.4	0	0	0
Aquilegia formosa	t	0	0.1	0	0	0
Aster sp.	0.8	1.1	3	0	0	0
Bassia scoparia	0.5	0	0.7	0	1.6	0
Berula erecta	5.3	0	5.1	1.9	0	19.3
Bromus tectorum	0.4	0	0	0.3	1.4	0.1
Carex nebrascensis	1.0	0	0	0.4	0	4.8
Carex praegracilis	0.2	0	0	0	0	0.8
Carex sp.	t	0	0	0	0	0.1
Chara sp.	0.2	0	1.0	0	0	0
Chenopodium sp.	0.1	0	0	0.5	0	0
Clematis ligusticifolia	1.0	4.8	0	0	0	0
Convolvulus arvensis	t	0	0	0.2	0	0
Eleocharis palustris	t	0	0	0	0	t
Epilobium sp.	t	0	0	0.2	0	0
Erigeron lonchophyllus	0.1	0	0	0	0	0.7
Iva axillaris	0.2	0	0	0.1	0.7	0
Juncus arcticus	0.2	0	0	0	0	1.1
Juncus saximontanus	0.1	0	0	0	0	0.4
Juncus torreyi	t	0	0	0	0	0.1
Maianthemum racemosum	t	0	0.1	0	0	0
Medicago polymorpha	1.0	0	t	3.9	0	5.6
Melilotus officinalis	t	0	0	0	0	0.2
Mimulus guttatus	0.1	0	0	0	0	0.3
Moss	1.0	3.7	0	0.2	0	1.3
Nasturtium officinale	7.4	15.2	2.6	1.6	13.6	4
Phleum pratense	0.1	0	0	0	0	0.4
Poa pratensis	4.7	2.7	1.1	14.6	1.1	4.2
Poa secunda	1.3	0	0	1.3	0	5
Populus angustifolia	51.9	37.5	51.4	59.6	68.8	42.1
Rhus trilobata	4.7	0	20	3.3	0	0
Rosa woodsii	9.0	0	21.6	15.6	7.8	0
Salix sp.	5.2	26	0	0	0	0
Sambucus nigra	1.4	0	0	0	6.9	0
Sisyrinchium halophilum	0.1	0	0	0.3	0	0.4
Sparganium eurycarpum	0.1	0	0.4	0	0	0
Taraxacum officinale	0.2	0	0.2	0.7	0	0.3
Urtica dioica	0.5	0	0	0	2.4	0
Verbascum thapsus	t	0	0	0	0	0.2
Veronica anagallis-aquatica	0.5	0	0	1.8	0	0.6
Total	**103.6**	**91**	**109.6**	**114.1**	**104.3**	**99.3**
Number of Species	**42**	**7**	**16**	**19**	**9**	**25**

Transect means are averages by meter, and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05%).

The dominance of the tree *Populus angustifolia*, on 10 of the 34 microcommunity segments (Figure 3-30). Internal spatial heterogeneity comparatively simple at Swallow Spring because of The 10 segments covered 109 out of 189 m included in the five transects. Where *Populus angustifolia* was not dominant, *Berula erecta*, *Nasturtium officinale*, and *Rosa woodsii* were frequent dominants (Figure 3-30).

```
044          POAN        NAOF      SALX         POAN     CLLI   POAN                   SPECIES
     01-------------08 09----12 13------27 28---------33 34-35 36----39                METERS
     M--------------M  A------A  S------S  M-------------------------M                  GRADIENT

045   ROWO     RHTR                  POAN                    BEER   ROWO   POAN   BARE   SPECIES
       01  02--------07 08--------------------------------29 30--35 36--38 39--41 42--44 METERS
      M--M D---------D  M---------------------------------M  A----A  M---------M D----D  GRADIENT

046   ROWO            POAN               POPR   AGGI VEAN BEER MEPO                      SPECIES
       01  02----------------------14 15----18  19   20   21   22                        METERS
      M-------------------------------------M S---S A------A M----M                      GRADIENT

047           POAN           NAOF               POAN                  BASC  IVAX  BASC   SPECIES
     01-----------------10 11-12 13---------------------------------33 34-35 36--39  40  METERS
     M------------------M  W--W  M----------------------------------------M  S----S D--D GRADIENT

048   POSE   MEPO      BEER      NAOF         POAN        BEER       POAN       MEPO   SPECIES
     01--03 04--06 07---------14 15--17 18--------------29 30--32 33------------42 43-44 METERS
     D---D  M---M  A------------------A  M--------------M  A----A  M-----------------M   GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (44-48) at Swallow Spring in 2009. Species codes are: AGGI (*Agrostis gigantea*), BARE (bare ground or litter), BASC (*Bassia scoparia*), BEER (*Berula erecta*), CLLI (*Clematis ligusticifolia*), IVAX (*Iva axillaris*), MEPO (*Medicago polymorpha*), NAOF (*Nasturtium officinale*), POAN (*Populus angustifolia*), POPR (*Poa pratensis*), POSE (*Poa secunda*), RHTR (*Rhus trilobata*), ROWO (*Rosa woodsii*), SALX (*Salix sp.*), and VEAN (*Veronica anagallis-aquatica*). Moisture gradient (GRADIENT) codes: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-30
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (44-48) at Swallow Spring in 2009

3.8.1.2.11 North Little Spring

The major taxa, by overall mean, on the aquatic transects at North Little Spring in 2009 were *Carex nebrascensis* (46 percent), *Carex simulata* (17 percent), and *Chara sp.* (10 percent) (Table 3-38). A total of 20 taxa occurred on the transects, which was the lowest number of the 14 sites (Table 3-25). Mean total cover, however, was high (95 percent) at this site.

Carex nebrascensis was the most abundant species on four of the transects, and *Chara sp.* was the most abundant on the fifth (Table 3-38). *Carex simulata* was the second most abundant species on three transects. *Carex nebrascensis* and *Juncus arcticus* were the second most abundant species on one transect each.

Internal spatial heterogeneity was simple at North Little Spring, in part because of the low species richness (Table 3-38). *Carex nebrascensis* was the most abundant species along the transects (Table 3-38) and was the most frequent dominant species, being the most abundant species on 10 of the 24 microcommunity segments, with a combined length of 86 out of 124 m of the combined transects (Figure 3-31). *Carex simulata* was the second-most frequent dominant species, being the most abundant species on seven of the segments, with a combined total length of 18 m.

Table 3-38
Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at North Little Spring in 2009

Species	Overall Mean	Transects				
		174	175	176	177	178
Algae	4.1	20.3	0	0	0	0
Argentina anserina	0.8	1.9	0.3	0	0	1.8
Berula erecta	2.8	5.7	2.1	0.9	0	5.3
Carex nebrascensis	46.1	51.7	18.7	60	33.0	67.2
Carex praegracilis	3.6	3.7	14.2	0	0	0
Carex simulata	17.1	35.6	0	17.0	23.0	9.8
Chara sp.	9.9	0	49.5	0	0	0
Eleocharis palustris	2.9	0	0.4	5.9	0	8.2
Epilobium sp.	0.1	0	0	0	0	0.4
Glaux maritima	0.1	0.4	0.1	0	0	0
Juncus arcticus	3.5	0.7	0.7	0	0	16.2
Juncus nevadensis	0.3	0.1	0	1.6	0	0
Juncus torreyi	0.1	0	0	0	0	0.6
Mimulus guttatus	0.3	1.2	0.4	0	0	0.1
Poa pratensis	0.7	0	0	0	0	3.3
Poa sp.	0.1	0	0	0	0	0.5
Ranunculus sceleratus	1.0	4.9	0	0	0	0.3
Rosa woodsii	0.8	0	0	0	0	3.9
Rumex crispus	0.1	0	0	0	0	0.4
Schoenoplectus pungens	0.1	0.3	0.2	0	0	0
Total	**94.5**	**126.5**	**86.6**	**85.4**	**56**	**118**
Number of Species	**20**	**12**	**10**	**5**	**2**	**14**

Transect means are averages by meter and overall mean is the average of the five transect means.

```
174   ARAN    CANE        ALGA       CANE   CASI        CANE         CASI CANE              SPECIES
       01  02------06 07--------12 13--15 16-17 18------------25 26-27  28                  METERS
      M--M S--------S A----------A S----S W---W S--------------S W---W S--S                 GRADIENT

175   CANE      CHAR       OPEN  CHAR   CASI                                                SPECIES
     01--03 04--------09 10-11 12--14 15--17                                                METERS
     S----S A-----------------------A W----W                                                GRADIENT

176         CANE       CASI                CANE                                             SPECIES
     01------------08 09-10 11----------------------------26                                METERS
     S-------------S  W---W S------------------------------S                                GRADIENT

177    CASI             CANE              CASI                                              SPECIES
     01----04 05-----------------------17 18--20                                            METERS
     W------W S-----------------------S  W----W                                             GRADIENT

178   POPR ELPA      CANE      CASI                     CANE                                SPECIES
       01   02  03----------09 10-11 12----------------------------------------33           METERS
      M--M W--W S------------S W---W S-----------------------------------------S            GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (174-178) at North Little Spring in 2009. Species codes are: ALGA (algae), ARAN (*Argentina anserina*), CANE (*Carex nebrascensis*), CASI (*Carex simulata*), CHAR (*Chara sp.*), ELPA (*Eleocharis palustris*), OPEN (open water), POPR (*Poa pratensis*). Moisture gradient (GRADIENT) codes: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-31
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (174-178) at North Little Spring in 2009

3.8.1.2.12 Big Springs

The major taxa, by overall mean cover, on the aquatic transects at Big Springs in 2009 were *Nasturtium officinale* (33 percent), *Eleocharis rostellata* (6 percent), *Carex praegracilis* (4 percent), moss (3 percent), and *Schedonorus pratensis* (3 percent) (Table 3-39). A total of 40 taxa occurred on the aquatic transects, which was about average for the 14 sites (Table 3-25). Mean total cover was below average for the 14 sites at 68 percent (Table 3-25).

Nasturtium officinale was the dominant species on four of the five transects, *Eleocharis rostellata* being dominant on one transect (Table 3-39). *Nasturtium officinale* was the second most dominant species on the transect dominated by *Eleocharis rostellata*. The second most dominant taxa on the other four transects were algae, *Argentina anserina*, moss, and *Schedonorus pratensis*.

Internal spatial heterogeneity was less complex at Big Springs than at most of the 14 sites, in part because of a high dominance by *Nasturtium officinale*. *Nasturtium officinale* was the most frequent dominant species, being the most abundant species on seven of the 38 microcommunity segments, which covered 51 percent of the combined lengths of the transects (55 out of 107 m) (Figure 3-32). *Eleocharis rostellata* was the second most frequent dominant species, being the most abundant species on five segments with a combined length of 12 m.

3.8.1.2.13 Unnamed 1 Spring

The major taxa, by overall mean, on the aquatic transects at Unnamed 1 Spring in 2009 were *Berula erecta* (16 percent), *Eleocharis rostellata* (13 percent), *Nasturtium officinale* (11 percent), and moss (9 percent)(Table 3-40). A total of 44 taxa occurred on the transects, which was about average for the 14 sites (Table 3-25). Mean total cover was slightly below average for the sites at 70 percent.

Nasturtium officinale was the most abundant species on two of the transects, and *Berula erecta*, *Chara sp*., and moss were the most abundant taxa on one transect each (Table 3-40). *Eleocharis rostellata* was the second most abundant species on two transects. *Berula erecta*, *Carex sp*., and moss were the second most abundant taxa on one transect each.

Internal spatial heterogeneity was moderate at Unnamed 1 Spring. *Eleocharis rostellata* was the most frequent dominant species, being the most abundant species on 9 of the 44 microcommunity segments, with a combined length of 36 out of 152 m of the combined transects (Figure 3-33). *Berula erecta* and *Nasturtium officinale* were the second most abundant species, being the dominant species on five segments each. *Berula erecta* and *Nasturtium officinale* were dominant on a total of 43 and 22 m respectively.

3.8.1.2.14 Stateline Springs

The major taxa, by overall mean cover, on the aquatic transects at Stateline Springs in 2009 were *Nasturtium officinale* (38 percent), moss (9 percent), *Juncus arcticus* (4 percent), *Argentina anserina* (2 percent), and *Potamogeton sp*. (2 percent) (Table 3-41). A total of 24 taxa occurred on the aquatic

Table 3-39
Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Big Springs in 2009

Species	Overall Mean	Transects				
		169	170	171	172	173
Agrostis gigantea	1.5	3	0	0.6	3.8	0
Algae	2.4	0	2.5	0	9.6	0
Aquilegia formosa	0.5	0	0	0	2.5	0
Argentina anserina	1.7	0.5	4.1	1.6	0.8	1.6
Asclepias speciosa	0.3	0	1.4	0	0	0
Bassia scoparia	0.1	0	0.4	0	0	0
Berula erecta	0.1	0	0	0.2	0.3	0
Carex nebrascensis	0.9	1	0	1.7	1.3	0.4
Carex praegracilis	3.5	12.1	0.9	0	4.2	0.5
Carex sp.	0.2	0	0	0.9	0	0
Chenopodium sp.	0.1	0	0.3	0	0	0
Cirsium scariosum	0.2	0.6	0	0	0	0.6
Crepis runcinata	0.1	0	0	0	0	0.5
Distichlis spicata	0.4	0	1.8	0	0	0
Eleocharis rostellata	5.7	0	0	7.6	5.1	15.9
Epilobium ciliatum	0.7	0	0	0	0	3.4
Equisetim arvense	t	0	0	0	0	0.1
Glaux maritima	0.5	0	2.3	0	0	0.3
Grindelia squarrosa	0.1	0.3	0	0	0	0
Hordeum jubatum	1.2	6.1	0.1	0	0	0
Juncus arcticus	2.4	5	3.5	0.4	0.7	2.2
Lemna trisulca	0.2	0	1.2	0	0	0
Leymus triticoides	0.8	1.3	1.1	0	1.3	0.3
Melilotus officinalis	1	5.0	0.1	0	0	0
Mimulus guttatus	0.3	1.3	0.2	0	0	0
Moss	3.3	0.4	0	16	0	0.2
Muhlenbergia richardsonis	0.1	0	0	0.4	0	0
Nasturtium officinale	32.9	58.5	6.4	70.2	16.7	12.6
Poa pratensis	0.9	2.3	0	1.3	0.7	0
Polypogon monspeliensis	0.2	0.8	0	0.3	0	0
Potamogeton sp.	1.1	0	0	0	0	5.4
Potentilla gracilis	0.2	0	0	0	0.9	0
Pyrrocoma lanceolata	0.2	0	0	0.4	0.4	0
Rosa woodsii	0.2	0	0	0	0.9	0
Rumex crispus	0.1	0.3	0	0	0	0
Schedonorus pratensis	3.3	16.3	0	0	0	0
Schoenoplectus americanus	t	0	0	0.1	0	0
Sisyrinchium halophilum	t	0.1	0	0	0.1	0
Trifolium repens	0.3	0	0	1.5	0	0
Veronica anagallis-aquatica	t	0	0	0	0.1	0
Total	**67.7**	**114.9**	**26.3**	**103.2**	**49.4**	**44**
Number of Species	**40**	**18**	**15**	**15**	**17**	**14**

Transect means are averages by meter, and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05%).

```
169   HOJU              NAOF              AGGI  SCPR   CAPR                           SPECIES
       01  02----------------------------17  18  19--21 22--24                        METERS
      M--M  A----------------------------A S-----------------S                        GRADIENT

170   DISP ASSP CAPR    OPEN     ALGA    NAOF     LETR  BARE  LETR  ARAN JUAR         SPECIES
       01   02   03  04--------09 10-11 12------16 17-18 19--21  22  23-24  25        METERS
      M------M  S--S A---------------------------A M-------------------------M        GRADIENT

171   TRRE ELRO                    NAOF                          MOSS  ELRO           SPECIES
       01   02  03-----------------------------------------25  26  27-28              METERS
      M--M W--W A-----------------------------------------------A  W---W              GRADIENT

172   ELRO POGR BARE   NAOF    ALGA  NAOF AQFO CAPR                                   SPECIES
     01-02  03   04  05----08 09-10 11--13 14   15                                    METERS
     W---W M-------M A-------------------A S--S M--M                                  GRADIENT

173   ARAN CISC    POTA     OPEN  NAOF    ELRO      OPEN    NAOF  ELRO                SPECIES
       01   02  03--------08 09-10 11-12 13------17 18----21 22-23 24-25              METERS
      M------M  A----------------------A  W-------W  A------------A W---W             GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (169-173) at Big Springs in 2009. Species codes are: AGGI (*Agrostis gigantea*), ALGA (algae), AQFO (Aquilegia formosa), ARAN (*Argentina anserina*), ASSP (*Asclepias speciosa*), BARE (bare ground), CAPR (*Carex praegracilis*), CISC (*Cirsium scariosum*), DISP (*Distichlis spicata*), ELRO (*Eleocharis rostellata*), HOJU (*Hordeum jubatum*), JUAR (*Juncus arcticus*), LETR (*Leymus triticoides*), MOSS (moss), NAOF (*Nastrutium officinale*), OPEN (open water), POGR (*Potentilla gracilis*), POTA (*Potamogeton sp.*), SCPR (*Schedonorus pratensis*), and TRRE (*Trifolium repens*). Moisture gradient (GRADIENT) codes: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-32
Spatial Heterogeneity (Most Abundant Species by Meter)
along the Five Aquatic Transects (169-173) at Big Springs in 2009

transects, the second fewest number of taxa of the 14 sites (Table 3-25). Mean total cover was 62 percent, which was also below average for the 14 sites.

Nasturtium officinale was the most abundant species on all five transects (Table 3-41). Moss was the second most abundant taxa on three of the transects, and algae and *Argentina anserina* were the second most abundant taxa on one transect each.

Internal spatial heterogeneity was relatively simple at Stateline Springs. *Nasturtium officinale* was the most frequent dominant species, being the most abundant species on 6 of the 24 microcommunity segments, which covered 66 percent of the combined lengths of the transects (59 out of 89 m; Figure 3-34). *Eleocharis rostellata* and *Juncus arcticus* were the second most abundant species, being the dominant species on three segments each.

3.8.2 Wetland/Meadow Transects

3.8.2.1 Summary of Wetland/Meadow Vegetation Data Overall

Species composition varied among the eight sites containing wetland/meadow transects. *Carex praegracilis* was the most abundant species at two of the sites and was the only species most abundant at more than one site (Table 3-42). *Juncus arcticus*, *Carex nebrascensis*, and *Thermopsis rhombifolia* were the most frequent major species, being one of the top three species at 5, 3, and 3 sites, respectively.

Table 3-40
Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Unnamed 1 Spring in 2009

Species	Overall Mean	Transects				
		164	165	166	167	168
Agrostis gigantea	1.5	3	0	0.6	3.8	0
Algae	2.4	0	2.5	0	9.6	0
Aquilegia formosa	0.5	0	0	0	2.5	0
Argentina anserina	1.7	0.5	4.1	1.6	0.8	1.6
Asclepias speciosa	0.3	0	1.4	0	0	0
Bassia scoparia	0.1	0	0.4	0	0	0
Berula erecta	0.1	0	0	0.2	0.3	0
Carex nebrascensis	0.9	1	0	1.7	1.3	0.4
Carex praegracilis	3.5	12.1	0.9	0	4.2	0.5
Carex sp.	0.2	0	0	0.9	0	0
Chenopodium sp.	0.1	0	0.3	0	0	0
Cirsium scariosum	0.2	0.6	0	0	0	0.6
Crepis runcinata	0.1	0	0	0	0	0.5
Distichlis spicata	0.4	0	1.8	0	0	0
Eleocharis rostellata	5.7	0	0	7.6	5.1	15.9
Epilobium ciliatum	0.7	0	0	0	0	3.4
Equisetim arvense	t	0	0	0	0	0.1
Glaux maritima	0.5	0	2.3	0	0	0.3
Grindelia squarrosa	0.1	0.3	0	0	0	0
Hordeum jubatum	1.2	6.1	0.1	0	0	0
Juncus arcticus	2.4	5.0	3.5	0.4	0.7	2.2
Lemna trisulca	0.2	0	1.2	0	0	0
Leymus triticoides	0.8	1.3	1.1	0	1.3	0.3
Melilotus officinalis	1.0	5.0	0.1	0	0	0
Mimulus guttatus	0.3	1.3	0.2	0	0	0
Moss	3.3	0.4	0	16.0	0	0.2
Muhlenbergia richardsonis	0.1	0	0	0.4	0	0
Nasturtium officinale	32.9	58.5	6.4	70.2	16.7	12.6
Poa pratensis	0.9	2.3	0	1.3	0.7	0
Polypogon monspeliensis	0.2	0.8	0	0.3	0	0
Potamogeton sp.	1.1	0	0	0	0	5.4
Potentilla gracilis	0.2	0	0	0	0.9	0
Pyrrocoma lanceolata	0.2	0	0	0.4	0.4	0
Rosa woodsii	0.2	0	0	0	0.9	0
Rumex crispus	0.1	0.3	0	0	0	0
Schedonorus pratensis	3.3	16.3	0	0	0	0
Schoenoplectus americanus	t	0	0	0.1	0	0
Sisyrinchium halophilum	t	0.1	0	0	0.1	0
Trifolium repens	0.3	0	0	1.5	0	0
Veronica anagallis-aquatica	t	0	0	0	0.1	0
Total	**67.7**	**114.9**	**26.3**	**103.2**	**49.4**	**44**
Number of Species	**40**	**18**	**15**	**15**	**17**	**14**

Transect means are averages by meter and overall mean is the average of the five transect means.
A "t" indicates a trace amount (<0.05%).

```
164   CARX JUAR    NAOF    ALGA PLMA CANE DISP                                       SPECIES
     01-02  03  04------08  09    10    11    12                                      METERS
     M---M S--S A------------ A M--M S--S M--M                                        GRADIENT

165   JUAR CAPR    NAOF    BEER ELRO   NAOF   BEER   NAOF     BEER      MOSS     ELRO SPECIES
       01   02  03----08 09-11  12  13---17 18--21 22--25 26-----32 33------40 41--44 METERS
      M-------M A------------A W--W A---------------------------------------A W----W  GRADIENT

166   AGGI                   BEER                    ELRO    JUAR SCPR AGGI ELTR      SPECIES
     01-02 03------------------------------------30 31--33 34---37 38   39   40       METERS
     S---S A-------------------------------------A W----W S--------------S M--M       GRADIENT

167   ELRO   CHAR  BEER    MOSS    JUNE CHAR       ELRO        DECE ARAN LETR         SPECIES
     01--03 04--06  07   08------12  13    14  15--------------23  24   25   26       METERS
     W----W A--------------------A W--W A--A W----------------W M------------M        GRADIENT

168   ELRO   NAOF    ELRO         MOSS        ELRO    MOSS   ELRO   MURI DECE         SPECIES
     01--03 04--06 07------11 12----------18 19----22 23-24 25----28  29   30         METERS
     W----W A----A W--------W A------------A W------W A---A W------W M-------M        GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (164-168) at Unnamed 1 Spring in 2009. Species codes are: AGGI (*Agrostis gigantea*), ALGA (algae), ARAN (*Argentina anserina*), BEER (*Berula erecta*), CANE (*Carex nebrascensis*), CAPR (*Carex praegracilis*), CARX (*Carex sp.*), CHAR (*Chara sp.*), DECE (*Deschampsia caespitosa*), DISP (*Distichlis spicata*), ELRO (*Eleocharis rostellata*), ELTR (*Elymus trachycaulis*), JUAR (*Juncus arcticus*), JUNE (*Juncus nevadensis*), LETR (*Leymus triticoides*), MOSS (moss), MURI (*Muhlenbergia richardsonis*), NAOF (*Nasturtium officinale*), PLMA (*Plantago major*), and SCPR (*Schedonorus pratensis*). Moisture gradient (GRADIENT) codes: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-33
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (164-168) at Unnamed 1 Spring in 2009

Table 3-41
Mean Percent Cover, Overall and by Species, of Vegetation along Aquatic Transects at Stateline Springs in 2009

Species	Overall Mean	Transects				
		131	132	133	134	135
Agrostis gigantea	1.0	1.1	0.1	0	3.4	0.3
Algae	1.4	0	1.1	0	1.8	4.1
Argentina anserina	2.0	3.1	0.4	0.9	5.5	0.2
Aster sp.	0.2	0	0	0	0.2	0.8
Berula erecta	0.6	0	0.4	0.7	1.6	0.5
Carex nebrascensis	0.9	1.4	0.8	1.8	0.3	0.2
Cirsium scariosum	0.2	0	0	0	0	0.9
Distichlis spicata	0.1	0.3	0	0	0	0.3
Eleocharis palustris	1.1	0	0.2	5.0	0.2	0
Eleocharis rostellata	1.2	1.5	2.8	0.3	0	1.4
Equisetum arvense	0.2	0.1	0.5	0	0.2	0.3
Glaux maritima	0.1	0.3	0	0	0	0.1
Juncus arcticus	3.7	2.9	2.1	2.0	11.5	0.2
Leymus triticoides	t	0.1	0	0	0	0
Moss	8.6	2.5	7.5	8.8	23.8	0.5
Nasturtium officinale	38.1	40.8	50.1	38	29.7	31.8
Polypogon monspeliensis	0.1	0	0	0	0.4	0
Potamogeton sp.	1.7	0	1.0	7.5	0	0
Pyrrocoma lanceolata	0.4	0	0	0	2.2	0
Schoenoplectus americanus	0.6	0.4	1.3	0.6	0.7	0
Sisyrinchium halophilum	t	0.1	0	0	0	0
Spartina gracilis	0.1	0	0	0	0	0.6
Trifolium sp.	t	0.1	0	0	0	0
Veronica anagallis-aquatica	0.1	0.4	0	0	0	0
Total	**62.4**	**55.1**	**68.3**	**65.6**	**81.5**	**42.2**
Number of Species	**24**	**15**	**13**	**10**	**14**	**15**

Transect means are averages by meter and overall mean is the average of the five transects.
A "t" indicates a trace amount (<0.05%).

```
131   ARAN            NAOF          ELRO                                                 SPECIES
       01  02--------------------13  14                                                  METERS
      M--M A----------------------A W--W                                                 GRADIENT

132   SCAM ELRO       NAOF      MOSS         NAOF       JUAR ELRO                        SPECIES
       01   02  03----------09 10-11 12--------------20  21   22                         METERS
      A--A W--W A-------------------------------------A S--S W--W                        GRADIENT

133   ARAN JUAR               NAOF             ELPA  POTA   ELPA                         SPECIES
       01   02  03--------------------------17  18  19--21 22--24                        METERS
      M--M S--S A---------------------------A W---W A----A W----W                        GRADIENT

134   PYLA ARAN  NAOF     MOSS      JUAR                                                 SPECIES
       01   02  03-04 06--------11 12-13                                                 METERS
      D--D M--M A----------------A S---S                                                 GRADIENT

135   DISP CISC           NAOF                                                           SPECIES
       01   02  03------------------------16                                             METERS
      M-------M A--------------------------A                                             GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the five aquatic transects (131-135) at Stateline Springs in 2009. Species codes are: ARAN (*Argentina anserina*), CISC (*Cirsium scariosum*), DISP (*Distichlis spicata*), ELPA (*Eleocharis palustris*), ELRO (*Eleocharis rostellata*), JUAR (*Juncus arcticus*), MOSS (moss), NAOF (*Nasturtium officinale*), POTA (*Potamogeton sp.*), PYLA (*Pyrrocoma lanceolata)*, and SCAM (*Schoenoplectus americanus*). Moisture gradient (GRADIENT) codes: D = surface commonly dry; M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-34
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Aquatic Transects (131-135) at Stateline Springs in 2009

Table 3-42
Summary of Overall Species, Composition, Cover, and Number of Plant Taxa on the Wetland/Meadow Transects in 2009

Site	Composition Overall (% Cover of Major Species)						Mean Total Cover (%)	Mean Plant Coverage (%)	Number of Taxa
Stonehouse Complex	CASI	(17)	CANE	(16)	JUAR	(9)	76.4	69.5	65
Keegan Ranch Complex	THRH	(7)	CANE	(7)	JUAR	(5)	60.8	57	72
West Spring Valley Complex	JUAR	(7)	ELRO	(7)	THRH	(6)	79.1	67.7	73
Shoshone Ponds	CAPR	(13)	JUAR	(5)	DISP	(3)	40.5	39.4	57
The Seep	ARAN	(12)	CANE	(7)	SPAI	(6)	49.7	49.4	44
Minerva Spring Complex	AGGI	(10)	SCPR	(9)	THRH	(8)	98.2	81	82
Blind Spring	UTMA	(35)	ZAPA	(6)	SPEU	(6)	85.6	71.3	32
Burbank Meadows	CAPR	(11)	JUAR	(9)	DISP	(8)	59.5	58.1	54
Overall Mean							**68.7**	**61.7**	**60**

Cover values are averages over 5-10 transects per site, and number of species is the total number observed on the sum of the transects per site.
Numbers in parentheses following species codes are mean cover values (%) for each of the three species with the highest mean cover values at that site.
Species codes: AGGI = *Agrostis gigantea*, ARAN = *Argentina anserina*, CANE = *Carex nebrascensis*, CAPR = *Carex praegracilis*, CASI = *Carex simulata*, DISP = *Distichlis spicata*, ELRO = *Eleocharis rostellata*, JUAR = *Juncus arcticus*, SCPR = *Schedonorus pratensis*, SPAI = *Sporobolus airoides*, SPEU = *Sparganium eurycarpum*, THRH = *Thermopsis rhombifolia*, UTMA = *Utricularia macrorhiza*, ZAPA = *Zannichellia palustris*.
Mean Total Cover is the mean of the cover values of all species, averaged over all transects at each site. It includes multiple hits per 1-cm mark per meter.
Mean Plant Coverage is the mean of the percent of the length of the transect where vegetation was present (i.e., first-hit counts only).

Mean total cover was highest at the Minerva Spring Complex (98 percent) and Blind Spring (86 percent) and lowest at Shoshone Ponds (41 percent) and the Seep (50 percent) (Table 3-42). Overall species richness (number of taxa) was also greatest at the Minerva Spring Complex (82) but lowest at Blind Spring (32) and the Seep (44). Overall mean total cover on the wetland/meadow transects was lower than on the aquatic transects (69 percent and 80 percent, respectively), but mean species richness was higher on the wetland/meadow transects than on the aquatic transects (60 and 42 percent; respectively) (Tables 3-25 and 3-42).

A total of 153 plant taxa were encountered along the wetland/meadow transects in 2009 (Table 3-43). This was about the same number (148) as encountered on the 70 aquatic transects (Table 3-26). However, the 63 wetland/meadow transects sampled a longer distance than did the 70 aquatic transects (4,863 and 1,931 m, respectively; Tables F-35 to F-38). Of the 153 taxa on the wetland/meadow transects, a third (51) occurred at only one site. In comparison, 26 taxa occurred at six (75 percent) or more sites, and only four species occurred on at least 75 percent of the transects (47 or more).

The most frequently encountered taxa were *Juncus arcticus* (eight sites, 59 transects), *Argentina anserina* (seven sites, 52 transects), *Carex praegracilis* (seven sites, 51 transects), *Carex nebrascensis* (eight sites, 47 transects), *Leymus triticoides* (seven sites, 44 transects), *Agrostis gigantea* (seven sites, 42 transects), *Distichlis spicata* (eight sites, 41 transects), *Poa pratensis* (seven sites, 38 transects), *Puccinellia lemmonii* (seven sites, 37 transects), and *Eleocharis palustris* (eight sites, 33 transects) (Table 3-43).

Species with the highest mean cover (averaged over all sites) were:

- *Carex nebrascensis* (5.3 percent)
- *Carex praegracilis* (4.9 percent)
- *Juncus arcticus* (4.9 percent)
- *Utricularia macrorhiza* (4.4 percent)
- *Argentina anserina* (3.9 percent)
- *Carex simulata* (3.1 percent)
- *Distichlis spicata* (2.7 percent), and
- *Thermopsis rhombifolia* (2.6 percent).

3.8.2.2 Summary of Wetland/Meadow Vegetation Data by Site

The species with the highest mean cover values varied among the eight sites with wetland/meadow transects (Table 3-44). In general, transects at the four northern sites (Stonehouse Complex, Keegan Ranch Complex, West Spring Valley Complex, and Shoshone Ponds) were more similar in their dominant species than they were to those at the southern part of Spring Valley or in Snake Valley (Burbank Meadows). *Juncus arcticus* and either *Carex nebrascensis* or *C. praegracilis* (or both) were the common dominants at the four northern sites. Additional species with high cover values at these sites, some increasing to dominant status at certain sites, were *Argentina anserina*, *Berula erecta*, *Carex simulata*, *Cirsium arevense*, *Eleocharis rostellata*, and *Thermopsis rhombifolia*.

Table 3-43
Plant Taxa Present on the Wetland/Meadow Sites in 2009
(Page 1 of 4)

Plant Taxa	Mean Cover (%)	Number of Sites Where Present	Number of Transects Where Present
Achillea millefolium	0.3	5	19
Agoseris glauca	t	2	2
Agrostis gigantea	2.2	7	42
Algae	0.5	4	11
Aquilegia formosa	0.1	1	4
Argentina anserina	3.9	7	52
Artemisia tridentata	t	2	3
Asclepias speciosa	t	2	2
Aster sp.	t	5	9
Astragalus sp.	t	1	2
Atriplex micrantha	t	1	4
Atriplex sp.	t	1	1
Atriplex truncata	t	1	1
Bassia scoparia	0.3	5	12
Berula erecta	1.1	7	25
Bidens cernua	t	2	4
Bromus inermis	0.2	1	4
Bromus tectorum	t	3	5
Cardaria draba	t	1	1
Carduus nutans	0.1	1	4
Carex aurea	t	1	1
Carex douglasii	t	1	1
Carex nebrascensis	5.3	8	47
Carex praegracilis	4.9	7	51
Carex rostrata	1.6	3	10
Carex simulata	3.1	5	20
Carex sp.	1.3	5	11
Castilleja minor	t	1	2
Catabrosa aquatica	t	1	3
Centaurium exaltatum	t	2	2
Chara sp.	0.5	4	8
Chenopodium berlandieri	t	1	1
Chenopodium sp.	0.1	3	5
Cirsium arvense	0.7	1	7
Cirsium scariosum	0.3	6	30
Cirsium vulgare	0.1	4	7
Conium maculatum	t	1	1
Convolvulus arvensis	t	1	1
Crepis runcinata	0.6	6	24

Table 3-43
Plant Taxa Present on the Wetland/Meadow Sites in 2009
(Page 2 of 4)

Plant Taxa	Mean Cover (%)	Number of Sites Where Present	Number of Transects Where Present
Dactylis glomerata	t	1	1
Deschampsia caespitosa	0.3	5	16
Descurainia sophia	t	2	3
Distichlis spicata	2.7	8	41
Dodecatheon pulchellum	t	1	1
Downingia laeta	t	1	1
Eleocharis palustris	1.4	8	33
Eleocharis quinqueflora	0.1	1	2
Eleocharis rostellata	2	6	15
Eleocharis sp.	0.1	3	3
Elymus elymoides	t	1	1
Elymus trachycaulis	0.9	4	10
Epilobium ciliatum	0.1	1	4
Epilobium sp.	0.1	4	8
Equisetum arvense	0.3	7	24
Ericameria nauseosa	0.1	5	14
Erigeron lonchophyllus	0.1	6	28
Festuca sororia	t	1	1
Galium trifidum	t	1	1
Glaux maritima	0.2	5	21
Helianthus nuttalii	t	2	5
Hesperochiron pumilus	t	1	3
Hippuris vulgaris	0.8	3	11
Hordeum brachyantherum	0.3	5	19
Hordeum jubatum	1	6	28
Hymenoxys lemmonii	t	2	4
Iris missouriensis	0.3	4	13
Iva axillaris	0.2	2	5
Ivesia kingii	0.2	4	8
Juncus arcticus	4.9	8	59
Juncus bufonius	0.1	1	2
Juncus longistylis	t	1	1
Juncus nevadensis	0.2	6	18
Juncus sp.	t	1	1
Juniperus scopulorum	0.2	1	5
Lactuca serriola	t	1	2
Lemna minor	0.3	2	5
Lemna minuta	t	1	1
Lemna sp.	0.5	3	4

Table 3-43
Plant Taxa Present on the Wetland/Meadow Sites in 2009
(Page 3 of 4)

Plant Taxa	Mean Cover (%)	Number of Sites Where Present	Number of Transects Where Present
Lemna trisulca	t	1	1
Leymus triticoides	1.4	7	44
Limosella aquatica	t	1	2
Medicago polymorpha	0.2	4	9
Melilotus officinalis	0.2	3	6
Mentha arvensis	t	1	1
Mentha spicata	t	1	1
Mimulus guttatus	0.4	6	19
Moss	0.7	6	12
Muhlenbergia asperifolia	0.1	5	18
Muhlenbergia richardsonis	0.2	5	21
Myriophyllum verticillatum	t	1	2
Nasturtium officinale	0.5	5	17
Nitrophila occidentalis	0.1	4	12
Pascopyrum smithii	0.1	1	1
Phalaris arundinacea	t	1	1
Phleum pratense	t	3	5
Phragmites australis	0.2	1	1
Plagiobothrys scouleri	t	1	1
Plantago major	t	3	6
Poa pratensis	0.8	7	38
Poa secunda	t	3	4
Poa sp.	t	2	2
Polygonum aviculare	0.6	4	7
Polygonum sp.	t	1	1
Polypogon monspeliensis	t	2	2
Potamogeton sp.	0.9	3	8
Potentilla gracilis	t	2	3
Potentilla hippiana	t	2	3
Potentilla pensylvanica	t	2	4
Puccinellia distans	0.3	5	11
Puccinellia lemmonii	1.7	7	37
Pyrrocoma lanceolata	0.2	7	27
Ranunculus cymbalaria	t	5	8
Ranunculus sceleratus	0.1	7	19
Rosa woodsii	0.6	1	1
Rumex crispus	0.1	3	7
Sagittaria cuneata	0.1	2	6
Sarcobatus vermiculatus	t	4	4

Table 3-43
Plant Taxa Present on the Wetland/Meadow Sites in 2009
(Page 4 of 4)

Plant Taxa	Mean Cover (%)	Number of Sites Where Present	Number of Transects Where Present
Schedonorus pratensis	1.2	5	11
Schoenoplectus acutus	0.7	4	13
Schoenoplectus americanus	0.3	4	9
Schoenoplectus pungens	0.1	6	10
Sida neomexicana	t	2	4
Sisyrinchium halophilum	0.1	5	20
Sium suave	t	1	1
Solidago nana	t	1	1
Solidago sp.	t	2	5
Sparganium eurycarpum	0.1	2	4
Spartina gracilis	0.5	5	12
Sphenopholis obtusata	t	3	6
Sporobolus airoides	1.2	6	16
Stellaria longipes	t	1	1
Stuckenia filiformis	0.1	2	2
Symphyotrichum eatonii	0.1	4	14
Taraxacum officinale	0.2	6	32
Thermopsis rhombifolia	2.6	3	16
Thinopyrum ponticum	t	1	2
Trifolium fragiferum	0.1	3	6
Trifolium hybridum	t	2	4
Trifolium pratense	0.1	2	7
Trifolium repens	0.4	6	19
Trifolium sp.	0.2	2	7
Triglochin concinna	t	2	2
Triglochin maritima	0.1	4	11
Triglochin palustris	t	1	1
Triglochin sp.	t	1	3
Typha latifolia	0.9	4	14
Utricularia macrorhiza	4.4	2	6
Verbena bracteata	t	1	1
Veronica anagallis-aquatica	0.1	4	10
Viola nephrophylla	0.1	3	6
Xanthium strumarium	t	1	1
Zannichellia palustris	0.8	2	8
Zigadenus elegans	t	1	1

Mean cover = average of the eight sites.
Total number of sites = 8.
Total number of transects = 63.
A “t” indicates a trace amount (<0.05%).

Table 3-44
Mean Cover (%) of Major Plant Taxa in 2009 at the Wetland/Meadow Transect Sites
(Page 1 of 2)

Species	Stonehouse	Keegan Ranch	West Spring Valley	Shoshone Ponds	The Seep	Minerva Spring	Blind Spring	Burbank Meadows
Achillea millefolium	---	0.5	0.2	0.7	t	0.9	---	---
Agrostis gigantea	0.6	0.3	3.2	1.3	2.3	9.7	---	0.5
Algae	0.1	1	0.8	---	---	1.9	---	---
Argentina anserina	0.7	4.9	0.9	3.1	12.4	1.5	---	7.6
Bassia scoparia	---	---	t	---	t	0.9	1.6	0.1
Berula erecta	1.3	0.2	5.3	0.1	t	1.6	---	t
Bromus inermis	---	---	1.2	---	---	---	---	---
Carex nebrascensis	16.2	6.5	5.1	2.5	6.7	5	0.4	t
Carex praegracilis	2.8	4.6	3.6	12.6	3.3	1.9	---	10.7
Carex rostrata	5.1	---	3	---	---	---	4.3	---
Carex simulata	16.7	2.8	2	---	---	1	2.1	---
Carex sp.	2.6	1.7	4.7	0.5	---	0.6	---	---
Chara sp.	t	0.2	---	---	---	1.7	2.2	---
Cirsium arvense	---	---	5.5	---	---	---	---	---
Cirsium scariosum	t	0.2	---	0.1	0.3	0.3	---	1.1
Crepis runcinata	0.2	1	t	0.1	0	0.2	---	3.2
Deschampsia caespitosa	0.2	t	---	---	1.3	0.5	---	t
Distichlis spicata	0.8	1.9	0.4	3.3	1.7	0.8	4.6	8.4
Eleocharis palustris	4.6	1	0.6	0.4	0.6	0.9	2.8	t
Eleocharis rostellata	5.9	0.1	6.6	---	t	2.5	1	---
Eleocharis sp.	t	---	---	0.5	---	---	---	t
Elymus trachycaulis	t	---	t	---	---	6.5	---	0.1
Equisetum arvense	t	0.1	1.5	t	t	0.4	---	t
Erigeron lonchophyllus	t	t	---	0.6	0.5	0.1	---	0.2
Glaux maritima	0.7	0.1	---	0.1	---	t	---	0.7
Hippuris vulgaris	0.1	0.1	---	---	---	---	6.1	---
Hordeum brachyantherum	1.3	0.6	---	0.1	---	0.2	---	0.1
Hordeum jubatum	t	0.6	t	---	1.4	4.9	---	0.9
Iris missouriensis	1.5	0.2	---	---	---	0.2	---	0.1
Iva axillaris	---	---	1.1	---	---	---	0.1	---
Ivesia kingii	---	0.1	---	0.4	0.7	---	---	t
Juncus arcticus	9.4	5.3	7	4.8	2.3	1.6	t	8.9
Juncus bufonius	---	---	---	---	0.5	---	---	---
Juniperus scopulorum	---	---	---	1.4	---	---	---	---
Lemna minor	t	---	2.2	---	---	---	---	---
Lemna sp.	0.3	0.1	3.9	---	---	---	---	---
Leymus triticoides	0.6	2.6	0.2	0.2	0.6	2.9	---	4.2

Table 3-44
Mean Cover (%) of Major Plant Taxa in 2009 at the Wetland/Meadow Transect Sites
(Page 2 of 2)

Species	Stonehouse	Keegan Ranch	West Spring Valley	Shoshone Ponds	The Seep	Minerva Spring	Blind Spring	Burbank Meadows
Medicago polymorpha	---	---	0.1	0.1	t	1.3	---	---
Melilotus officinalis	---	t	t	---	---	1.6	---	---
Mimulus guttatus	0.1	0.4	1.9	t	---	0.4	0.5	---
Moss	0.1	3.6	0.1	0.1	---	1.2	0.7	---
Muhlenbergia asperifolia	---	---	t	0.5	0.2	0.1	---	0.1
Muhlenbergia richardsonis	---	0.4	0.1	0.4	0.3	t	---	---
Nasturtium officinale	0.7	0.9	0.1	0.1	---	2.2	---	---
Phragmites australis	---	---	1.9	---	---	---	---	---
Poa pratensis	0.1	1.9	1.7	0.5	0.1	2	---	0.1
Polygonum aviculare	---	---	t	---	3.8	1.3	---	t
Potamogeton sp.	---	---	---	---	---	6.6	0.3	0.1
Puccinellia distans	0.2	---	---	---	1.8	t	t	0.2
Puccinellia lemmonii	0.5	0.7	0.1	2.7	1.3	1.5	---	6.4
Pyrrocoma lanceolata	0.1	0.1	0.1	0.4	0.1	0.3	---	0.1
Rosa woodsii	---	---	---	---	---	4.6	---	---
Schedonorus pratensis	t	0.3	0.5	0.1	---	8.8	---	---
Schoenoplectus acutus	0.7	0.2	1.9	---	---	---	2.8	---
Schoenoplectus americanus	t	t	t	---	---	---	2.1	---
Sparganium eurycarpum	---	0.2	0.4	---	---	---	5.8	---
Spartina gracilis	---	0.2	---	0.3	0.4	0.2	---	2.8
Sporobolus airoides	---	1.4	0.3	t	5.7	1.8	---	0.5
Taraxacum officinale	---	0.9	0.2	0.2	0.4	0.1	---	0.1
Thermopsis rhombifolia	---	7.4	5.6	---	---	7.7	---	---
Trifolium pratense	---	---	t	---	---	1.1	---	---
Trifolium repens	0.1	0.7	0.2	1.7	---	0.3	---	t
Trifolium sp.	---	0.3	---	---	---	---	---	0.9
Typha latifolia	0.5	1.1	0.6	---	---	---	5	---
Utricularia macrorhiza	---	0.3	---	---	---	---	34.8	---
Veronica anagallis-aquatica	---	0.8	---	t	0.1	0.1	---	---
Zannichellia palustris	0.1	---	---	---	---	---	6.2	0

Transect means are averages by meter, and overall mean is the average of the ten transects.
Major plant taxa = plant taxa with at least 1% of the mean cover of any of the eight sites.
A “t” indicates a trace amount (<0.05%)
Dashed lines (---) indicate that the taxa was not present at the site (cover = 0).

Argentina anserina and *Carex nebrascensis* were also dominant at the Seep, along with *Sporobolus airoides*, but *Juncus arcticus* was not (Table 3-44). Transects at Burbank Meadows had three dominants common with the four in northern sites in Spring Valley (*Argentina anserina*, *Carex praegracilis*, and *Juncus arcticus*) but had greater numbers of *Distichlis spicata* and *Puccinellia lemmonii*.

The wetland/meadow transects at the Minerva Spring Complex and at Blind Spring differed the most from the transects at the other sites. None of the species that were most abundant at these two sites were among those most abundant at the other six sites. The transects at the Minerva Spring Complex were dominated by *Agrostis gigantea*, *Schedonorus pratensis*, and *Elymus trachycaulis*, and transects at Blind Spring were dominated by aquatic or wetland species, those with the highest cover being *Utricularia macrorhiza*, *Zannichellia palustris*, *Hippuris vulgaris*, *Sparganium eurycarpum*, and *Typha latifolia* (Table 3-44).

3.8.2.2.1 Stonehouse Complex

The major species, by overall mean cover, on the wetland/meadow transects at the Stonehouse Complex were *Carex simulata* (17 percent), *Carex nebrascensis* (16 percent), *Juncus arcticus* (9 percent), *Eleocharis rostellata* (6 percent), *Carex rostrata* (5 percent), and *Eleocharis palustris* (5 percent) (Table 3-45). A total of 65 taxa occurred on the transects in 2009, which was average for the eight sites (Table 3-42). Total overall cover averaged 76, percent which was above average for the eight wetland/meadow sites.

Carex nebrascensis and *Juncus arcticus* were the only species to occur on all 10 transects at this site (Table 3-45). *Carex nebrascensis* was the major species on five transects, and *Carex simulata* was the major species on two transects. *Eleocharis palustris*, *Eleocharis rostellata*, and *Juncus arcticus* were the major species on one transect each. *Carex praegracilis*, *Carex rostrata*, *Carex sp.*, and *Iris missouriensis* were the only other taxa with a cover of at least 10 percent of the transect mean for any of the 10 transects.

Spatial heterogeneity varied from moderate to substantial along the wetland/meadow transects at Stonehouse Complex (Figure 3-35). *Carex nebrascensis* was the most frequent dominant species, having the highest cover value in 24 of the 117 microcommunity segments along the transects, with a combined length of 284 out of 907 m (31 percent) in the 10 transects (Figure 3-35). *Carex simulata* was the second most frequent dominant, being dominant in 18 segments with a combined length of 157 m. *Juncus arcticus* and *Carex praegracilis* followed, being dominant on 13 and 12 segments, respectively.

3.8.2.2.2 Keegan Ranch Complex

The major taxa, by overall mean cover, on the wetland/meadow transects at the Keegan Ranch Complex were *Thermopsis rhombifolia* (7 percent), *Carex nebrascensis* (7 percent), *Juncus arcticus* (5 percent) *Argentina anserina* (5 percent), *Carex praegracilis* (5 percent), moss (4 percent), *Carex simulata* (3 percent), and *Leymus triticoides* (3 percent) (Table 3-46). A total of 72 taxa occurred on

Table 3-45
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Stonehouse Complex in 2009
(Page 1 of 2)

Species	Overall Mean	029	030	031	032	033	034	035	036	037	038
Agoseris glauca	t	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Agrostis gigantea	0.6	0.1	0.0	t	2.5	0.3	0.2	t	0.0	0.0	2.8
Algae	0.1	0.0	0.6	0.0	0.0	0.0	0.0	t	0.0	0.1	0.0
Argentina anserina	0.7	0.8	1.2	2.1	1.1	0.2	0.3	0.2	0.0	0.4	0.7
Asclepias speciosa	t	t	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aster sp.	0.1	0.0	0.0	0.4	0.5	0.2	0.0	0.0	0.0	0.0	0.0
Berula erecta	1.3	1.4	0.2	0.0	0.0	6.0	3.2	1.0	1.1	0.0	0.0
Carex aurea	t	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Carex nebrascensis	16.2	4.1	13.0	13.1	7.4	25.1	19.2	13.3	9.1	13.2	44.9
Carex praegracilis	2.8	1.8	0.8	7.1	7.1	0.1	0.0	4.9	0.0	1.5	4.5
Carex rostrata	5.1	0.0	0.0	0.0	2.0	8.7	0.0	0.0	31.6	8.5	0.0
Carex simulata	16.7	19.3	21.6	0.0	18.8	21.6	28.2	0.0	51.3	0.0	6.1
Carex sp.	2.6	0.0	0.0	4.9	0.0	0.0	0.0	12.0	0.0	9.1	0.0
Catabrosa aquatica	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.1	0.1
Chara sp.	t	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Cirsium scariosum	t	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	t
Crepis runcinata	0.2	0.2	0.0	0.7	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Deschampsia caespitosa	0.2	0.0	0.2	0.1	0.2	0.0	0.5	0.1	0.0	0.6	0.0
Distichlis spicata	0.8	0.7	0.0	0.7	1.8	0.0	0.0	0.0	0.0	0.1	4.5
Downingia laeta	t	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Eleocharis palustris	4.6	2.3	8.9	0.6	26.9	0.0	1.7	5.5	0.5	0.0	0.0
Eleocharis quinqueflora	0.4	0.0	0.0	0.0	0.0	0.0	2.0	1.6	0.0	0.0	0.0
Eleocharis rostellata	5.9	35.8	20.8	0.0	0.0	1.5	0.0	0.8	0.0	0.0	0.0
Eleocharis sp.	t	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elymus trachycaulis	t	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Epilobium sp.	t	0.0	0.0	0.0	0.0	0.0	t	0.0	0.0	0.0	0.0
Equisetum arvense	t	0.0	0.0	t	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Erigeron lonchophyllus	t	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Glaux maritima	0.7	3.3	1.2	0.4	0.3	1.0	0.9	0.2	0.0	t	0.0
Helianthus nuttalii	t	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hesperochiron pumilus	0.1	0.0	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Hippuris vulgaris	0.1	0.0	0.0	0.3	0.1	0.0	0.4	0.0	0.0	t	0.0
Hordeum brachyantherum	1.3	0.0	0.0	0.1	0.3	0.1	0.1	0.0	0.0	0.6	0.1
Hordeum jubatum	t	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
Iris missouriensis	1.5	0.0	5.1	7.0	2.2	0.4	0.1	0.0	0.0	0.0	0.0
Juncus arcticus	9.4	8.3	13.5	2.0	10.3	12.3	31.3	5.1	0.2	3.6	7.6

Table 3-45
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Stonehouse Complex in 2009
(Page 2 of 2)

Species	Overall Mean	029	030	031	032	033	034	035	036	037	038
Juncus longistylis	t	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Lemna minor	t	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0
Lemna sp.	0.3	0.0	0.0	0.0	0.0	0.0	2.0	0.6	0.0	0.0	0.0
Leymus triticoides	0.6	0.5	0.7	1.4	1.3	0.4	0.0	0.0	0.0	1.4	0.4
Mimulus guttatus	0.1	t	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0
Moss	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
Nasturtium officinale	0.7	0.0	0.1	0.0	t	0.5	5.8	0.1	0.0	0.0	0.0
Nitrophila occidentalis	0.1	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Phalaris arundinacea	0.1	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Poa pratensis	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	t	0.5
Poa sp.	t	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Puccinellia distans	0.2	0.0	0.0	0.0	0.5	0.2	0.0	t	0.0	0.8	0.1
Puccinellia lemmonii	0.5	0.5	0.0	0.9	0.1	2.1	0.0	0.0	0.0	0.0	1.1
Pyrrocoma lanceolata	0.1	0.2	0.1	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.3
Ranunculus cymbalaria	0.1	0.0	0.0	0.7	0.1	0.0	0.3	0.1	0.0	0.0	0.0
Ranunculus sceleratus	0.2	0.8	0.2	t	0.3	0.3	0.1	0.1	0.0	0.3	0.0
Sarcobatus vermiculatus	t	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Schedonorus pratensis	t	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Schoenoplectus acutus	0.7	0.0	0.0	0.0	t	2.4	4.5	0.0	0.0	0.0	0.0
Schoenoplectus americanus	t	t	0.2	0.0	t	0.0	0.0	0.0	0.0	0.0	0.1
Schoenoplectus pungens	t	0.0	0.0	0.1	0.0	0.0	0.0	t	0.0	t	0.0
Solidago sp.	t	0.0	0.2	0.0	0.0	0.0	0.0	t	0.0	0.0	0.0
Sphenopholis obtusata	t	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Trifolium repens	0.1	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Triglochin concinna	t	t	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triglochin maritima	0.3	0.0	2.4	0.0	t	t	0.1	t	0.0	0.0	0.9
Triglochin palustris	t	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Typha latifolia	0.5	0.0	0.0	0.0	0.1	0.0	0.2	0.0	4.9	0.0	0.0
Zannichellia palustris	0.1	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.2
Total	**76.4**	**81.7**	**91.2**	**43.8**	**86.6**	**84.8**	**101.9**	**46.6**	**98.7**	**40.7**	**75.3**
Number of Species	**65.0**	**26.0**	**21.0**	**27.0**	**33.0**	**24.0**	**25.0**	**25.0**	**7.0**	**21.0**	**20.0**

Transect means are averages by meter, and overall mean is the average of the ten transects.
A “t” indicates a trace amount (<0.05%)

```
029   CAPR  GLMA  DISP  CAPR  CANE  CASI  BEER  CASI  JUAR  CASI  ELRO  CASI  ELRO     SPECIES
     01-03 04-05 06-11 12-13 14-19 20-21 22-23 24-26 27-38 39-53 54-88 89-91 92-102    METERS
     S---S W---W M---M S---------S W---W A---A W---W S---S W--------------------W     GRADIENT

030   JUAR  CASI  ELRO  JUAR  ELRO  ELPA  CANE  CASI  CANE  ELPA  JUAR  CASI  CANE     SPECIES
     01-14 15-25 26-40 41-44 45-56 57-62 63-66 67-73 74-79 80-81 82-86 87-88 89-93     METERS
     S---S W---------W S---S W---------W S---S W---W S---S W---W S---S W---W S---S     GRADIENT

031   CAPR  IRMI  CAPR  IRMI  CANE  ELPA  CANE  CARX  AGGI   CANE   ARAN CAPR  PULE    SPECIES
     01-09 10-11 12-17 18-25 26-34 35-36 37-40 41-44 45-52 54---93 94-95  96  97-100   METERS
     S-------------------------S  W---W S---S M---M S-----------S M-- M S--S M----M    GRADIENT

032   DISP  JUAR  IRMI  CAPR  JUAR          ELPA         CAPR ARAN  JUAR  CANE   CASI   SPECIES
     01-05 06-11 12-13 14-16 17--22 23-------------58  59   60  61-67 68-72 73----95   METERS
     M---M S---------------------S  W---------------W S--S M--M S---------S W------W   GRADIENT

033   JUAR  CASI BEER  CASI  CARO  JUAR  CARO  CASI  BEER  SCAC  CASI  CANE  ELRO     SPECIES
     01-16 17-26  27  28-35 36-38 39-40 41-43 44-46 47-51 52-54 55-59 60-98 99-100     METERS
     S---S W---W A--A W---------W S---S W---------W A---------A W---W S---S W----W     GRADIENT

034   CANE  CASI  CANE  JUAR  ELQU  CANE  NAOF  SCAC  CANE  NAOF  CASI  JUAR  CASI     SPECIES
     01-06 07-10 11-15 16-20 21-23 24-34 35-36 37-40 41-44 45-46 47-54 55-75 76-77     METERS
     S---S W---W S---------S W---W S---S A---------A S---S A---A W---W S---S W---W     GRADIENT

035   CANE  JUAR  CAPR   ELPA   CARX   ELQU   CARX    CANE   CARX  CANE  CARX  CANE    SPECIES
     01-07 08-11 12-14 15---29 30--37 38-42 43---59 60---75 76-81 82-87 88-96 97-100   METERS
     S--------------S  W----W  S---S  W---W S-------------------------------------S    GRADIENT

036   CASI        CANE                      CASI                      CARO        CASI   SPECIES
     01--05 06----------22 23------------------------65 66---------------94 95---100   METERS
     W----W S-----------S  W-------------------------------------------------------W   GRADIENT

037   JUAR CAPR LETR  CANE     CARX        CANE      JUAR  CANE    CARO    CANE CAPR LETR  SPECIES
     01-03  04   05  06-07 08------21 22------35 36-40 41-42 43-----53 54-60  61   62    METERS
     S-------------------S M--------M S--------------------S W-------W S------------S    GRADIENT

038   DISP   JUAR      CANE       AGGI   JUAR CAPR AGGI   CANE     CAPR JUAR PULE  DISP  SPECIES
     01--09 10-11 12----------44   45   46-50  51   52  53-----73   74   75   76  77-78  METERS
     M----M  S-----------------------------------------------------------S M--------M    GRADIENT
```

Spatial heterogeneity (most abundant species by meter) along the ten wetland/meadow transects (029-038) at Stonehouse Complex in 2009. Species codes are: AGGI = *Agrostis gigantea*, ARAN = *Argentina anserina*, BEER = *Berula erecta*, CANE = *Carex nebrascensis*, CAPR = *Carex praegracilis*, CARO = *Carex rostrata*, CARX = *Carex sp.*, CASI = *Carex simulata*, DISP = *Distichlis spicata*, ELPA = *Eleocharis palustris*, ELQU = Eleocharis quinqueflora, ELRO = *Eleocharis rostellata*, GLMA = Glaux maritima, IRMI = Iris missouriensis, JUAR = *Juncus arcticus*, LETR = *Leymus triticoides*, NAOF = *Nasturtium officinale*, PULE = *Puccinellia lemmonii*, SCAC = *Schoenoplectus acutus*. Moisture gradient (GRADIENT) codes: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-35
Spatial Heterogeneity (most abundant species by meter)
along the Ten Wetland/Meadow Transects (029-038) at Stonehouse Complex in 2009

the transects in 2009 and this was high for the eight sites (Table 3-42). Total overall cover averaged 61 percent and this was below average for the eight wetland/meadow sites.

Seven of the 72 taxa occurred on all eight transects: *Argentina anserina*, *Carex nebrascensis*, *Carex praegracilis*, *Juncus arcticus*, *Leymus triticoides*, *Poa pratensis*, and Trifolium repens (Table 3-46). *Carex nebrascensis* was the major species on three of the transects. *Argentina anserina*, *Carex praegracilis*, *Juncus arcticus*, moss, and *Thermopsis rhombifolia* were the major taxa on one transect each. *Carex simulata*, *Carex sp.*, *Distichlis spicata*, and Typha latifolia were the only other species with cover of at least 10 percent of a respective transect mean.

Spatial heterogeneity was substantial along the wetland/meadow transects at Keegan Ranch Complex (Figure 3-36) because of the micro-topographic complexity of the landscape and the length of the

Table 3-46
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Keegan Ranch Complex in 2009
(Page 1 of 2)

Species	Overall Mean	Transects							
		021	022	023	024	025	026	027	028
Achillea millefolium	0.5	4	0.1	0	0.1	t	0	0	0
Agoseris glauca	t	0.1	0	0	0	0	0	0	0
Agrostis gigantea	0.3	0.8	0.4	0.5	0.4	0.1	0.1	0	0
Algae	1	0	2.6	0	0	0	1.8	0	3.3
Argentina anserina	4.9	1.3	2.3	13.5	6.3	6.5	3.1	5.8	0.1
Aster sp.	t	0	0	t	0	0	0	0	0
Astragalus sp.	t	0	0	0	t	0	0.3	0	0
Berula erecta	0.2	0	0.6	0.1	0	0	0	0	1
Bidens cernua	0.4	0	0	0.5	0	0	0	0	2.8
Carex nebrascensis	6.5	3.2	1.1	6.5	0.6	14.9	9.9	4.1	11.4
Carex praegracilis	4.6	6	2.8	1	12.3	3.3	2.9	6.3	3.9
Carex simulata	2.8	0	2.6	0	0	0	6.1	9.8	3.9
Carex sp.	1.7	4.6	0	8.2	0	0	0	0	0.8
Chara sp.	0.2	0	0	0	0	0	1.7	0	0
Cirsium scariosum	0.2	0	0.1	0.3	0	0.2	0.2	1	0
Cirsium vulgare	0.4	1.4	0	0	0.6	1	0.1	0	0
Crepis runcinata	1	0	0.1	0	3.6	0.5	t	3.6	0
Deschampsia caespitosa	t	0	0	0	0	0	0	0	0.1
Distichlis spicata	1.9	0	0	3.9	3.4	1.2	6.7	0	t
Eleocharis palustris	1	0.9	1.6	0	3.5	0.4	t	t	1.3
Eleocharis rostellata	0.1	0	0.8	0	0	0	0	0	0
Epilobium sp.	t	0.1	0	t	0	0	t	0	0
Equisetum arvense	0.1	t	0	t	0.6	0.2	0.1	0	t
Ericameria nauseosa	0.4	0	0	0.1	0.3	1.8	0.7	0	0
Erigeron lonchophyllus	t	0	0.1	0	0	t	0	0	0.1
Festuca sororia	0.2	0	0	0	0	0	0	0	1.5
Glaux maritima	0.1	0	0	0.2	0	0	0	0.3	0
Hippuris vulgaris	0.1	0	0	0.1	0	0	0.3	0	0
Hordeum brachyantherum	0.6	0.2	1.2	0	0	3.1	0	0.1	0
Hordeum jubatum	0.6	0.1	2.1	0	0	2.3	t	0.3	t
Iris missouriensis	0.2	0.1	0.4	0	0	0.2	0	0.5	0
Ivesia kingii	0.1	0	0	0	0.2	0	0.3	0	0
Juncus arcticus	5.3	5.1	13.4	5	3.1	7	2.7	3.1	2.7
Juncus nevadensis	0.1	0	0.1	0	0	0	0.2	0	0.2
Lemna sp.	0.1	0	0	0.9	0	0	0	0	0
Lemna trisulca	t	0	0	0	0	0	0.2	0	0
Leymus triticoides	2.6	4.9	1.6	1.8	1.7	2.6	1.2	6.2	0.6
Melilotus officinalis	t	t	0	0	0	0	0	0	0

Table 3-46
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Keegan Ranch Complex in 2009
(Page 2 of 2)

Species	Overall Mean	Transects							
		021	022	023	024	025	026	027	028
Mimulus guttatus	0.4	0	1.2	0	0	0	0	0	1.4
Moss	3.6	16.9	2.1	0	0	0	9.8	0	0
Muhlenbergia richardsonis	0.4	0.2	1.2	0.4	0.4	0.8	0	0.3	0
Nasturtium officinale	0.9	3.1	2.3	0	0	0	0	0	1.9
Nitrophila occidentalis	0.1	0	0	0	0.3	0	0.8	0	0
Phleum pratense	0.1	0.5	0	0	0	0	0	0	0
Poa pratensis	1.9	4.7	0.4	2	4.2	1.1	2	0.5	0.5
Potentilla gracilis	t	0	0	0.1	0	t	0	0	0
Potentilla pensylvanica	t	0	0	0	0.1	0.1	0	0	0.1
Puccinellia lemmonii	0.7	0.2	2.6	0	1.2	0.6	0.8	0.3	0
Pyrrocoma lanceolata	0.1	0	0.1	0.1	0.2	t	t	0	0
Ranunculus sceleratus	0.1	0	0	0	0	0	0.1	0	0.6
Rumex crispus	0.1	0.4	0.6	0	0	0.1	0	0	0
Sarcobatus vermiculatus	t	0	0	0	t	0	0	0	0
Schedonorus pratensis	0.3	2.4	0	0	0	0	0	0	0
Schoenoplectus acutus	0.2	0	0	0	0	0	1.4	0.1	0
Schoenoplectus americanus	t	0	0	0	0	0	0	0	0.2
Sida neomexicana	0.1	0.3	0.2	0	0	0.1	0	0	0
Sisyrinchium halophilum	0.1	0.2	0.2	0	0	0	t	0	0
Sium suave	t	0	0	0.2	0	0	0	0	0
Solidago sp.	0.2	0.6	0	0	0	0.6	0	0	0.1
Sparganium eurycarpum	0.2	0	0	1.3	0	0	0	0	0.2
Spartina gracilis	0.2	0	0	0	0	0	1.2	0	0
Sphenopholis obtusata	t	0	0	0.1	0	0	0	0	0
Sporobolus airoides	1.4	0	0	4.5	3.9	0	2.6	0	0
Stellaria longipes	t	0	0	0.1	0	0	0	0	0
Taraxacum officinale	0.9	3	1.1	0.1	0.7	0.4	0.2	1.8	0
Thermopsis rhombifolia	7.4	14.5	2.8	10.5	10.4	5.1	0	14.8	0.9
Trifolium repens	0.7	0.4	0.1	0.3	1.4	1	0.4	0.2	1.4
Trifolium sp.	0.3	0	0	2.1	0	0	0	0	0
Typha latifolia	1.1	0	0	0	0	0	0.9	0.8	7.4
Utricularia macrorhiza	0.3	0	0	0	0	0	2.1	0	0
Veronica anagallis-aquatica	0.8	4.5	1.2	0.2	0	0.1	0	0	0.1
Viola nephrophylla	t	0	0	0	0.1	0	0	0	0
Total	**60.8**	**84.6**	**50.1**	**64.6**	**59.6**	**55.3**	**60.9**	**59.9**	**48.5**
Number of Taxa	**72**	**32**	**33**	**32**	**27**	**31**	**37**	**21**	**30**

Transect means are averages by meter and overall mean is the average of the eight transects.
A "t" indicates a trace amount (<0.05%).

```
021   SCPR  AGGI  THRH  CAPR  POPR  THRH  CAPR   MOSS    LETR  THRH  LETR  THRH  CARX    SPECIES
     01-04 05-06 07-08 09-15 16-17 18-20 21-23 24----56 57-72 73-76 77-81 82-88 89-100   METERS
     S--------S  M---M S---S M---------M S---S A------A S---S M---M S---S M----------M   GRADIENT

022   CASI  NAOF  MOSS  VEAN  CASI  PULE  CASI  JUAR  ELRO  BEER  THRH  TAOF  CAPR  THRH SPECIES
     01-03 04-09 10-13 14-15 16-18 19-21 22-25 26-27 28-29 30-32 32-37 38-39 40-45 46-53 METERS
     W---W A--------------A W----W M---M W---W S---S W---W A---A M---------M S---S M---M GRADIENT

022   JUAR  ARAN  JUAR  HOJU  ARAN  JUAR  CAPR   JUAR     MURI     JUAR     MURI     JUAR    SPECIES
     54-65 66-69 70-85 86-90 91-95 96-98 99-101 102-111 112-113 114-116 117-118 119-120  METERS
     S---S M---M S---S M---------M S-------------------S M-----M S-----S M-----M S-----S  GRADIENT

023   ARAN  SPAI  ARAN  DISP  THRH SPAI  DISP  ARAN  JUAR  CANE  CARX  SPEU  TRIF ARAN   SPECIES
     01-02 03-07 08-14 15-18 19-32  33  34-35 36-37 38-39 40-47 48-52 53-60 61-63  64    METERS
     M--------------------------------------------M S---------S M----M A---A M--------M   GRADIENT

024      CAPR      SPAI       CAPR       SPAI   DISP     CAPR    SPAI     CAPR     ARAN   SPECIES
     01--------10 11-12 13-----------25 26-28 29----34 35----40 41-42 43-------51 52-54  METERS
     S---------S  M---M S------------S  M-----------M  S-----S  M--M  S--------S  M---   GRADIENT

024   THRH  CAPR    THRH     CAPR  ARAN    DISP    EQAR  POPR   TRRE   POPR  MURI  ELPA  SPECIES
     55-57 58-60 61-------70  71  72--75 76----81 82-83 84-85 86---90 91--94  95   96-99  METERS
     ---M  S---S M--------M  S--S M-------------M W---W M---------------------- M W---W  GRADIENT

025   ARAN  CANE  HOBR  TRRE  CANE  THRH  ERNA  THRH  ARAN  JUAR  CIVU  JUAR  CANE  JUAR  SPECIES
     01-09 10-35 36-43 44-46 47-52 53-57 58-59 60-65 66-71 72-76 77-79 80-88 89-97 98-100 METERS
     M---M S---S M--------M  S---S M---M D---D M---------M S---S M---M S--------------S  GRADIENT

026   DISP  CAPR  JUAR  DISP  JUAR  ARAN  CANE  POPR  DISP ERNA  DISP  ARAN  POPR  ALGA  SPECIES
     01-08 09-11 12-13 14-15 16-18 19-20 21-25 26-28 29-30  31   32-38 39-40 41-42 43-47  METERS
     M---M S---------S M---M S---S M---M S---S M---------M D--D M---------------M A----  GRADIENT

026   SCAC  UTMA SCAC  TYLA UTMA  SCAC  UTMA  CASI  CANE  ARAN  SPAI  ARAN  CANE  CASI   SPECIES
       48  49-51  52  53-54  55  56-58 59-60 61-62 63-64 65-68 69-75 76-79 80-84 85-87   METERS
      ------------------------------------A  W---W S---S M---------------------M W---W   GRADIENT

026   MOSS    CANE  TRRE   CAPR   PULE    SPGR    DISP    SPGR    DISP    CAPR           SPECIES
     88-108 109-110  111 112-115 116-117 118-119 120-122 123-126 127-128 129-130         METERS
     A----A S-----S M--M S-----S M----M  S-----S M----M  S-----S M-----M S-----S         GRADIENT

027      CAPR           THRH      ARAN   CRRU       CASI       CANE  TYLA   CAPR CANE ARAN   SPECIES
     01--------22 23--------46 47--54 55-58 59---------84 85-88 89--95 96-98  99  100    METERS
     S---------S  M----------------M  S---S W-----------W S---S A----A S-------S M---M   GRADIENT

028   CANE  CASI  TYLA  NAOF  ALGA  MIGU  CASI  BICE  CARX  CANE  TRRE  CANE  ALGA  LETR SPECIES
     01-03 04-08 09-26 27-28 29-31 32-33 34-35 36-39 40-41 42-66 67-68 69-70 71-74 75-78 METERS
     S---S W---W A---------------A W---------W S---------------S M---M S---S A---A S---S GRADIENT
```

Species codes are: AGGI = *Agrostis gigantea*, ALGA = algae, ARAN = *Argentina ansernia*, BEER = *Berula erecta*, BICE = *Bidens cernua*, CANE = *Carex nebrascensis*, CAPR = *Carex praegracilis*, CARX = *Carex sp.*, CASI = *Carex simulata*, CIVU = *Cirsium vulgare*, CRRU = *Crepis runcinata*, ELPA = *Eleocharis palustris*, ELRO = *Eleocharis rostellata*, EQAR = *Equisetum arvense*, ERNA = *Ericameria nauseosa*, HOBR = *Hordeum brachyantherum*, HOJU = *Hordeum jubatum*, JUAR = *Juncus arcticus*, LETR = *Leymus triticoides*, MIGU = *Mimulus guttatus*, MOSS = moss, MURI = *Muhlenbergia richardsonis*, NAOF = *Nasturtium officinale*, POPR = *Poa pratensis*, PULE = *Puccinellia lemmonii*, SCAC = *Schedonorus actus*, SCPR = *Schedonorus pratensis*, SPAI = *Sporobolus airoides*, SPEU = *Sparganium eurycarpum*, SPGR = *Spartina gracilis*, TAOF = *Taraxacum officinale*, THRH = *Thermopsis rhombifolia*, TRIF = *Trifolium sp.*, TRRE = *Trifolium repens*, TYLA = *Typha latifolia*, UTMA = *Utricularia macrorhiza*, VEAN = *Veronica anagallis-aquatica*. Moisture gradient (GRADIENT) codes: D = surface commonly dry; M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-36
Spatial Heterogeneity (most abundant species by meter) along the Eight Wetland/Meadow Transects (021-028) at Keegan Ranch Complex in 2009

transects. There were 36 micro-community dominant species and 150 recognized micro-community segments along the eight transects (Figure 3-36). *Carex praegracilis* was the most frequent dominant species, being dominant on 15 of the segments with a combined length of 95 m out of the total of 791 m (12 percent) included in the 8 transects. *Carex nebrascensis* and *Juncus arcticus* were the next most frequent dominants, each being dominant on 13 segments, with combined lengths of 98 m and 72 m, respectively.

3.8.2.2.3 West Spring Valley Complex

The major taxa, by overall mean cover, on the wetland/meadow transects at the West Spring Valley Complex were *Juncus arcticus* (7 percent), *Eleocharis rostellata* (7 percent), *Thermopsis rhombifolia* (6 percent), Cirsium arvense (6 percent), *Berula erecta* (5 percent), *Carex nebrascensis* (5 percent), *Carex sp*. (5 percent), *Lemna sp*. (4 percent), *Carex praegracilis* (4 percent), *Agrostis gigantea* (3 percent), and *Carex rostrata* (3 percent) (Table 3-47). A total of 73 taxa occurred on the transects in 2009 and this total was the second highest species richness for the 8 sites (Table 3-42). Total overall cover averaged 79 percent and this was above average for the eight wetland/meadow sites.

Carex nebrascensis and *Juncus arcticus* were the only species to occur on all 8 transects at this site (Table 3-47). *Juncus arcticus* was the major species on two transects and *Carex rostrata*, Cirsium arvense, *Eleocharis rostellata*, Lemna sp., *Schoenoplectus acutus*, and *Thermopsis rhombifolia* were the major taxa on one transect each. *Bromus tectorum*, *Carex nebrascensis*, *Carex praegracilis*, *Carex simulata*, *Carex sp*., *Iva axillaris*, *Mimulus guttatus*, and *Phragmites australis* were the other species with cover values equal to at least 10 percent of the mean of at least one transect.

Spatial heterogeneity varied considerably among the wetland/meadow transects at the West Spring Valley Complex (Figure 3-37). A total of 31 taxa were dominant on the micro-community segments at this site. *Thermopsis rhombifolia* was the most frequent dominant species, having the highest cover value in 8 of the 97 micro-community segments along the transects, but had a combined length of only 17 m out of a total of 267 m (6 percent) in the 8 transects (Figure 3-37). *Carex nebrascensis*, *Carex praegracilis*, and *Juncus arcticus* were the next most frequent dominants, each species being dominant on 7 segments and with combined lengths of 18 m, 15 m, and 16 m, respectively.

3.8.2.2.4 Shoshone Ponds

The major species, by overall mean cover, on the wetland/meadow transects at Shoshone Ponds were *Carex praegracilis* (13 percent), *Juncus arcticus* (5 percent), *Distichlis spicata* (3 percent), *Argentina anserina* (3 percent), *Puccinellia lemmonii* (3 percent), and *Carex nebrascensis* (3 percent) (Table 3-48). A total of 57 taxa occurred on the transects in 2009 and this total was about average for the 8 sites (Table 3-42). Total overall cover averaged 41 percent and this was the lowest mean for the 8 wetland/meadow sites.

Argentina anserina and *Juncus arcticus* were the only species that occurred on all 10 transects at this site (Table 3-48). *Carex praegracilis* was the major species on five transects and *Puccinellia lemmonii* was the major species on two transects. *Agrostis gigantea*, *Distichlis spicata*, and *Juncus arcticus* were the major species on one transect each. *Carex nebrascensis*, *Carex sp*., *Eleocharis sp*., *Juniperus scopulorum*, and *Trifolium repens* were the only other species with cover values equal to at least 10 percent of the respective total cover of any of the transects.

Spatial heterogeneity varied from moderate to substantial along the wetland/meadow transects at Shoshone Ponds (Figure 3-38). *Carex praegracilis* was the most frequent dominant species, having the highest cover value in 33 of the 129 micro-community segments along the transects, with a combined length of 340 m out of a total of 930 m (37 percent) in the 10 transects (Figure 3-38). *Juncus arcticus* was the second-most frequent dominant, being dominant on 19 segments with a

Table 3-47
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the West Spring Valley Complex in 2009
(Page 1 of 2)

Species	Overall Mean	Transects							
		085	086	087	088	089	090	091	092
Achillea millefolium	0.2	0.1	0	0.4	0.6	0	0	0.3	0
Agrostis gigantea	3.2	4.1	8.7	5	5.5	0.4	0	1.8	0.4
Algae	0.8	3	0	0	0	0	0	3.2	0
Argentina anserina	0.9	0.1	0.4	0	3.0	1.5	0	1.5	0.3
Atriplex micrantha	0.2	0	0.5	0.2	0.4	0	0	0	0.1
Bassia scoparia	t	0	0	0.2	0	0	0	0	0
Berula erecta	5.3	10.7	3.9	2.5	16.8	5.8	0	0.4	2.4
Bromus inermis	1.2	0	0	0	0.8	0	5.6	3.3	0.2
Bromus tectorum	0.1	0.5	0	0	0.6	0	0	0	0
Cardaria draba	0.1	0	0	0	0.9	0	0	0	0
Carex douglasii	0.1	0	0	0	0	0	0	0	0.4
Carex nebrascensis	5.1	7.9	0.4	4.1	6.6	8.6	1.2	8.7	3.5
Carex praegracilis	3.6	4.3	10.5	0	1.2	0	8.9	3.6	0
Carex rostrata	3.0	16.7	4.9	0	2.3	0	0	0	0
Carex simulata	2.0	12.2	3.1	0	0.4	0	0	0	0
Carex sp.	4.7	2.8	0	34.1	0	0	0	0	0.8
Castilleja minor	0.1	0.1	0	0.4	0	0	0	0	0
Cirsium arvense	5.5	1	12.5	1.7	20.8	0.3	6.1	0	1.5
Cirsium vulgare	0.1	0	0	0.8	0	0	0	0	0
Convolvulus arvensis	0.1	0	0	0	0.5	0	0	0	0
Crepis runcinata	t	0	0	t	0	0	0	0	0
Distichlis spicata	0.4	0	0	2.4	0	0.4	0.4	t	0
Eleocharis palustris	0.6	0	0	0	0	0	0	3.5	1.6
Eleocharis rostellata	6.6	9.4	8.2	34.9	0	0.2	0	0	0
Elymus trachycaulis	t	t	0	t	0	0	0	0	0.2
Epilobium ciliatum	0.4	0.4	0	1.8	0	0.7	0	0	0.3
Epilobium sp.	0.5	1.6	1.9	0	0.5	0	0	0	0
Equisetum arvense	1.5	1	4.2	0.8	0.9	0	1.5	3	0.2
Ericameria nauseosa	0.6	0	0	1.1	3.4	0	0	0	0
Galium trifidum	t	0	0	0	0.1	0	0	0	0
Hordeum jubatum	t	0.1	0	0	0.1	0	0	0	0
Iva axillaris	1.1	0.6	0	0	0	0	4.5	2.8	1.1
Juncus arcticus	7	12.5	8.4	9.1	3.2	0.5	9.8	11.8	0.3
Juncus nevadensis	0.3	0.4	1	0	0	0.6	0	0.2	0
Juncus sp.	0.1	0	0	0	0	0.8	0	0	0
Lactuca serriola	t	0	0	0.1	0	0	0	0	0.2
Lemna minor	2.2	0	10.4	0	6.3	0	0	0.8	0
Lemna sp.	3.9	0	0	0	0	31.5	0	0	0
Leymus triticoides	0.2	0.3	1	0	0	0	0.3	0.3	0
Medicago polymorpha	0.1	0.1	0	0	0.1	0.4	0	0	0

Table 3-47
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the West Spring Valley Complex in 2009
(Page 2 of 2)

Species	Overall Mean	Transects 085	086	087	088	089	090	091	092
Melilotus officinalis	t	0	0	0	0.2	0	0	0	0
Mimulus guttatus	1.9	4	0.4	2.4	1.6	6.7	0	0	0.2
Moss	0.1	0	0	0	0	0	0	0.5	0
Muhlenbergia asperifolia	t	0.2	0	0	0	0	0	0	0
Muhlenbergia richardsonis	0.1	0	0	0.2	0	0.4	0	0	0.3
Nasturtium officinale	0.1	0	0.2	0	0	0	0	0.3	0
Phleum pratense	t	0	0.1	0	0	0	0	0.2	0
Phragmites australis	1.9	0	0	0	15.1	0	0	0	0
Poa pratensis	1.7	0.3	8.2	0	2	0.1	0	2.2	1
Poa secunda	0.1	0	t	0	0	0.4	0	0	0
Polygonum aviculare	t	0	0.2	0	0	0	0	0	0
Polypogon monspeliensis	0.1	0.4	0	0	0	0	0	0	0
Potentilla hippiana	0.2	0	0	1.3	0	0	0	0	0
Puccinellia lemmonii	0.1	0	0	0	0	0	0.6	0	0
Pyrrocoma lanceolata	0.1	0	0	0	0	0	0.7	0.3	0
Rumex crispus	0.1	0	0.2	0.2	0	0	0	0	0.1
Schedonorus pratensis	0.5	0.2	1	1.5	1.6	0	0	0	0
Schoenoplectus acutus	1.9	0	0	0	4.7	0.8	0	0	10
Schoenoplectus americanus	t	0.3	0	0	0	0	0	0	0
Schoenoplectus pungens	0.2	1.2	0	0	0	0	0	0	0
Sparganium eurycarpum	0.4	0	0	0	0	3.3	0	0.1	0
Sporobolus airoides	0.3	0	0	1.7	0	0	0.2	0.3	0
Stuckenia filiformis	t	0	0	0	0	0	0	0.3	0
Symphyotrichum eatonii	0.5	0.1	0	0.5	1.8	0.2	0	0.8	0.5
Taraxacum officinale	0.2	0	0	0.1	0.2	0	0	1.5	0
Thermopsis rhombifolia	5.6	4.0	23.0	7.6	9.8	0	0	0	0
Thinopyrum ponticum	0.1	0	0	0	0	0.1	0.9	0	0
Trifolium pratense	t	0	0	0	0	0.2	0	0	0
Trifolium repens	0.2	0	0	0	0	0	0	1.9	0
Triglochin maritima	t	0	0	0.2	0	0	0	0	0
Typha latifolia	0.6	t	0	2.4	0	0	0	0	2.5
Verbena bracteata	t	0.2	0	0	0	0	0	0	0
Viola nephrophylla	0.3	0.3	0.7	1.2	0	0	0	0	0
Total	**79.1**	**101.1**	**114**	**118.9**	**112**	**63.9**	**40.7**	**53.6**	**28.1**
Number of Taxa	**73**	**36**	**26**	**31**	**31**	**22**	**13**	**27**	**23**

Transect means are averages by meter and overall mean is the average of the eight transects.
A “t” indicates a trace amount (<0.05%)

```
074   CAPR ELPA  CAPR ELPA  CAPR  TRRE  JUAR  CAPR  POPR  CAPR  CANE  CAPR  CANE  JUAR   SPECIES
     01-03  04  05-08  09  10-17 18-19 20-22 23-27 28-29 30-45 46-50 51-57 58-76 77-80   METERS
     S---S W--W S---S W--W S---S M---M S---------S M---M S---------------------------S   GRADIENT

075    CANE   JUAR   CANE  CAPR   JUAR                CAPR                   JUSC        SPECIES
     01---05 06-07 08---12 13-15 16--19 20--------------------------------54 55-56       METERS
     S-----------------------------------------------------------------------S D----D    GRADIENT

075   CAPR    JUSC     DISP    JUSC  CAPR  JUAR  ARAN  JUAR  ARAN     CAPR     ARAN      SPECIES
     57--60 61----66 67----72 73-75 76-77 78-79 80-81 82-84 85-87 88--------96 97-100    METERS
     S----S D------D M------M D---D S---------S M---M S---S M---M S----------S M----M    GRADIENT

076   ARAN ACMI  CAPR  ARAN  CAPR  ARAN  ACMI  JUAR  ARAN  CAPR  ARAN   CAPR    POPR    SPECIES
       01   02  03-04 05-06 07-09 10-11 12-13 14-15 16-20 21--34 35-36 37-----99 100     METERS
     M--------M S---S M---M S---S M---------M S---S M---M S----S M---M S-------M M--M    GRADIENT

077   CAPR ARAN CAPR  MURI CAPR JUAR  CAPR  MUAS  CAPR  POPR  CAPR MUAS  CAPR ARAN CAPR  SPECIES
     01-25  26 27-51 52-53  54   55  56-63 64-66 67-77 78-79 80-94  95  96-97  98 99-100 METERS
     S---S M--M S--S M---M S-------------------------S M---M S--------------S M--M S--S  GRADIENT

078   SPGR   ERNA  DISP   JUAR   DISP    SPGR               DISP                 CAPR    SPECIES
     01--06 07-09 10--13 14-16 17----25 26-28 29-----------------------------97 98-100   METERS
     S----S D---D M----M S---S M------M S---S M------------------------------M S----S    GRADIENT

079   JUAR  ELEO  BEER  AGGI  TRRE  AGGI  JUAR  AGGI  CARX  ELEO  AGGI SCPR  ELEO  JUAR  SPECIES
     01-03 04-06 07-09 10-12 13-15 16-18 19-20 21-23 24-27 28-30 31-35  36  37-48 49-50  METERS
     S---S W---W A---A S---S M---M S---------------------S W---W S--------S W---W S---S  GRADIENT

081   CAPR MURI  CAPR  ARAN  CAPR  ARAN  PULE  ARAN    PULE     IVKI  PULE  IVKI  ERNA   SPECIES
       01   02  03-15 16-22 23-24 25-32 33-41 42-43 44------75 76-81 82-83 84-93 94-100  METERS
      S--S M--M S---S M---M S---S M------------------------------------------M  D---D   GRADIENT

082        DISP                    JUAR                        CAPR    ARAN  CANE  JUAR    SPECIES
     01-----------21 22------------------------------75 76-----87 88-90 91-93 94--100    METERS
     M-------------M S------------------------------------------S M---M S-----------S    GRADIENT

083   DISP  PULE  DISP  CAPR  DISP  CAPR  DISP  PULE  DISP  PULE  JUAR  CAPR JUAR  PULE  SPECIES
     01-12 13-14 15-17 18-19 20-25 26-33 34-36 37-45 46-49 50-74 75-76 77-92  93  94-100 METERS
     M---------------M S---S M---M S---S M---------------------M S--------------S M---M  GRADIENT

084   JUAR  ARAN  JUAR  ARAN  JUSC  JUAR  TRRE  PYLA  TRRE  CAPR  JUSC  CAPR  POPR  ACMI   SPECIES
     01-04 05-24 25-27 28-31 32-34 35-39 40-52 53-56 57-68 69-76 77-85 86-93 94-95 96-100 METERS
     S---S M---M S---S M---M D---D S---S M---M D----D M--M S---S D---D S---S M--------M  GRADIENT
```

Species codes are: AGGI = *Agrostis gigantea*, ALGA = algae, ARAN = *Argentina ansernia*, BEER = *Berula erecta*, BRIN = *Bromus inermis*, CANE = *Carex nebrascensis*, CAPR = *Carex praegracilis*, CARO = *Carex rostrata*, CARX = *Carex sp.*, CASI = *Carex simulata*, CIAR = Cirsium arvense, DISP = *Distichlis spicata*, ELPA = *Eleocharis palustris*, ELRO = *Eleocharis rostellata*, EQAR = *Equisetum arvense*, ERNA = *Ericameria nauseosa*, IVAX = *Iva axillaris*, JUAR = *Juncus arcticus*, LEMI = *Lemna minor*, LEMN = *Lemna sp.*, MEPO = *Medicago polymorpha*, MIGU = *Mimulus guttatus*, MURI = *Muhlenbergia richardsonis*, PHAU = *Phragmites australis*, POPR = *Poa pratensis*, SCAC = *Schoenoplectus acutus*, SCPR = *Schedonorus pratensis*, SYEA = *Symphyotrichum eatonii*, THRH = *Thermopsis rhombifolia*, TRRE = *Trifolium repens*, TYLA = *Typha latifolia*. Moisture gradient (GRADIENT) codes are: D = surface commonly dry; M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-37
Spatial Heterogeneity (Most Abundant Species by Meter) along the Eight Wetland/Meadow Transects (085-092) at the West Spring Valley in 2009

combined length of 107 m. *Argentina anserina* was the third-most frequent dominant species, begin dominant on 16 segments totaling 67 m.

3.8.2.2.5 The Seep

The major species, by overall mean cover, on the transects at the Seep were *Argentina anserina* (12 percent), *Carex nebrascensis* (7 percent), *Sporobolus airoides* (6 percent), *Polygonum aviculare* (4 percent), and *Carex praegracilis* (3 percent) (Table 3-49). A total of 44 taxa occurred on the transects in 2009 and this total was second lowest species richness for the 8 sites (Table 3-42). Total overall cover averaged 50 percent and this was the second lowest mean for the 8 wetland/meadow sites.

Table 3-48
Mean Percent Cover, Overall and by Species, of Vegetation Along Wetland/Meadow Transects at Shoshone Ponds in 2009
(Page 1 of 2)

Species	Overall Mean	Transects									
		074	075	076	077	078	079	081	082	083	084
Achillea millefolium	0.7	0	1	1.6	0.4	0	0	0.2	0	0.8	2.5
Agrostis gigantea	1.3	1.4	0	0	0	0	6.9	0	0.6	0	3.8
Argentina anserina	3.1	t	1.5	4.8	4	0.6	0.9	4.9	1.5	t	12.9
Artemisia tridentata	t	t	0.1	0	0	0	0	0	0	0	0
Berula erecta	0.1	0.3	0	0	0	0	1	0	0	0	0
Bromus tectorum	t	t	0	0	0	0	0	0	0	0	0
Carex nebrascensis	2.5	18.2	2	0	0	0	2.4	0	0.9	0	1.3
Carex praegracilis	12.6	22.4	8.8	23.4	31.2	2.9	0	5.9	5.2	11.5	14.9
Carex sp.	0.5	0	0	0	0	0	5	0	0	0	0
Cirsium scariosum	0.1	t	0	0	0	0	0	0.3	0	0.1	0.8
Cirsium vulgare	t	0	0	0	0	0	0.3	0	0	0	0
Crepis runcinata	0.1	0	0	0	0	t	0	0.1	0	0.6	0.3
Distichlis spicata	3.3	0	1.2	0.2	0	18.5	0	0	2.2	10.7	0
Eleocharis palustris	0.4	4.2	0	0	0	0	0	0	0	0	0.1
Eleocharis sp.	0.5	0	0	0	0	0	5.3	0	0	0	0
Epilobium sp.	t	0.1	0	0	0	0	0	0	0	0	0
Equisetum arvense	t	0	0	0	0	0	0	0.1	0	t	0
Ericameria nauseosa	0.2	0	0.2	0.2	0	0.3	0	1.1	0.1	0	0
Erigeron lonchophyllus	0.6	t	0.2	t	0	0	0	1.8	0.1	0.2	3.3
Glaux maritima	0.1	0	0	0	0	0	0	0	0	0	0.5
Hordeum brachyantherum	0.1	0	0	0	t	0	0	0.2	0.4	0	0
Hymenoxys lemmonii	0.1	0	0	0	0	0.5	0	0.1	0	0	0
Ivesia kingii	0.4	0	0	0	0	0.3	0	3.8	0	0.1	0
Juncus arcticus	4.8	7.9	3.1	0.9	2.9	3.2	4.7	2.2	7.1	4.3	11.2
Juncus nevadensis	t	0.1	0	0	0	0	0	0	0	0	0
Juniperus scopulorum	1.4	0.6	8	0	0	0	0.2	0.2	0	0	4.6
Leymus triticoides	0.2	0	t	t	0.2	0.2	0	1.3	0	0	0
Medicago polymorpha	0.1	0	0	0	0	0	0.1	0	0	0	0.5
Mimulus guttatus	t	t	0	0	0	0	0	0	0	0	0
Moss	0.1	1.1	0	0	0	0	0	0	0	0	0
Muhlenbergia asperifolia	0.5	0	0.4	0.3	4.1	0	0	0.2	0	0.1	0.3

Table 3-48
Mean Percent Cover, Overall and by Species,
of Vegetation Along Wetland/Meadow Transects at Shoshone Ponds in 2009
(Page 2 of 2)

Species	Overall Mean	Transects									
		074	075	076	077	078	079	081	082	083	084
Muhlenbergia richardsonis	0.4	0.3	0.4	0.8	1.2	0	0	0.7	0	0	0.1
Nasturtium officinale	0.1	t	0	0	0	0	0.5	0	0	0	0
Nitrophila occidentalis	t	0	0	0	0	0	0	0	0	0.3	0
Plagiobothrys scouleri	t	0	0	0	0	0	0	0	t	0	0
Plantago major	t	0.3	0	t	0	0	0	0	0	0	0
Poa pratensis	0.5	1.1	0.6	0.2	0.5	0.1	0.6	0.6	0	0	1.4
Poa secunda	t	0	0	0	0.1	0	0	0	0	0	0
Polypogon monspeliensis	t	0	0	0	0	0	0.2	0	0	0	0
Potentilla gracilis	0.1	0	0	0	0	0	0	0.5	0	0	0
Puccinellia lemmonii	2.7	0	0.1	t	0.4	0	0	13.7	0.4	11.8	0.5
Pyrrocoma lanceolata	0.4	0.1	0	0.1	0.4	0.1	0	0	0.1	0.5	2.4
Ranunculus cymbalaria	t	0	0	0	0	0	0.1	0	0	0	0
Ranunculus sceleratus	t	0.4	0	0	0	0	0	0	0	0	t
Sarcobatus vermiculatus	t	0	0	0	0	0	0	0	0.1	0	0
Schedonorus pratensis	0.1	0	0	0	0	0	0.6	0	0	0	0
Schoenoplectus pungens	t	0	0	0	0	0	0.1	0	0	0	t
Sida neomexicana	t	0	0	0	0	0	0	0	0	0	0.1
Sisyrinchium halophilum	t	0	0	0	0	0	t	0	0	0.1	0.3
Spartina gracilis	0.3	0	0	0	0.1	2.4	0	0	0	0	0
Sporobolus airoides	t	0	0	0	0	0	0	t	0	0	0
Taraxacum officinale	0.2	0.9	t	0.2	0.1	0	0.2	0.5	0	t	0.5
Trifolium fragiferum	0.1	0	0	0	0	0	0.6	0	0	0	0
Trifolium hybridum	0.1	0	0	0	0	0	0.6	0	0	0	0
Trifolium repens	1.7	1.6	0	0	0	0	3.2	0	0.4	0	11.9
Veronica anagallis-aquatica	t	0	0	0	0	0	0.3	0	0	0	0
Zigadenus elegans	t	0	0	0	0	0	0	0.1	0	0	0
Total	**40.5**	**61**	**27.6**	**32.7**	**45.6**	**29.1**	**33.8**	**38.5**	**19.1**	**41.1**	**74.2**
Number of Species	**57**	**24**	**16**	**15**	**14**	**12**	**22**	**22**	**14**	**16**	**24**

Transect means are averages by meter and overall mean is the average of the eight transects.
A “t” indicates a trace amount (<0.05%)

```
085   EQAR THRH ALGA  CASI  BEER  MIGU CARO  CAPR   CARO  JUAR  CARX THRH  AGGI          SPECIES
        01   02   03  04-06 07--10  11   12  13-15 16---20  21  22-24  25  26-27          METERS
      W--W M--M A--A W---W A----A W------W S----S W-----W S--S M--------M S---S          GRADIENT

086   JUAR THRH  ELRO CARO LEMI BEER CASI AGGI THRH CAPR CIAR POPR CAPR EQAR CAPR THRH    SPECIES
        01 02-03 04-05  06 07-13  14   15 16-17  18   19   20 21-22  23   24 23-25  26    METERS
      S--S M--M W-------W A--------A W-------W M---------------------M W---W M------M    GRADIENT

087   THRH  JUAR CARX  ELRO  CARX  TYLA  CARX  AGGI  CARX  ELRO  CARX  AGGI  DISP  ERNA  SPECIES
     01-02 03-05  06   07-12 13-15 16-17 18-19 20-21 22-35 36-45 46-47 48-49 50-52 53-54  METERS
     M---M S-------S  W---W S---S A---A S---------------S W---W S---------S M---M D---D  GRADIENT

088   SCPR POPR THRH AGGI CIAR    PHAU    CIAR    THRH     BEER     CANE     CIAR        SPECIES
        01   02   03   04 05-06 07------13  14  15------22 23------29 30--32 33------38    METERS
      S--S M-------M S--S M---------------------------M  A--------A S----S M--------M    GRADIENT

089   MURI MEPO  MIGU   CANE            LEMN              BEER CANE LEMN CANE  ARAN POPR  SPECIES
        01   02  03--05 06-07 08-----------------------23  24   25   26 27-29 30-31  32   METERS
      M-------M W----W S---S A-----------------------------A S--S A--A S--S M-------M   GRADIENT

090   IVAX   CIAR   CAPR      JUAR       BRIN   JUAR CAPR IVAX                          SPECIES
     01--03 04-05 06----09 10--------15 16----19  20   21   22                           METERS
     S----S M---M S-------------------S M------M S------------S                          GRADIENT

091    BRIN    ARAN IVAX  JUAR IVAX  CANE    JUAR CANE ELPA  CAPR TRRE  ALGA ELPA         SPECIES
     01----06  07    08  09-10  11  12--14 15-16  17   18  19-20  21  22-23  24           METERS
     M----------M S--------------------------------S W--W S---S M--M A---A W--W           GRADIENT

092   SYEA  CANE   SCAC  TYLA           SCAC           TYLA  SCAC  CIAR IVAX  BEER IVAX   SPECIES
        01  02--06 07-09 10-11 12-----------------31 32--36 37-39  40   41  42-43  44     METERS
      S---------S A--------------------------------------------A M--M S--S A---A S--S    GRADIENT
```

Species codes are: ACMI = *Achillea millefolium*, AGGI = *Agrostis gigantea*, ARAN = *Argentina anserina*, BEER = *Berula erecta*, CANE = *Carex nebrascensis*, CAPR = *Carex praegracilis*, CARX = *Carex sp.*, DISP = *Distichlis spicata*, ELEO = *Eleocharis sp.*, ELPA = *Eleocharis palustris*, ERNA = *Ericameria nauseosa*, IVKI = *Ivesia kingii*, JUAR = *Juncus arcticus*, JUSC = *Juniperus scopulorum*, MUAS = *Muhlenbergia asperifolia*, MURI = *Muhlenbergia richardsonis*, POPR = *Poa pratensis*, PULE = *Puccinellia lemmonii*, PYLA = *Pyrrocoma lanceolata*, SCPR = *Schedonorus pratensis*, SPGR = *Spartina gracilis*, TRRE = *Trifolium repens*. Moisture gradient (GRADIENT) codes are: D = surface commonly dry; M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-38
Spatial Heterogeneity (most abundant species by meter) along the Ten Wetland/Meadow Transects (074-079, 081-084) at Shoshone Ponds in 2009

Table 3-49
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Seep in 2009
(Page 1 of 2)

Species	Overall Mean	Transects				
		069	070	071	072	073
Achillea millefolium	t	0.1	0	0	0	0
Agrostis gigantea	2.3	2.2	1	2.5	1.6	4.3
Argentina anserina	12.4	23.6	12.5	12.9	5.5	7.4
Artemisia tridentata	t	0	0	0	0	t
Aster sp.	t	0.2	0	0	0	0
Bassia scoparia	t	0	0.2	0	0	0
Berula erecta	t	0	t	0	0	0
Carex nebrascensis	6.7	3.1	4.4	6.9	10.1	9.2
Carex praegracilis	3.3	7.9	0.2	2.4	3.5	2.6

Table 3-49
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Seep in 2009
(Page 2 of 2)

Species	Overall Mean	Transects				
		069	070	071	072	073
Centaurium exaltatum	t	0	0	0	0	0.1
Chenopodium berlandieri	t	0	0	0.2	0	0
Cirsium scariosum	0.3	0.5	0.2	0.3	0.2	0.4
Deschampsia caespitosa	1.3	0.3	0.2	0	1.7	4.4
Descurainia sophia	t	0	t	0	0	0
Distichlis spicata	1.7	1.7	1.1	0.3	5.4	t
Eleocharis palustris	0.6	0.2	1.3	1.4	0.1	0
Eleocharis rostellata	t	0	0	0	0	0.2
Equisetum arvense	t	0	0	0.1	0	0
Ericameria nauseosa	t	0.2	t	0	0	0
Erigeron lonchophyllus	0.5	0.5	0.2	1	0.2	0.4
Hordeum jubatum	1.4	2	t	0.9	4.2	0
Ivesia kingii	0.7	t	0	0	3.3	0
Juncus arcticus	2.3	4.4	0.8	2.1	2.8	1.3
Juncus bufonius	0.5	0	0	0	0.2	2.3
Juncus nevadensis	0.3	0	0	t	0.3	1.3
Leymus triticoides	0.6	0.5	0.3	0.3	1.8	t
Medicago polymorpha	t	0	0.1	0	0	0
Muhlenbergia asperifolia	0.2	0.2	0	0.6	0.3	0
Muhlenbergia richardsonis	0.3	t	0	0.7	t	0.7
Plantago major	0.1	0	0	0	0.1	0.3
Poa pratensis	0.1	0	0	0.3	0	0.1
Poa sp.	0.2	0	0.9	0	0	0
Polygonum aviculare	3.8	0	5.6	7.2	6.4	0
Puccinellia distans	1.8	0	5.4	3.3	0.4	0
Puccinellia lemmonii	1.3	1.5	0.2	0.6	4.3	0
Pyrrocoma lanceolata	0.1	0.3	0	0	0.2	0
Ranunculus cymbalaria	t	0	0	0	0	0.2
Ranunculus sceleratus	0.1	0	0.1	0.1	0.1	0
Sisyrinchium halophilum	0.2	0.3	0.1	0.4	0.1	0.1
Spartina gracilis	0.4	0	0.1	0	1.9	0
Sporobolus airoides	5.7	19.7	7.2	0	1.4	0
Symphyotrichum eatonii	t	0	0	0	0	0.1
Taraxacum officinale	0.4	1.1	0.1	0.2	0.2	0.3
Veronica anagallis-aquatica	0.1	0	0.1	0.2	0	0
Total	**49.7**	**70.5**	**42.3**	**44.9**	**56.3**	**35.7**
Number of Species	**44**	**23**	**27**	**24**	**27**	**22**

Transect means are averages by meter and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05%)

Eleven of the 44 taxa occurred on all five transects (Table 3-42). *Argentina anserina* was the major species on three transects and *Carex nebrascensis* was the major species on two transects. In addition to these two species, *Agrostis gigantea*, *Carex praegracilis*, *Deschampsia caespitosa*, *Polygonum aviculare*, *Puccinellia distans*, and *Sporobolus airoides* each had cover values greater than 10 percent of the transect mean on at least one transect.

Spatial heterogeneity was moderate along the wetland/meadow transects at the Seep (Figure 3-39). *Argentina anserina* was the most frequent dominant species, having the highest cover value on 16 of the 91 micro-community segments along the transects, with a combined length of 127 m out of a total of 485 m (26 percent) in the 5 transects (Figure 3-39). *Carex nebrascensis* was the second-most frequent dominant, being dominant on 13 segments with a combined length of 70 m. *Agrostis gigantea* was the third-most frequent dominant, being dominant on 8 segments totaling 33 m.

```
069   SPAI  DISP  ARAN  CANE  ARAN  CAPR  ARAN  AGGI    JUAR    AGGI    PULE    ARAN     SPECIES
     01-36 37-39 40-41 42-45 46-61 62-64 65-95 96-99 100-102 103-105 106-107 108-110    METERS
     M--------------M  S---S M---M S---S M---M S------------------S  M------------M    GRADIENT

070    SPAI    DISP  SPAI       ARAN       ELPA  ARAN  POAV  ARAN  ELPA  POAV  ELPA     SPECIES
     01----11 12-13 14-16 17-----------35 36-37 38-39 40-42 43-45 46-47 48-49 50-52     METERS
     M---------------------------------M  W---W M---------------M W---W M---M W---W     GRADIENT

070     POAV      CANE  PUDI  CANE     PUDI     POSP  JUAR BASC  POAV   AGGI   JUAR     SPECIES
     53---------69 70-72 73-74 75--78 79----87 88-89   90   91  92-93 94---98 99-100    METERS
     M----------M S---S M---M S----S M------------M S---S M--------M S------------S     GRADIENT

071   PULE  ARAN  ERLO  JUAR  AGGI  ARAN  CAPR  CANE  PUDI  CANE        POAV           SPECIES
       01  02-04 05-06 07-10 11-13 14-16 17-18 19-22 23-25 26--34 35--------------67    METERS
      M--------------M S---------S M---M S---------S M---M S----S M---------------M     GRADIENT

071   CANE  ELPA    ARAN    CAPR MURI  ARAN  CAPR ARAN MURI PULE                        SPECIES
     68-70 71-74 75------88  89    90  91-95 96-97  98   99   100                       METERS
     S---S W---W M--------M S--S M--------M S---S M------------M                        GRADIENT

072   IVKI SPGR   IVKI   DISP   PULE  IVKI  PULE    DISP     CAPR  CANE     POAV       SPECIES
     01-02  03   04---11 12--17 18-21 22-23 24-26 27-------41 42-46 47-50 51-------65   METERS
     M---M S--S M-----------------------------------------M  S---------S M--------M     GRADIENT

072   JUAR  HOJU JUAR   POAV    CANE    ARAN   CANE   JUBU JUAR CANE  AGGI             SPECIES
       66  67-69  70   71---77 78----85 86-87 88---92 93-94  95 96-97 98-100            METERS
     S---S M---M S--S M-----M S------S M---M S-----S M---M S--------------S             GRADIENT

073   ARAN  AGGI   CANE   JUBU   CANE   DECE  AGGI  CANE  AGGI  DECE  ARAN   CAPR ARAN  SPECIES
     01-02 03--11 12--20 21-22 23---34 35-38 39-40 41-43 44-47 48-51 52--71 72-74  75   METERS
     M---M S-----------S M---M S-----S M---M S---------------S M----------M S---S M--M  GRADIENT
```

Species codes are: AGGI = *Agrostis gigantea*, ARAN = *Argentina anserina*, BASC = *Bassia scoparia*, CANE = *Carex nebrascensis*, CAPR = *Carex praegracilis*, DECE = *Deschampsia caespitosa*, DISP = *Distichlis spicata*, ELPA = *Eleocharis palustris*, ERLO = *Erigeron lonchophyllus*, HOJU = *Hordeum jubatum*, IVKI = *Ivesia kingii*, JUAR = *Juncus arcticus*, JUBU = *Juncus bufonius*, MURI = *Muhlenbergia richardsonis*, POAV = *Polygonum aviculare*, POSP = Poa sp., PUDI = *Puccinellia distans*, PULE = *Puccinellia lemmonii*, SPAI = *Sporobolus airoides*, SPGR = *Spartina gracilis*. Moisture gradient (GRADIENT) codes are: M = surface soil often saturated; S = intermittently flooded, soil generally saturated; w = standing water most of the time.

Figure 3-39
Spatial Heterogeneity (most abundant species by meter)
along the Five Wetland/Meadow Transects (069-073) at the Seep in 2009

3.8.2.2.6 Minerva Spring Complex

The major taxa, by overall mean cover, on the wetland/meadow transects at the Minerva Spring Complex were *Agrostis gigantea* (10 percent), *Schedonorus pratensis* (9 percent), *Thermopsis rhombifolia* (8 percent), *Elymus trachycaulis* (7 percent), *Potamogeton sp*. (7 percent), *Carex nebrascensis* (5 percent), *Hordeum jubatum* (5 percent), *Rosa woodsii* (5 percent), *Leymus triticoides* (3 percent), and *Eleocharis rostellata* (3 percent) (Table 3-51). A total of 82 taxa occurred on the transects in 2009 and this was highest species richness value for the 8 sites (Table 3-42). Total overall cover averaged 98 percent and this was also the highest value for the 8 wetland/meadow sites.

Agrostis gigantea and *Juncus arcticus* were the only species that occurred on all seven of the transects at this site (Table 3-51). *Elymus trachycaulis* was the major species on two transects and *Agrostis gigantea*, *Carex nebrascensis*, *Eleocharis rostellata*, *Potamogeton sp*., and *Rosa woodsii* were the major taxa on one transect each. Algae, *Chara sp*., *Hordeum jubatum*, *Sporobolus airoides*, and *Thermopsis rhombifolia* were the other taxa that had cover values equal to at least 10 percent of the mean of any one transect.

Spatial heterogeneity was substantial along the wetland/meadow transects at Minerva Spring Complex (Figure 3-40). *Agrostis gigantea* was the most frequent dominant species, having the highest cover value in 15 of the 84 microcommunity segments along the transects, but with a combined length of only 39 m out of a total of 276 m (14 percent) in the 7 transects (Figure 3-40). *Schedonorus pratensis* was the second-most frequent dominant, being dominant in 8 segments with a combined length of 20 m. *Thermopsis rhombifolia* was the third-most frequent dominant species, being dominant on 6 segments with a combined length of 12 m.

3.8.2.2.7 Blind Spring

The major species, by overall mean cover, on the wetland/meadow transects at Blind Spring were *Utricularia macrorhiza* (35 percent), *Zannichellia palustris* (6 percent), *Hippuris vulgaris* (6 percent), *Sparganium eurycarpum* (6 percent), *Typha latifolia* (5 percent), *Distichlis spicata* (5 percent), *Carex rostrata* (4 percent), *Eleocharis palustris* (3 percent), and *Schoenoplectus acutus* (3 percent) (Table 3-52). A total of 32 taxa occurred on the transects in 2009 and this total was lowest species richness value for 8 sites (Table 3-42). Total overall cover averaged 86 percent and this was the second highest mean for the 8 wetland/meadow sites.

Nine species occurred on all five of the transects: *Bassia scoparia*, *Distichlis spicata*, *Eleocharis palustris*, *Hippuris vulgaris*, *Sagittaria cuneata*, *Schoenoplectus acutus*, *Sparganium eurycarpum*, *Typha latifolia*, and *Utricularia macrorhiza* (Table 3-52). *Utricularia macrorhiza* was the major species on all five transects. *Zannichellia palustris* was the second most abundant species on two transects and *Carex rostrata*, *Chara sp*., and *Typha latifolia* were the second most abundant taxa on one transect each.

Spatial heterogeneity was moderate at Blind Spring (Figure 3-41). *Distichlis spicata* and *Utricularia macrorhiza* were the most frequent dominant species, each having the highest cover value on 11 of the 63 micro-community segments along the transects (Figure 3-41). *Utricularia macrorhiza* was

Table 3-50 Fall 2009 Site Assessment

Site	Season	Channel Area	Pool Area	Total Aquatic Area	Season	Channel Area	Pool Area	Total Aquatic Area
Stonehouse Complex	Spring	807	1072	1879	Fall	214	246	460
Willow Spring	Spring	173	209	382	Fall	136	34	170
Keegan Spring Complex North	Spring	2600	9584	12184	Fall	1804	8675	10479
West Spring Valley Complex 1	Spring	762	513	1275	Fall	700	347	1049
South Millick Spring	Spring	1351	0	1351	Fall	1499	71	1570
Unnamed 5 Spring	Spring	1249	1402	2651	Fall	1106	1651	2757
Four Wheel Drive Spring	Spring	40	179	219	Fall	101	140	241
Willard	Spring	6	30	36	Fall	0	0	0
Shoshone Ponds	Spring	0	679	679	Fall	0	629	629
Big Spring/Lake Creek Reach # 1	not mapped in Spring				Fall	249	0	458
Minerva Spring Complex Middle	Spring	417	161	578	Fall	401	136	537
Minerva Spring Complex North	Spring	452	1307	1759	Fall	359	1201	1560
Swallow Spring	Spring	800	102	902	Fall	709	100	809
North Little Spring	Spring	109	74	183	Fall	40	60	100
Big Spring	Spring	410	0	410	Fall	303	0	303
Big Spring/ Lake Creek Reach # 2	not mapped in Spring				Fall	245	0	249
Big Spring/Lake Creek Reach # 3	not mapped in Spring				Fall	458	0	245
Big Spring/ Lake Creek Reach # 4	not mapped in Spring				Fall	355	0	354
Big Spring/ Lake Creek Reach # 5	not mapped in Spring				Fall	205	0	204
Unnamed 1 Spring North of Big	Spring	197	10	207	Fall	123	7	130
Stateline Springs	Spring	131	0	131	Fall	122	9	131

dominant on a longer length of the transects (95 m) than *D. spicata* (35 m). *Sparganium eurycarpum* was the third-most frequent dominant species, being dominant on 6 segments, totaling 12 m.

3.8.2.2.8 Burbank Meadows

The major species, by overall mean cover, on the wetland/meadow transects at Burbank Meadows were *Carex praegracilis* (11 percent), *Juncus arcticus* (9 percent), *Distichlis spicata* (8 percent),

Table 3-51
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Minerva Spring Complex in 2009
(Page 1 of 2)

Species	Overall Mean	Transects						
		002	003	004	005	006	007	008
Achillea millefolium	0.9	3.2	1.5	0	1.3	0	0	0.2
Agrostis gigantea	9.7	10.3	3	10.8	22.2	17.4	1.3	3.2
Algae	1.9	0	0	0	1.5	1.3	0	10.4
Aquilegia formosa	0.4	1.3	0	0	0.5	1.1	0	0.1
Argentina anserina	1.5	0	1.8	0.3	0.8	2.1	5.5	0
Asclepias speciosa	0.1	0.6	0	0	0	0	0	0
Aster sp.	0.1	0.4	0.1	0	0	0	0	0
Bassia scoparia	0.9	0.2	5.6	0	0	0	0.7	0
Berula erecta	1.6	1.6	1.7	0	0.1	7.8	0	0.1
Bromus tectorum	0.1	0	0.5	0.2	0	0	0	0
Carduus nutans	0.9	1.8	0.4	0	0.2	3.7	0	0
Carex nebrascensis	5.0	1.3	t	3.2	3.1	0	23.6	3.9
Carex praegracilis	1.9	2.1	3.7	0.4	t	0	6	0.9
Carex simulata	1.0	0	0	0	3.5	3.7	0	0
Carex sp.	0.6	0	0	0	4.0	0	0	0
Chara sp.	1.7	0	0	0	1.7	0	2.1	8
Chenopodium sp.	0.1	0	0	0.8	0	0	0	0
Cirsium scariosum	0.3	0.4	0.6	0.6	0.2	0	0	0
Cirsium vulgare	t	0	0	0.1	0	0	0	0
Conium maculatum	t	0	0	0	0	0	0	0.1
Crepis runcinata	0.2	0.2	0.2	0	0	0	0.7	0
Dactylis glomerata	0.3	0	0	0	2.0	0	0	0
Deschampsia caespitosa	0.5	0.3	0	0	0.1	0	2.5	0.5
Descurainia sophia	0.1	0.1	0	0.3	0	0	0	0
Distichlis spicata	0.8	0	1.4	0	0	0	4.4	0
Eleocharis palustris	0.9	0	0.2	0.7	1.1	1.9	2.5	0
Eleocharis rostellata	2.5	1.9	0	0	0	1.4	0	14.3
Elymus trachycaulis	6.5	24	14.5	6.8	0.4	0	0	0
Equisetum arvense	0.4	0	1.2	0.1	0.2	0.3	0.4	0.9
Ericameria nauseosa	t	0	0.1	0	0	0	0	0
Erigeron lonchophyllus	0.1	0.1	0.3	0	0.1	0	0.5	t
Glaux maritima	t	0	0	0	0	0	0.1	0
Helianthus nuttallii	0.3	0	0	0	t	1.5	0.1	0.6
Hordeum brachyantherum	0.2	0	0	1.2	0	0	0	0
Hordeum jubatum	4.9	6.2	1.8	25.8	0.2	0.3	0	0.1
Iris missouriensis	0.2	0.2	0.1	0	0.9	0	0	0
Juncus arcticus	1.6	0.3	0.7	0.5	0.5	0.8	7.9	0.8
Juncus nevadensis	0.7	1.8	0.3	0	1.2	1.3	0.2	0.4
Lemna minuta	0.1	0	0	0	0.4	0	0	0
Leymus triticoides	2.9	0	5.6	0.4	3	4.4	7.2	0
Medicago polymorpha	1.3	3	0	0	0.9	5.2	0	0
Melilotus officinalis	1.6	1.4	0	7.5	1.8	0.4	0	0
Mentha arvensis	t	0	0	0	t	0	0	0

Table 3-51
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at the Minerva Spring Complex in 2009
(Page 2 of 2)

Species	Overall Mean	Transects 002	003	004	005	006	007	008
Mentha spicata	t	0.2	0	0	0	0	0	0
Mimulus guttatus	0.4	1	0.4	0.1	0.2	0	0	1.1
Moss	1.2	0	0	0	0.4	0.8	6.8	0.2
Muhlenbergia asperifolia	0.1	0	0	0	0.1	0	0.4	0
Muhlenbergia richardsonis	t	0	0	0	0.1	0	0	0.1
Myriophyllum verticillatum	0.3	0	0	0.6	1.8	0	0	0
Nasturtium officinale	2.2	7.2	0	0	0.1	1.8	5.8	0.2
Pascopyrum smithii	0.7	0	4.8	0	0	0	0	0
Phleum pratense	0.1	0.1	0	0	0.3	0	0	0
Poa pratensis	2.0	3.2	0.8	6.7	0.8	0.2	0.2	0
Poa secunda	0.1	0	1	0	0	0	0	0
Polygonum aviculare	1.3	0	0	9	0	0	0	0
Polygonum sp.	t	t	0	0	0	0	0	0
Potamogeton sp.	6.6	0	0	27.3	19.1	0	0	0
Potentilla hippiana	0.1	0	0	0.2	0.2	0	0	0
Puccinellia distans	t	0.1	0	0	0	0	0	0
Puccinellia lemmonii	1.5	0	7.3	0.4	2.3	0	0.3	0
Pyrrocoma lanceolata	0.3	0	0	0	0	0	1	0
Ranunculus sceleratus	t	0	0	0.1	0	0	0	0
Rosa woodsii	4.6	0	0	0	0	32.3	0	0
Rumex crispus	0.2	0	0	1.3	0	0	0	0
Sagittaria cuneata	t	0	0	0	0	0	0	0.2
Schedonorus pratensis	8.8	3.8	0	11.4	19.8	26.8	0	0
Schoenoplectus pungens	0.1	0	0	0	0	0	0	0.1
Sisyrinchium halophilum	0.3	0.1	t	0	1.6	0	0.4	0
Solidago nana	t	0	0	0	0.3	0	0	0
Spartina gracilis	0.2	0	1.3	0	0	0	0.4	0
Sporobolus airoides	1.8	0	11	0	0	0	1.4	0
Stuckenia filiformis	0.4	0	0	0	0	0	0	3
Symphyotrichum eatonii	0.3	0	0	0.1	0.9	0.6	0.6	0
Taraxacum officinale	0.1	0.2	0.2	0.2	0.2	0.1	0	0
Thermopsis rhombifolia	7.7	12.2	0.8	10.9	8.6	21.6	0	0
Trifolium fragiferum	0.1	0.4	0	0.3	0	0	0	0
Trifolium hybridum	0.2	0.5	0	0.2	0.4	0	0	0
Trifolium pratense	1.1	1.4	0	1	1.1	3.7	0.1	0.1
Trifolium repens	0.3	0.7	1.4	0.1	0.1	0	0	0
Triglochin maritima	0.1	0	0	0	0	0	0	0.4
Veronica anagallis-aquatica	0.1	0.2	0	0.5	0	0	0	0
Viola nephrophylla	0.1	0	0	0	0.3	0	0	0.2
Total	**98.2**	**94**	**74.3**	**130.1**	**110.6**	**142.5**	**84**	**50.7**
Number of Species	**82**	**39**	**34**	**35**	**50**	**26**	**28**	**27**

Transect means are averages by meter and overall mean is the average of the seven transects.
A “t” indicates a trace amount (<0.05%)

```
002   THRH    ELTR    THRH  ELTR SCPR  NAOF   ELRO  AGGI  MEPO  AGGI  ELTR  BEER AGGI    SPECIES
     01-02 03-----17 18-19 20-23  24  25--28 29-31 32-35 36-40 41-43 44-47 48-49  50     METERS
     M---M S-------S M---M S--------S A----A W---W S---S M---M S---------S A---A S--S    GRADIENT

003    SPAI    PULE   AGGI ARAN LETR AGGI PULE HOJU PASM   ELTR   ACMI   PASM  LETR      SPECIES
     01---06 07--10  11    12    13   14    15   16    17  18---23 24-25 26-27 28-30     METERS
     M-----------M  S--S M--M S-------S M-------M D--D S-----S M---M D---D S----S        GRADIENT

004   HOJU SCPR    POTA     POPR  POAV    HOJU    SCPR AGGI  POPR  AGGI THRH  MEOF  ELTR    SPECIES
     01-02  03   04-----20 21-23 24-28 29----40   41    42   43-44 45-48  49  50-52 53---60 METERS
     M---M S--S A-------A M-----------------M S--------S M---M S---S M--------M S----S    GRADIENT

005   DAGL  AGGI THRH LETR  SCPR  POTA  AGGI  SCPR  AGGI  CASI  POTA  SCPR  THRH SCPR    SPECIES
     01-03 04-07  08   09  10-12 13-15 16-23 24-25 26-29 30-32 33-41 42-47 48-49  50     METERS
     M---M S---S M--M S--------S A---A S---S S---------S W---W A---A S---S M---M S--S    GRADIENT

006    THRH    SCPR   AGGI  ROWO ARAN CASI AGGI CANE NAOF  BEER   ROWO                  SPECIES
     01---04 05---09 10-12 13-15  16   17   18   19   20  21-22 23----28                 METERS
     M-----M S-----------S M--------M W--W S-------S A--------A M------M                 GRADIENT

008     LETR    DISP AGGI CHAR MOSS NAOF CANE ELPA JUAR     CANE                          SPECIES
     01------08  09   10   11   12   13   14   15   16  17-------25                      METERS
     S--------S M--M S--S A------------A S--S W--W S--------------S                      GRADIENT

009   AGGI  ELRO  CHAR  ALGA  CHAR  STFI  CANE         ELRO       MIGU AGGI              SPECIES
       01  02-03 04-05 06--09  10  11-12 13--16 17------------30 31-32  33               METERS
      S--S W---W A--------------------A S----S W-------------------W S--S                GRADIENT
```

Species codes are: ACMI = *Achillea millefolium*, AGGI = *Agrostis gigantea*, ALGA = algae, ARAN = *Argentina anserina*, BEER = *Berula erecta*, CANE = *Carex nebrascensis*, CASI = *Carex simulata*, CHAR = *Chara sp.*, DAGL = Dactylis glomerata, DISP = *Distichlis spicata*, ELRO = *Eleocharis rostellata*, ELTR = *Elymus trachycaulis*, HOJU = *Hordeum jubatum*, JUAR = *Juncus arcticus*, LETR = *Leymus triticoides*, MEOF = *Melilotus officinalis*, MEPO = *Medicago polymorpha*, MIGU = *Mimulus guttatus*, MOSS = moss, NAOF = *Nasturtium officinale*, POAV = *Polygonum aviculare*, POPR = *Poa pratensis*, POTA = *Potamogeton sp.*, PSAM = *Pascopyrum smithii*, PULE = *Puccinellia lemmonii*, ROWO = *Rosa woodsii*, SCPR = *Schedonorus pratensis*, SPAI = *Sporobolus airoides*, STFI = *Stuckenia filiformis*, THRH = *Thermopsis rhombifolia*. Moisture gradient (GRADIENT) codes are: D = surface commonly dry; M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-40
Spatial Heterogeneity (most abundant species by meter) along the Seven Wetland/Meadow Transects (002-006) at the Minerva Complex in 2009

Argentina anserina (8 percent), *Puccinellia lemmonii* (6 percent), *Leymus triticoides* (4 percent), *Crepis runcinata* (3 percent), and *Spartina gracilis* (3 percent) (Table 3-53). A total of 54 taxa occurred on the transects in 2009 and this was below average for the 8 sites (Table 3-42). Total overall cover averaged 60 percent and this was also below average for the 8 wetland/meadow sites.

Carex praegracilis, *Cirsium scariosum*, *Distichlis spicata*, *Juncus arcticus*, *Leymus triticoides*, and *Puccinellia lemmonii* were the only species that occurred on all 10 transects at this site (Table 3-53). *Carex praegracilis* and *Distichlis spicata* were the major species on three transects each and *Puccinellia lemmonii* was the major species on two transects. *Argentina anserina*, *Juncus arcticus*, and *Spartina gracilis* were the major species on one transect each. *Crepis runcinata* and *Leymus triticoides* were the only other species with cover values of at least 10 percent of the mean on a respective transect.

Spatial heterogeneity at Burbank Meadows was substantial in relation to number of micro-community segments but was low in relation to number of dominant species (Figure 3-42). This suggests substantial micro-topographic variability (large number of segments) but with only low to moderate elevational differences (relatively small number of dominant species). *Carex praegracilis* was the most frequent dominant species, having the highest cover value in 35 of the 196 micro-community segments along the transects, with a combined length of 177 m out of a total of

Table 3-52
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at Blind Springs in 2009

Species	Overall Mean	Transects				
		011	012	013	014	015
Atriplex sp.	0.1	0	0.4	0	0	0
Atriplex truncata	t	0	0.1	0	0	0
Bassia scoparia	1.6	1.6	0.6	1.2	1.9	2.8
Bidens cernua	0.2	0.1	1.1	0	0	0
Carex nebrascensis	0.4	0	1	0.9	0	0.2
Carex rostrata	4.3	6.9	0	0	9.6	4.9
Carex simulata	2.1	5.1	0	4.5	0.8	0.1
Chara sp.	2.2	3.6	2.6	4.6	0	0
Chenopodium sp.	0.3	0.1	0	0	1.4	0
Distichlis spicata	4.6	7.3	4	4.4	3.3	4.2
Eleocharis palustris	2.8	6.2	0.6	2	1	4.4
Eleocharis rostellata	1	2.8	0	2.3	0	0
Hippuris vulgaris	6.1	4.5	6.9	2.4	10.5	6.4
Iva axillaris	0.1	0	0	0	0	0.6
Juncus arcticus	t	0	0	0	0	0.2
Juncus nevadensis	0.1	0	0	0	0	0.3
Limosella aquatica	0.1	0.2	0	0.1	0	0
Mimulus guttatus	0.5	2.4	0	0.3	0	0
Moss	0.7	3.5	0	0	0	0
Potamogeton sp.	0.3	0.2	1	0.1	0	0
Puccinellia distans	t	0	0	t	0	0
Ranunculus cymbalaria	0.1	0	0	0.3	0	0
Ranunculus sceleratus	t	0	0	0	0	0.2
Sagittaria cuneata	0.8	0.3	1.1	0.5	0.4	1.5
Sarcobatus vermiculatus	0.1	0	0	0	0.7	0
Schoenoplectus acutus	2.8	3.5	3.7	3.6	1.8	1.2
Schoenoplectus americanus	2.1	4.5	0	0	3.3	2.6
Schoenoplectus pungens	0.4	0	0.2	2	0	0
Sparganium eurycarpum	5.8	4.4	3.9	1.6	8.1	10.8
Typha latifolia	5	6.4	8.8	2.5	4	3.2
Utricularia macrorhiza	34.8	46.8	16.9	17.6	54.5	38.3
Zannichellia palustris	6.2	5.5	0.6	0	14.1	10.8
Total	**85.6**	**115.9**	**53.5**	**50.9**	**115.4**	**92.7**
Number of Species	**32**	**21**	**17**	**19**	**15**	**17**

Transect means are averages by meter and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05%)

```
011   DISP  ZAPA HIVU TYLA  UTMA ELPA  CHAR MIGU ELRO SCAM  UTMA TYLA  UTMA  ELPA  DISP  SPECIES
     01-02 03-05  06    07  08-20  21  22-23  24   25    26  27-31  32  33-35 36-37 38-43 METERS
     M---M A---A W--W A--------A W--W A---A W-------W A------------------A W---W M---M GRADIENT

012   DISP  SPEU HIVU SCAC    UTMA    TYPH   SCAC  UTMA  HIVU  POTA  CHAR BICE  DISP  SPECIES
     01--04 05-08  09   10  11-----19 20--24 25-26 27--34 35-36 37-38 39-40  41  42-43 METERS
     M----M A---A W--W A--------------------------------A  W---W A---------A S--S M---M GRADIENT

013    DISP   CHAR  SCAC    UTMA       ELRO   CASI    UTMA   TYLA SPEU  CHAR  DISP       SPECIES
     01---05 06-07 08-09 10------17 18---22 23-25 26-----32  33    34  35-36 37--39      METERS
     M-----M A-------------------A  W-----------W A----------------------A M----M        GRADIENT

014   DISP SAVE DISP  ZAPA SPEU HIVU UTMA SPEU        UTMA         ZAPA  DISP BASC CHEN  SPECIES
       01   02   03  04-06  07   08   09   10  11-------------37 38---44  45   46   47   METERS
     M------------M A------------------------------------------------A M--M D------D    GRADIENT

015    DISP   ZAPA  SPEU TYLA UTMA TYLA       UTMA       SPEU  ZAPA IVAX  DISP           SPECIES
     01---05 06-07 08-09  10   11   12  13-----------26 27-29 30-31  32  33-34           METERS
     M-----M  A------------------------------------------------A S--S M---M              GRADIENT
```

Species codes are: BASC = *Bassia scoparia*, BICE = *Bidens cernua*, CHAR = *Chara sp.*, CHEN = *Chenopodium sp.*, DISP = *Distichlis spicata*, ELPA = *Eleocharis palustris*, ELRO = *Eleocharis rostellata*, HIVU = *Hippuris vulgaris*, IVAX = *Iva axillaris*, MIGU = *Mimulus guttatus*, POTA = *Potamogeton sp.*, SAVE = *Sarcobatus vermiculatus*, SCAC = *Schoenoplectus acutus*, SCAM = *Schoenoplectus americanus*, SPEU = *Sparganium eurycarpum*, TYLA = *Typha latifolia*, TYPH = *Typha sp.*, UTMA = *Utricularia macrorhiza*, ZAPA = *Zannichellia palustris*. Moisture gradient (GRADIENT) codes are: D = surface commonly dry; M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-41
Spatial Heterogeneity (most abundant species by meter) along the Five Wetland/Meadow Transects (011-015) at Blind Spring in 2009

Table 3-53
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at Burbank Meadows in 2009
(Page 1 of 2)

Species	Overall Mean	Transects									
		139	140	141	142	143	144	145	146	147	148
Agrostis gigantea	0.5	0.2	0.2	1.6	0.3	0.1	0	2.1	0	0	0
Argentina anserina	7.6	9.5	25.2	8.6	4.5	12.7	0	4.3	2	3.7	5.9
Aster sp.	0.1	0	0	0.6	0	0	0	0	0	0.6	0
Bassia scoparia	0.1	0.2	0	0	0	0	0	0	0	1.1	0
Berula erecta	t	0	0	0	0	0	0	t	0	0	0
Carex nebrascensis	t	0	0	0	0	0	0	0.1	0	0	0.1
Carex praegracilis	10.7	7.4	11.3	5.6	8.9	11.8	0.4	25.1	3.4	28	4.6
Centaurium exaltatum	t	0	0	0	0	0	0	0	t	0	0
Chenopodium sp.	t	0	0	0	0	0	0.1	0	0.2	0	0
Cirsium scariosum	1.1	0.2	2.3	1.1	0.3	3	0.4	0.4	0.1	2.9	0.6
Crepis runcinata	3.2	0.5	2	13.7	0	9.5	0	0.5	0.2	0.2	5.2
Deschampsia caespitosa	t	0	0	0.1	0	0	0	0	0	0	0
Distichlis spicata	8.4	8.3	6.8	3.4	12.4	3	6.4	2.1	11.4	1.4	28.3
Dodecatheon pulchellum	t	0	0	t	0	0	0	0	0	0	0
Eleocharis palustris	t	0.1	0	0	0	0	0	0	0	0	0
Eleocharis sp.	t	0	0	0	0	0	0	t	0	0	0
Elymus elymoides	t	0	0	0	0	0	0	0.1	0	0	0

Table 3-53
Mean Percent Cover, Overall and by Species, of Vegetation along Wetland/Meadow Transects at Burbank Meadows in 2009
(Page 2 of 2)

Species	Overall Mean	Transects									
		139	140	141	142	143	144	145	146	147	148
Elymus trachycaulus	0.1	0	0	0.9	t	0	0	0	0	0	0
Equisetum arvense	t	0	0	0	0	t	0	0	0	0	0
Erigeron lonchophyllus	0.2	0	0.3	0.1	0.2	0.1	0	1.6	0	0	0.1
Glaux maritima	0.7	0.2	1.2	0.5	0.5	0.2	0.1	2.4	0	t	1.7
Hordeum brachyantherum	0.1	0.1	0.2	0	0	0.4	0	0	0	0.4	0.2
Hordeum jubatum	0.9	0.4	0.2	0	4.7	0.3	0	0.2	0.5	2.1	0.1
Hymenoxys lemmonii	0.2	1.7	t	0	0	0	0	0	0	0	0
Iris missouriensis	0.1	0	0	0	0	0.9	0	0	0	0	0
Ivesia kingii	t	0	0	0	0	0	t	0	0	0	0
Juncus arcticus	8.9	9.7	5.3	11.7	8.8	7.5	4.4	14.4	4.3	11.4	11.3
Leymus triticoides	4.2	7	1.5	2.2	9.1	4.4	1.3	0.2	4.1	5.8	5.9
Muhlenbergia asperifolia	0.1	0.1	0.5	0.2	0	0.4	0	0	t	0	0.2
Nitrophila occidentalis	0.5	0.1	t	0.4	0	0.1	0.3	0.2	0	0	3.4
Plantago major	t	0	0	0	0.1	0	0	0	t	0	0
Poa pratensis	0.1	0.2	0.1	0	0.1	0.1	0	0	t	0	0
Polygonum aviculare	t	0	0	0	0.2	0	0	0	0	0.1	0
Potamogeton sp.	0.1	0	0	0	0	0.8	0	0	0	0.1	t
Potentilla pensylvanica	0.1	0	0	0	0	0	0	0.9	0	0	0
Puccinellia distans	0.2	0	0	0	2.4	0	0	0	0	0	0
Puccinellia lemmonii	6.4	2.2	7.5	15.9	6.9	14.9	4.8	0.1	5.3	3.2	3.2
Pyrrocoma lanceolata	0.1	t	0.3	0	0	0.4	0.3	0	0	0.1	0
Ranunculus cymbalaria	t	0	0	0	0.3	0	0	0	0	0	0
Ranunculus sceleratus	t	0	0	0	0	0	0	0.1	0	0	t
Schoenoplectus pungens	t	0	0	0	0	0	0	t	0	0	0
Sisyrinchium halophilum	0.1	0.1	0.1	0	0.4	0.1	0	0	0	0	t
Spartina gracilis	2.8	0	0	3	0	9.6	13	0.9	1.8	0	0
Sphenopholis obtusata	0.1	0.1	0.7	0	0	0.1	0	0.1	0	0	0
Sporobolus airoides	0.5	1.6	1.2	0	0	0.2	0	0	1.9	0	0
Symphyotrichum eatonii	t	0	0	0	0.1	0	0	0.1	t	0	0
Taraxacum officinale	0.1	0.2	0.2	0	0.5	0	0	0.1	0	0	0
Trifolium fragiferum	0.2	0	1.9	0	0	0	0	0	0.2	0	0.1
Trifolium repens	t	0	0	0	0	0	0	t	0	0	0
Trifolium sp.	0.9	4.2	t	0.7	3.7	0.3	0	t	0	0	0
Triglochin concinna	t	0	0	0	0	0	0	0	0.3	0	0
Triglochin maritima	0.1	0	t	0.7	0	0	0	0	0	0	0.2
Triglochin sp.	t	0	0	t	0	0	t	0	0.1	0	0
Xanthium strumarium	t	0	0	0	0	0	0	0	0	t	0
Total	**59.5**	**54.3**	**69**	**71**	**64.4**	**80.9**	**31.5**	**56**	**35.8**	**61.1**	**71.1**
Number of Species	**54**	**24**	**25**	**21**	**21**	**25**	**13**	**26**	**20**	**17**	**20**

Transect means are averages by meter and overall mean is the average of the ten transects.
A "t" indicates a trace amount (<0.05%).

1,000 m (18 percent) in the 10 transects (Figure 3-42). *Juncus arcticus* was the second-most frequent dominant, being dominant on 31 segments with a combined length of 124 m. *Puccinellia lemmonii* and *Distichlis spicata* were the next most frequent dominant species (25 and 23 segments, respectively) and dominant on 119 m and 194 m, respectively.

3.8.3 Phreatophytic Shrubland Transects

3.8.3.1 Summary of Shrubland Vegetation Data Overall

Sarcobatus vermiculatus was the dominant species at all the shrubland sites (Table 3-54). Overall mean total cover was 17 percent and overall mean cover of *Sarcobatus vermiculatus* was 14 percent. Only 29 species were encountered along the transects in 2009 and half of these (14) had overall means less than 0.05 percent (trace amount; Table 3-55). Of the remaining species, *Atriplex confertifolia*, *Artemisia tridentata*, and *Distichlis spicata* had the highest overall mean cover (0.5 percent, 0.4 percent, and 0.4 percent, respectively; Table 3-55). Only two species occurred on more than a third of the transects. *Sarcobatus vermiculatus* occurred on all transects and *Atriplex confertifolia* occurred on 21 of the transects (84 percent) (Table 3-55).

Mean overall cover was highest (20 percent) in North Spring Valley and lowest (13 percent) in Hamlin Valley (Table 3-54). On average, 11 species occurred on the transects at each of the five sites and species richness was relatively high in North and Middle Spring Valley and in Snake Valley and relatively low in South Spring Valley and Hamlin Valley (Table 3-54). Mean overall cover and species richness were much lower on the phreatophytic shrubland transects than on either the aquatic or wetland/meadow transects, as should be expected because of the drier conditions on the shrubland sites. Mean overall cover on the shrubland transects was less than 25 percent that of the wetland/meadow transects and species richness was less than 20 percent (Table 3-42 and Table 3-54).

3.8.3.2 Summary of Shrubland Vegetation Data by Site

All five sites were dominated by *Sarcobatus vermiculatus* and all other species had low cover values at all sites (Table 3-56). The Spring Valley sites were more similar to each other than to the sites in Hamlin or Snake Valleys. The Spring Valley sites had *Artemisia tridentata*, *Ericameria nauseosa*, *Distichlis spicata*, and *Sporobolus airoides* and the Hamlin Valley and Snake Valley transects lacked these species. The Middle and South Spring Valley sites had *Suaeda* species present and the North Spring Valley transects had relatively large numbers of *Halogeton glomeratus*. *Grayia spinosa* was most common on the Hamlin Valley transects, being either absent or occurring only in trace amounts at the other sites. *Gutierrezia sarothrae* was present on the Snake Valley transects, but was absent on all others.

3.8.3.2.1 North Spring Valley

Sarcobatus vermiculatus was the major species on the North Spring Valley transects, with a mean cover value of 18 percent (Table 3-57). The second-most abundant species was *Halogeton glomeratus*, with a mean cover of 1 percent. Total overall cover averaged 20 percent and this was the

```
139  HYLE  CAPR  HYLE  JUAR  ARAN  LETR  ARAN  CAPR  LETR  ARAN  LETR  DISP  PULE       SPECIES
     01-04 05-08 09-10 11-18 19-20 21-25 26-27 28-29 30-33 34-35 36-43 44-49 50-51       METERS
     D---D S---S D---D S---S M---M S---S M---M S---------S M---M S---S M----------       GRADIENT

139  DISP  SPAI  DISP  ARAN  TRIF  ARAN  TRIF  ARAN  JUAR  PULE  DISP                    SPECIES
     52-54 55-58 59-60 61-68 69-70 71-76 77-78 79-81 82-83 84-85 86-100                  METERS
     ---------------------------------------------M S----S M----------M                  GRADIENT

140  CAPR  PULE  SPAI  PULE  DISP  PULE  DISP  PULE  CRRU  JUAR  ARAN  CAPR  ARAN  CAPR  SPECIES
      01   02-05 06-07 08-12 13-17 18-25 26-36 37-46 47-48 49-50 51-66 67-68 69-98 99-100 METERS
     S--S M------------------------------------M  S--------S  M---M S---S M---M S---S  GRADIENT

141  CRRU  PULE   CRRU   PULE  CRRU    PULE   CRRU   PULE    SPGR    PULE    CRRU      SPECIES
     01-03 04-05 06---10 11-12 13--16 17---21 22--25 26-27 28-----34 35--38 39---43      METERS
     S---S M---M S-----S M---M S----S M-----M S----S M---M S-------S M----M S-----S      GRADIENT

141     PULE         CRRU       ARAN      JUAR     ARAN     JUAR      CAPR     JUAR     CAPR    SPECIES
     44---------53 54--------62 63---67 68-----74 75-77 78------87 88-89 90-----98 99-100  METERS
     M----------M S---------S M-----M S-------S M---M S-------------------------------S   GRADIENT

142  JUAR   HOJU  ARAN    JUAR       PUDI     CAPR    JUAR  DISP    PULE       CAPR    SPECIES
     01--04 05-06 07-08 09---------17 18--21 22-----29 30-32 33-34 35-----41 42-------52 METERS
     S----S M---------M S--------- S M----M S-------------S M-------------M S---------S  GRADIENT

142  PULE       DISP       CAPR    DISP           LETR          DISP  ARAN  BARE  LETR   SPECIES
     53-54 55-----------67 68-69 70-----76 77---------------92 93-94 95-96 97-98 99-100  METERS
     M-------------------M S---S M-------M S----------------S M---------------M S----S  GRADIENT

143  CISC  PULE  CRRU  CAPR  ARAN CISC  POMO  CAPR  ARAN  JUAR  DISP  PULE  CRRU  PULE  SPECIES
     01-03 04-06 07-08 09-11 12-13  14  15-16 17-18 19-30 31-33 34-37 38-43 44-47 48-51  METERS
     S---S M---M S---------S M---M S--S A---A S---S M---M S---S M---------M S---S M---M  GRADIENT

143  SPGR  DISP  SPGR  PULE  SPGR  LETR  PULE  CAPR  SPGR  PULE  SPGR  PULE  ARAN       SPECIES
     52-57 58-59 60-63 64-66 67-68 69-73 74-78 79-80 81-82 83-85 86-87 88-94 95-100      METERS
     S---S M---M S---S M---M S---------S M---M S---------S M---M S---S M----------M      GRADIENT

144  JUAR  DISP   SPGR    CISC  SPGR  PULE    SPGR     JUAR  SPGR  PULE  SPGR   DISP    SPECIES
      01   02-09 10----30 31-32 33--41  42   43------73 74-75 76-77 78-82 83--91 92--100 METERS
      S---S M--M S-------------------S M--M S--------------------S M---M S----S M----M   GRADIENT

145  SPGR  CRRU  JUAR             CAPR                JUAR  CAPR  JUAR  CAPR   JUAR     SPECIES
     01-03 04-05 06--09 10--------------------------37 38-39 40-41 42-43 44-45 46----51  METERS
      S-----------------------------------------------------------------------------    GRADIENT

145     CAPR       JUAR   CAPR  JUAR    CAPR     JUAR        CAPR      JUAR   CAPR      SPECIES
     52---------62 63--66 67-68 69---73 74--77 78-----84 85---------95 96-97 98--100     METERS
     ----------------------------------------------------------------------------S      GRADIENT

146  SPAI  DISP  SPAI  CAPR LETR     DISP     SPAI     DISP     PULE        DISP        SPECIES
     01-03 04--07  08   09-10  11  12--------22 23--26 27------34 35-37 38-------------61 METERS
     M---------------M S--------S M---------------------------------------------------M GRADIENT

146   PULE  CAPR    LETR      ARAN     SPGR  DISP   LETR  CAPR DISP   PULE             SPECIES
     62---66  67   68------75 76----81 83-84 85--88 89-90 91-92  93 94-----100           METERS
     M-----M S-------------S M------M S---S M----M S---------S M------------M           GRADIENT

147  JUAR   CAPR   ARAN  JUAR CISC    CAPR     JUAR       CAPR      JUAR    CAPR        SPECIES
     01--05 06--10 11-12 13-15  16  17------29 30--35 36-------51 52-54 55------66       METERS
     S-----------S M---M S-------------------------------------------------------S       GRADIENT

147  LETR  CAPR   JUAR  CAPR  JUAR  CAPR  JUAR  CAPR  JUAR  CAPR  JUAR BASC             SPECIES
     67-69 70--75 76-77 78-79 80-83 84-87 88-89 90-91 92-93 94-96 97-99  100             METERS
     S-------------------------------------------------------------S M--M               GRADIENT

148          DISP            JUAR  CRRU CAPR  JUAR   CRRU  NIOC   LETR JUAR     DISP    SPECIES
     01------------------21 22-23 24-26  27   28--31 32-34 35---39  40   41   42-------52 METERS
     M--------------------M S-----------------------------------------------S M---------M GRADIENT

148  NIOC   CRRU  ARAN   JUAR  ARAN  CAPR  CRRU           DISP          LETR   ARAN     SPECIES
    53--56 57-58 59--62 63-64 65-67 68-69 70--72 73-------------------93 94--97 98-100   METERS
    S----------S M----M S---S M---M S----------S M--------------------M S----S M----M   GRADIENT
```

Species codes are: ARAN = *Argentina anserina*, BARE = bare ground, BASC = *Bassia scoparia*, CAPR = *Carex praegracilis*, CISC = *Cirsium scariosum*, CRRU = Crepis runcinata, DISP = *Distichlis spicata*, HOJU = *Hordeum jubatum*, HYLE = *Hymenoxys lemmonii*, JUAR = *Juncus arcticus*, LETR = *Leymus triticoides*, NIOC = *Nitrophila occidentalis*, POMO = *Potamogeton sp.*, PUDI = *Puccinellia distans*, PULE = *Puccinellia lemmonii*, SPAI = *Sporobolus airoides*, SPGR = *Spartina gracilis*, TRIF = *Trifolium sp.* Moisture gradient (GRADIENT) codes are: D = surface commonly dry; M = surface soil often saturated; S = intermittently flooded, soil generally saturated; W = standing water most of the time; A = perennial standing water.

Figure 3-42
Spatial Heterogeneity (most abundant species by meter)
along the Ten Wetland/Meadow Transects (139-148) at Burbank Meadows in 2009

Table 3-54
Summary of Overall Species Composition, Cover, and Number of Plant Taxa on the Phreatophytic Shrubland Transects in 2009

Site	Composition Overall (% Cover of Major Species)						Mean Total Cover (%)	Mean Plant Coverage (%)	Number of Taxa
North Spring Valley	SAVE	(18)	HAGL	(1)	ATCO	(1)	20.4	20.4	12
Middle Spring Valley	SAVE	(11)	ARTR	(2)	SUMO	(1)	14.3	14.3	14
South Spring Valley	SAVE	(13)	DISP	(2)	ATCO	(1)	17.3	17.3	9
Hamlin Valley	SAVE	(11)	GRSP	(1)	ATCO	(1)	13	12.9	6
Snake Valley	SAVE	(15)	GUSA	(1)	ATCO	(1)	17.9	17.9	13
Overall Mean	**SAVE**	**(14)**	**ATCO**	**(1)**			**16.6**	**16.6**	**11**

Cover values are averages of five transects per site and number of species is the total number observed on the five transects per site.
Numbers in parentheses following species codes are mean cover values (%) for each of the three species with the higher mean cover values at that site.
Species codes: ARTR = *Artemisia tridentata,* ATCO - *Atriplex confertifolia,* DISP - *Distichlis spicata,* GRSP = *Grayia spinosa,* GUSA = *Gutierrezia sarothrae,* HAGL = *Halogeton glomeratus,* SAVE = *Sarcobatus vermiculatus,* SUMO = *Suaeda moquinii.*
Mean Total Cover is the mean of the cover values of all species, averaged over all transects at each site. it includes multiple hits per 1-cm mark per meter.
Mean Plant Coverage is the mean of the percent of the length of the transect where vegetation was present (i.e., first-hit counts only).

Table 3-55
Plant Taxa Present on the 25 Phreatophytic Shrubland Transects in 2009

Plant Taxa	Mean Cover (%)	Number of Sites Where Present	Number of Transects Where Present
Achnatherum hymenoides	t	1	2
Artemisia tridentata	0.4	3	7
Atriplex canescens	t	1	2
Atriplex confertifolia	0.5	5	21
Bassia americana	0.1	1	2
Bassia scoparia	t	1	2
Chenopodium incanum	t	1	1
Chenopodium leptophyllum	t	1	1
Chenopodium sp.	t	1	1
Chrysothamnus viscidiflorus	t	2	2
Descurainia sophia	t	1	1
Distichlis spicata	0.4	3	7
Elymus elymoides	t	2	2
Ephedra viridis	t	1	1
Ericameria nauseosa	0.2	3	6
Grayia spinosa	0.2	3	3
Gutierrezia sarothrae	0.1	1	3
Halogeton glomeratus	0.3	3	6
Iva axillaris	t	1	1
Krascheninnikovia lanata	0.1	1	2
Machaeranthera carnosa	t	1	1
Picrothamnus desertorum	0.1	2	3
Poa secunda	t	1	1
Sarcobatus vermiculatus	13.7	5	25
Sphaeralcea coccinea	t	1	1
Sporobolus airoides	0.1	2	3
Suaeda calceoliformis	0.1	1	1
Suaeda moquinii	0.1	2	3
Tetradymia spinosa	0.1	3	4

Mean cover = Average of the 5 site means.
Total number of sites = 5.
Total number of transects = 25.
A “t” indicates a trace amount (<0.05%).

Table 3-56
Mean Cover (%) of Plant Taxa in 2009 at the Five Phreatophytic Shrubland Sites

Species	North Spring Valley	Middle Spring Valley	South Spring Valley	Hamlin Valley	Snake Valley
Achnatherum hymenoides	---	---	---	---	t
Artemisia tridentata	0.2	1.5	0.3	---	---
Atriplex canescens	---	---	---	---	0.2
Atriplex confertifolia	0.4	0.4	0.9	0.5	0.5
Bassia americana	---	---	---	---	0.4
Bassia scoparia	---	---	0.2	---	---
Chenopodium incanum	---	0.2	---	---	---
Chenopodium leptophyllum	0.1	---	---	---	---
Chenopodium sp.	---	---	t	---	---
Chrysothamnus viscidiflorus	0.1	t	---	---	---
Descurainia sophia	t	---	---	---	---
Distichlis spicata	0.1	0.1	1.6	---	---
Elymus elymoides	---	t	---	t	---
Ephedra viridis	---	---	---	---	t
Ericameria nauseosa	0.2	0.1	0.7	---	---
Grayia spinosa	t	t	---	0.8	---
Gutierrezia sarothrae	---	---	---	---	0.6
Halogeton glomeratus	1.4	---	---	0.2	---
Iva axillaris	---	0.1	---	---	---
Krascheninnikovia lanata	---	---	---	---	0.2
Machaeranthera carnosa	---	t	---	---	---
Picrothamnus desertorum	---	---	---	0.1	0.2
Poa secunda	t	---	---	---	---
Sarcobatus vermiculatus	17.8	11	12.9	11.4	15.4
Sphaeralcea coccinea	---	---	---	---	t
Sporobolus airoides	0	0.2	0.1	---	---
Suaeda calceoliformis	---	---	0.6	---	---
Suaeda moquinii	---	0.7	---	---	t
Tetradymia spinosa	0.1	t	---	---	0.3

A “t” indicates a trace amount (<0.05%).
Dashed lines (---) indicate that the taxa was not present at the site (cover = 0.0%).

highest value of the five shrubland sites (Table 3-54). Twelve species were encountered on the transects in 2009 and this was above average for the five sites.

Sarcobatus vermiculatus was the only species to occur on all five transects at this site and it was the major species on all five transects (Table 3-57). *Atriplex confertifolia* was the second-most frequent species, occurring on four transects, followed by *Artemisia tridentata* which occurred on three.

Table 3-57
Mean Percent Cover, Overall and by Species, of Vegetation along the Five North Spring Valley Phreatophytic Shrubland Transects in 2009

Species	Overall Mean	Transects				
		153	154	157	158	185
Artemisia tridentata	0.2	0	0.5	0.4	0.3	0
Atriplex confertifolia	0.4	t	1.2	0.5	0.1	0
Chenopodium leptophyllum	0.1	0	0	0	0	0.7
Chrysothamnus viscidiflorus	0.1	0	0	0.3	0	0
Descurainia sophia	t	0	t	0	0	0
Distichlis spicata	0.1	0.5	0	0	0	0
Ericameria nauseosa	0.2	0.6	0.5	0	0	0
Grayia spinosa	t	0	0	0.1	0	0
Halogeton glomeratus	1.4	0	0	0	0	7
Poa secunda	t	0	0	0	0.1	0
Sarcobatus vermiculatus	17.8	23.4	10.7	12.3	16.6	26.2
Tetradymia spinosa	0.1	0	0	0	0	0.3
Total	**20.4**	**24.5**	**12.9**	**13.6**	**17.1**	**34.2**
Number of Species	**12**	**4**	**5**	**5**	**4**	**4**

Transect means are averages by meter and overall mean is the average of the five transects.
A “t” indicates a trace amount (<0.05%).

Spatial heterogeneity was relatively minor along the North Spring Valley shrubland transects (Figure 3-43). *Sarcobatus vermiculatus* dominated the site, with the shrubs occurring as an open canopy along the transects. This was the dominant species on 399 m (80 percent) of the 500 m of the transects. Gaps in the greasewood canopy were filled by one of six other species or by bare ground.

3.8.3.2.2 Middle Spring Valley

Sarcobatus vermiculatus was the major species at the Middle Spring Valley sites, with a mean cover of 11 percent (Table 3-58). The second-most abundant species was *Artemisia tridentata*, with a mean cover of 2 percent, and *Suaeda moquinii* was the third-most abundant species, with a mean cover of 1 percent. Total overall cover averaged 14 percent and this was below average for the five shrubland sites (Table 3-54). Fourteen species were encountered on the transects in 2009 and this was the highest number for the five sites.

```
153   SAVE  ERNA  DISP ERNA            SAVE               BARE  SAVE  BARE  SAVE    SPECIES
     01-03 04-07 08-09  10  11----------------------------83 84-85 86-92 93-96 97-100   METERS
     M---M D---D M---M D--D M-----------------------------------------------------M    GRADIENT

154   BARE  SAVE    BARE    SAVE    BARE      SAVE     ATCO   BARE       SAVE        SPECIES
     01-03 04--07 08----13 14----19 20--23 24---------35 36--38 39-40 41------------54  METERS
     M--------------------------------------------------------------------------------M  GRADIENT

154   ATCO        SAVE        ERNA  ATCO   ARTR    SAVE   BARE   SAVE  BARE  ARTR  SAVE  SPECIES
     55-56 57-------------72 73-75 76--79 80-81 82-----88 89-91 92-93 94-96 97-98 99-100 METERS
     M--------------------M D---D M----M D---D M----------------------M D-----D M---M GRADIENT

157   BARE    SAVE    BARE  SAVE   BARE          SAVE      BARE         SAVE           SPECIES
     01-02 03-----09 10-11 12--15 16-17 18-------------32 33-34 35------------------54  METERS
     M--------------------------------------------------------------------------------M  GRADIENT

157   CHVI          SAVE            BARE  SAVE    BARE  SAVE     BARE    ARTR              SPECIES
     55-57 58------------------77 78-79 80---84 85-86 87--90 91-----97 98-100           METERS
     D---D M-----------------------------------------------------M D--------D           GRADIENT

158           SAVE          BARE        SAVE        BARE             SAVE               SPECIES
     01-----------------28 29-30 31-------------55 56-57 58--------------------------100 METERS
     M--------------------------------------------------------------------------------M  GRADIENT

185    SAVE    HAGL   SAVE    HAGL  SAVE  HAGL  SAVE  HAGL    SAVE     HAGL    SAVE     SPECIES
     01----13 14-17 18----30 31-35 36-39 40-43 44-45 46-49 50------71 72-76 77------100 METERS
     M--------------------------------------------------------------------------------M  GRADIENT
```

Species codes are: ARTR = *Artemisia tridentata*, ATCO = *Atriplex confertifolia*, BARE = bare ground, CHVI = *Chrysothamnus viscidiflorus*, DISP = *Distichlis spicata*, ERNA = *Ericameria nauseosa*, HAGL = *Halogeton glomeratus*, SAVE = *Sarcobatus vermiculatus*. Moisture gradient (GRADIENT) codes are: D = surface commonly dry; M = surface soil often saturated.

Figure 3-43
Spatial Heterogeneity (most abundant species by meter) along the Five Shrubland Transects (153-154, 157-158, 185) in North Spring Valley in 2009

Table 3-58
Mean Percent Cover, Overall and by Species, of Vegetation along the Five Middle Spring Valley Phreatophytic Shrubland Transects in 2009

Species	Overall Mean	Transects				
		151	152	155	156	184
Artemisia tridentata	1.5	6.4	0.5	0.4	0	0
Atriplex confertifolia	0.4	0	0.6	0.4	1.1	0
Chenopodium incanum	0.2	0.9	0	0	0	0
Chrysothamnus viscidiflorus	t	0	0	0.1	0	0
Distichlis spicata	0.1	0	0	0.7	t	t
Elymus elymoides	t	0	0	t	0	0
Ericameria nauseosa	0.1	0	0	0	0	0.5
Grayia spinosa	t	0.1	0	0	0	0
Iva axillaris	0.1	0	0	0	0	0.5
Machaeranthera carnosa	t	0	0	0	0.1	0
Sarcobatus vermiculatus	11	9.9	15.9	9.4	16.5	3.4
Sporobolus airoides	0.2	0	0	1	0	0
Suaeda moquinii	0.7	0	2.2	0	1.1	0
Tetradymia spinosa	t	0	0.2	0	0	0
Total	**14.3**	**17.3**	**19.4**	**12**	**18.8**	**4.4**
Number of Species	**14**	**4**	**5**	**7**	**5**	**4**

Transect means are averages by meter and overall mean is the average of the five transects.
A "t" indicates a trace amount (<0.05%).

Sarcobatus vermiculatus was the only species to occur on all five transects at this site and it was the major species on all five transects (Table 3-58). *Artemisia tridentata* was the second-most frequent species, occurring on three transects and being the second-most abundant species on one transect.

Spatial heterogeneity was moderate along the Middle Spring Valley shrubland transects (Figure 3-44). *Sarcobatus vermiculatus* was the most frequent dominant species, being dominant along 259 m (52 percent) of the 500 m of transects. Bare ground (including areas with litter but no live vegetation) was also frequent, with 152 (30 percent) of the 500 1-m units having no vegetation present. *Artemisia tridentata* was the second-most frequent dominant along the transects, being the dominant species on 9 of the 123 micro-community segments with a combined length of 36 m. *Atriplex confertifolia* was the third-most common dominant, being dominant on 6 of the segments with a combined length of 19 m.

```
151   SAVE  BARE SAVE  BARE  ARTR  CHIN SAVE  CHIN  SAVE  BARE  SAVE  BARE  ARTR        SPECIES
     01-06 07-13  14  15-17 18-19 20-21  22   23-26 27-31 32-33 34-36 37-41 42-48       METERS
     M------------------M D-----------D M--M D---D M-------------------M D------D       GRADIENT

151   SAVE  BARE  SAVE  ARTR  BARE  ARTR  BARE SAVE  BARE  ARTR  SAVE  ARTR  SAVE  BARE  SPECIES
     49-51 52-56 57-61 62-64 65-67 68-72 73-74  75   76-78 79-84 85-88 89-92 93-98 99-100 METERS
     M---------------M D------------------D M---------M D-----D M---M D---D M---------M  GRADIENT

152   BARE SAVE  ATCO  BARE   SAVE    BARE   ATCO   BARE   SAVE   SUMO  ARTR   SAVE     SPECIES
     01-03  04   05-07 08-10 11----18 19-21 22---26 27-28 29---34 35-37 38-39 40----51   METERS
     M---------------------------------------------------------M S---S D----D M-----M   GRADIENT

152   BARE  SAVE  BARE    SAVE    SUMO  SAVE  BARE  SAVE  BARE   SAVE   BARE   SAVE     SPECIES
     52-53 54-57 58-59 60-----71 72-73 74-76 77--81 82-84 85-86 87--91 92-93 94---100   METERS
     M-------------------------M S---S M-----------------------------------------M      GRADIENT

155   BARE  ATCO  SAVE  BARE  SAVE  BARE  SAVE  DISP  SAVE  BARE  DISP  ARTR  DISP      SPECIES
     01-03 04-06 07-20 21-22 23-24 25-31 32-33 34-35 36-37 38-39 40-41 42-46 47-48      METERS
     M-------------------------------------------------------------M D---D M----M      GRADIENT

155   ATCO  SAVE  BARE  SAVE  ATCO  DISP  ARTR  SPAI  BARE  SAVE  BARE  SAVE  SPAI      SPECIES
     49-51 52-55 56-58 59-61 62-64 65-66 67-68 69-70 71-72 73-82 83-85 86-97 98-100     METERS
     M---------------------------------M D---D M----------------------------------M     GRADIENT

156   SAVE   BARE   SAVE    BARE    SAVE    ATCO     SAVE      BARE    SAVE    BARE     SPECIES
       01   02--06 07----13 14--18 19----25 26-27 28--------38 39-40 41-----48 49--52   METERS
      M----------------------------------------------------------------------------M    GRADIENT

156       SAVE      SUMO   SAVE    BARE            SAVE           BARE   SAVE SUMO      SPECIES
     53--------62 63-65 66----71 72-73 74------------------93 94--97 98-99  100         METERS
     M----------M S---S M-----------------------------------------------M S----S        GRADIENT

184   SAVE  IVAX  ERNA  IVAX   BARE   SAVE  BARE   SAVE   BARE  SAVE  BARE SAVE  BARE   SPECIES
     01-02 03-04 05-06 07-10 11---18 19-20 21-22 23---30 31-32 33-35 36-40  41   42-46  METERS
     M---M S---S D---D S-------S M------------------------------------------------M    GRADIENT

184   SAVE  ERNA   BARE          SAVE          BARE  SAVE     BARE    SAVE      BARE    SPECIES
     47-49 50--53 54--57 58-------------72 73-74 75--78 79-----85 86-88 89----------100 METERS
     M---M D--------D M--------------------------------------------------------------M GRADIENT
```

Species codes are: ARTR = *Artemisia tridentata*, ATCO = *Atriplex confertifolia*, BARE = bare ground, DISP = *Distichlis spicata*, ERNA = *Ericameria nauseosa*, IVAX = *Iva axillaris*, SAVE = *Sarcobatus vermiculatus*, SPAI = *Sporobolus airoides*, SUMO = *Suaeda moquinii*. Moisture gradient (GRADIENT) codes are: D = surface commonly dry; M = surface soil often saturated; S = intermittently flooded, soil generally saturated.

Figure 3-44
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Shrubland Transects (151, 152, 155, 156, 184) in Middle Spring Valley in 2009

3.8.3.2.3 South Spring Valley

Sarcobatus vermiculatus was the major species on the South Spring Valley transects, with a mean cover of 13 percent (Table 3-58). The second-most abundant species was *Distichlis spicata*, with a mean cover of 2 percent, followed by *Atriplex confertifolia* with a mean cover of 1 percent. Total overall cover averaged 17 percent, which was average for the five shrubland sites (Table 3-54). Nine species were encountered on the transects in 2009 and this was below average for the five sites.

Sarcobatus vermiculatus and *Atriplex confertifolia* occurred on all five transects at this site (Table 3-58). *Sarcobatus vermiculatus* was the most abundant species on all five transects and *Artemisia tridentata*, *Atriplex confertifolia*, *Distichlis spicata*, *Ericameria nauseosa*, and *Suaeda calceoliformis* were the second-most abundant species on one transect each.

Spatial heterogeneity on the South Spring Valley transects was moderate in relation to number of micro-community segments but simple in relation to number of species (Figure 3-45). There were only six dominant species on these transects. *Sarcobatus vermiculatus* was the most frequent dominant, being the dominant on 47 of the 106 segments, with combined lengths of 306 m (61 percent) out of a total of 500 m along the five transects. *Distichlis spicata* was the second-most frequent dominant species, being dominant on 13 segments with a combined length of 50 m. A relatively large number of the segments (29) supported little or no vegetation and these bare segments had a combined length of 91 m (18 percent of the combined lengths of the transects).

3.8.3.2.4 Hamlin Valley

Sarcobatus vermiculatus was the major species on the Hamlin Valley transects, with a mean cover of 11 percent in 2009 (Table 3-59). The second-most abundant species was *Grayia spinosa*, with a mean cover of 1 percent, and the third-most abundant species was *Atriplex confertifolia*. Total overall cover averaged 13 percent and this was the lowest value for the five shrubland sites (Table 3-54). Six species occurred on the transects in 2009 and this was also the lowest species richness value for the five sites.

Sarcobatus vermiculatus and *Atriplex confertifolia* occurred on all five transects (Table 3-59). *Sarcobatus vermiculatus* was the major species on all five transects. *Atriplex confertifolia* was the second-most abundant species on four of the transects and *Grayia spinosa* was the second-most abundant species on one transect.

Spatial heterogeneity was relatively simple along the shrubland transects in Hamlin Valley (Figure 3-46). Only five species were dominant on the micro-community level and only two species, *Sarcobatus vermiculatu*s and *Atriplex confertifolia*, were dominants on four of the transects. Two transects (159 and 162) were dominated almost entirely by *Sarcobatus vermiculatus*, this species being dominant on 195 of the 200 m. The most spatial heterogeneity occurred on one transect (163). Of the 20 micro-community segments along this transect, 7 were dominated by *Sarcobatus vermiculatus*, 4 by *Grayia spinosa*, 3 by *Halogeton glomeratus*, 2 by *Picrothamnus desertorum*, and 4 were bare.

```
130  DISP  SAVE  DISP  SAVE  DISP  SAVE  ATCO  SAVE  DISP  ATCO  DISP  SAVE  DISP      SPECIES
    01-05 06-07 08-12 13-15 16-21 22-25 26-27 28-29 30-32 33-34 35-36 37-38 39-45      METERS
    M-------------------------------------------------------------------------M      GRADIENT

130  SAVE  DISP  SAVE  DISP  SAVE  DISP  SAVE  DISP  SAVE  ERNA  DISP  SAVE            SPECIES
    46-54 55-56 57-63 64-65 66-73 74-76 77-79 80-84 85-92 93-94 95-97 98-100           METERS
    M---------------------------------------------------M D---D M----------M           GRADIENT

136     SAVE         BARE        SAVE    BARE      SAVE      BARE  ATCO    SAVE    BARE  SPECIES
    01-------11 12---------24 25----30 31-33 34--------45 46-47 48-50 51-----57 58-59  METERS
    M----------------------------------------------------------------------------M     GRADIENT

136    SAVE      BARE SAVE  BARE     SAVE    BARE  SAVE  BARE  SAVE    BARE  SAVE  BARE  SPECIES
    60------68 69-70  71  72-73 74-----81 82-83 84-85 86-88 89---93 94-95 96--99  100  METERS
    M----------------------------------------------------------------------------M     GRADIENT

137      SAVE        DISP   SAVE  ERNA        SAVE        ATCO BARE SUCA  BARE  SAVE   SPECIES
    01----------12 13---17 18-20 21-23 24-------------39 40-41  42   43  44-45 46---50 METERS
    M--------------------------M D---D M------------------------M S--------S M-------M GRADIENT

137  ATCO   SAVE  SUCA SAVE  BARE     SAVE     SUCA   SAVE    BARE   SAVE   SUCA  SAVE SPECIES
    51--54 55-57 58-59  60  61--65 66------75 76-77 78----84 85-86 87---94 95-97 98-100 METERS
    M----------M S---S M--------------------M S---S M--------------------M S---S M---M GRADIENT

138  DISP     SAVE         BARE          SAVE      BARE        SAVE        BARE         SPECIES
    01-02 03---------13 14-------22 23----------34 35-36 37------------51 52-53        METERS
    M-------------------------------------------------------------------------M        GRADIENT

138     SAVE    ERNA    SAVE     BARE  SAVE      ERNA      BARE  SAVE  BARE  ERNA      SPECIES
    54------61 62-64 65------72 73-75 76--79 80--------89 90-91 92-94 95--98 99-100    METERS
    M--------M D---D M--------------------M D--------------D M---------M D-------D     GRADIENT

149   ARTR   BARE  ARTR    SAVE    BARE      SAVE     BARE        SAVE        BARE     SPECIES
    01---05 06-07 08-09 10-----16 17--20 21-------29 30--33 34-----------46 47---51    METERS
    D-----------------D M-----------------------------------------------------M        GRADIENT

149   SAVE    BARE  SAVE  BARE   SAVE    BARE   SAVE    BARE   ARTR   SAVE  BARE  SAVE SPECIES
    52----58 59-61 62-64 65-67 68----74 75-77 78----84 85-86 87---92 93-95 96-97 98-100 METERS
    M-----------------------------------------------------M D-------D M--------------M GRADIENT
```

Species codes are: ARTR = *Artemisia tridentata*, ATCO = *Atriplex confertifolia*, BARE = bare ground, DISP = *Distichlis spicata*, ERNA = *Ericameria nauseosa*, SAVE = *Sarcobatus vermiculatus*, SUCA = *Suaeda calceoliformis*. Moisture gradient (GRADIENT) codes: D = surface commonly dry, M = surface soil often saturated, S = intermittently flooded, soil generally saturated.

Figure 3-45
Spatial Heterogeneity (most abundant species by meter) along the Five Shrubland Transects (130, 136-138, 149) in South Spring Valley in 2009

3.8.3.2.5 Snake Valley

Sarcotabus vermiculatus was the major species at the Snake Valley shrubland sites, with a mean cover of 15 percent (Table 3-60). The next most abundant species were *Gutierrezia sarothrae* and *Atriplex confertifolia*, each with 1 percent mean cover. Total overall cover averaged 18 percent and this was above average for the five shrubland sites (Table 3-54). Thirteen species occurred on the transects in 2009 and this was also above average for the five sites.

Sarcobatus vermiculatus was the only species to occur on all five of these transects and it was the major species on all five (Table 3-60). *Atriplex confertifolia* was the second-most frequent species, occurring on four transects, and *Gutierrezia sarothrae* was third-most abundant, occurring on three transects.

Spatial heterogeneity on the shrubland transects in Snake Valley was moderate in relation to number of micro-community segments but simple in relation to number of dominant species (Figure 3-47). There were only five dominant species on these transects. *Sarcobatus vermiculatus* was the most

Table 3-59
Mean Percent Cover, Overall and by Species, of Vegetation along the Five South Spring Valley Phreatophytic Shrubland Transects in 2009

Species	Overall Mean	Transects				
		130	136	137	138	149
Artemisia tridentata	0.3	0	0	0	0	1.6
Atriplex confertifolia	0.9	0.6	1.3	2	0.2	0.5
Bassia scoparia	0.2	0	0	0.8	0.2	0
Chenopodium sp.	t	0	0	t	0	0
Distichlis spicata	1.6	5.4	0	1.8	1	0
Ericameria nauseosa	0.7	0.7	0	1	1.7	0
Sarcobatus vermiculatus	12.9	11.5	15.6	19.8	6.9	10.7
Sporobolus airoides	0.1	t	0	0.5	0	0
Suaeda calceoliformis	0.6	0	0	2.8	0	0
Total	**17.3**	**18.2**	**16.9**	**28.7**	**10**	**12.8**
Number of Species	**9**	**5**	**2**	**8**	**5**	**3**

Transect means are averages by meter and overall mean is the average of the five transects.
A "t" indicates a trace amount (<0.05%).

```
159                         SAVE                       BARE            SAVE              SPECIES
     01--------------------------------------------65 66-67 68----------------------100  METERS
     M-------------------------------------------------------------------------------M   GRADIENT

160    SAVE   ATCO    SAVE      BARE   SAVE      BARE       ATCO           BARE          SPECIES
     01---05 06-08 09------17 18---22 23--26 27-------36 37-----43 44-----------------61 METERS
     M--------------------------------------------------------------------------------M  GRADIENT

160   ATCO        BARE       SAVE  BARE  SAVE    ATCO     BARE  ATCO   SAVE              SPECIES
     62-63 64------------77 78-79 80-81 82-83 84------91 92-94 95--98 99-100             METERS
     M---------------------------------------------------------------------M             GRADIENT

161    SAVE   BARE      SAVE        BARE    SAVE  BARE         SAVE           BARE       SPECIES
     01---05 06-08 09---------19 20-----26 27-29 30--33 34-----------------51 52-53      METERS
     M---------------------------------------------------------------------------M       GRADIENT

161     SAVE     BARE  SAVE  ATCO  BARE   ATCO    BARE    SAVE    BARE         SAVE      SPECIES
     54------61 62-63 64-65 66-67 68-69 70---74 75----80 81-82 83------90 91--------100  METERS
     M-------------------------------------------------------------------------------M   GRADIENT

162                     SAVE                    BARE                SAVE                 SPECIES
     01--------------------------------------53 54--57 58---------------------------100  METERS
     M-------------------------------------------------------------------------------M   GRADIENT

163     SAVE       GRSP     SAVE  GRSP  SAVE   BARE GRSP  BARE    GRSP        SAVE       SPECIES
     01-----09 10-------21 22-23 24-25 26--29 30-31  32  33-34 35------42 43---------55  METERS
     M-------M D---------D M---M D---D M--------M D---------------------D M-----------M  GRADIENT

163   BARE PIDE   SAVE    HAGL   PIDE  BARE    HAGL    SAVE    HAGL      SAVE            SPECIES
     56-58  59  60----65 66--69 70-71 72--75 76---80 81----86 87--90 91-------100        METERS
     D--------D M------M D-------------------------D M------M D----D M----------M        GRADIENT
```

Species codes are: ATCO = *Atriplex confertifolia,* BARE = bare ground, GRSP = *Grayia spinosa*, HAGL = *Halogeton glomeratus*, PIDE = *Picrothamnus desertorum*, SAVE = *Sarcobatus vermiculatus*. Moisture gradient (GRADIENT) codes are: D = surface commonly dry, M = surface soil often saturated.

Figure 3-46
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Shrubland Transects (159-163) in Hamlin Valley in 2009

Table 3-60
Mean Percent Cover, Overall and by Species, of Vegetation along the Five Hamlin Valley Phreatophytic Shrubland Transects in 2009

Species	Overall Mean	Transects 159	160	161	162	163
Atriplex confertifolia	0.5	0.5	1.2	0.6	0.1	t
Elymus elymoides	t	0	0	0	0	t
Grayia spinosa	0.8	0	0	0	0	3.8
Halogeton glomeratus	0.2	t	0	0	0	0.8
Picrothamnus desertorum	0.1	0	0	0	0	0.3
Sarcobatus vermiculatus	11.4	16.5	3.1	5.5	23.9	8.2
Total	**13**	**17**	**4.3**	**6.1**	**24**	**13.1**
Number of Species	**6**	**3**	**2**	**2**	**2**	**6**

Transect means are averages by meter and overall mean is the average of the five transects.
A "t" indicates a trace amount (<0.05%).

```
 179   SAVE   BARE    SAVE   BARE                  SAVE                    HAGL    SAVE        SPECIES
      01--04 05--08 09---13 14-15 16------------------------------47 48-49 50-----56        METERS
      M------------------------------------------------------------M D---D M-------M        GRADIENT

 179   BARE  SAVE  BARE      SAVE       BARE          SAVE        BARE                      SPECIES
      57-59 60-61 62-63 64--------73 74------81 82-------------97 98-100                    METERS
      M----------------------------------------------------------------M                    GRADIENT

 180          SAVE          BAAM   SAVE      BARE      BAAM     SAVE        BARE            SPECIES
      01---------------17 18---22 23-35 36---------46 47-49 50-------58 59-------67         METERS
      M---------------------------------------------------------------------------M         GRADIENT

 180    SAVE    BAAM    BARE  SAVE  BARE ATCO  BARE   BAAM    BARE  SAVE  BAAM              SPECIES
      68---72 73---77 78-80 81-82 83-84  85   86-88 89---92 93-94 95-97 98-100              METERS
      M---------------------------------------------------------------------M               GRADIENT

 181   GUSA  SAVE  GUSA  BARE  ATCO  SAVE  BARE  GUSA  BARE  SAVE  BARE  SAVE  BARE         SPECIES
        01  02-04 05-07 08-13 14-15 16-27 28-30 31-36 37-38 39-43 44-46 47-50 51-52         METERS
      D---D M---M D------D M---------------M D---------D M------------------------M         GRADIENT

 181   SAVE    BARE    SAVE  BARE      SAVE      BARE           SAVE           GUSA BARE    SPECIES
      53-55 56-----62   63  64-65 66-------74 75-76 77-------------------96 97-99  100      METERS
      M------------------------------------------------------------------M D--------D       GRADIENT

 182      SAVE      GUSA  SAVE  GUSA  BARE   SAVE  BARE  SAVE   BARE  GUSA      SAVE        SPECIES
      01-------12 13-14 15-17 18-19 20--25 26-27 28-29 30-32 33---37  38   39----------53   METERS
      M---------M D---D M---M D-------D M----------------------M D-----D M------------M     GRADIENT

 182   BARE  SAVE  BARE  GUSA  ATCO GUSA  BARE  SAVE  BARE  ATCO  BARE  SAVE  BARE  SAVE    SPECIES
      54-60 61-62 63-64 65-67 68-69  70  71-75 76-80 81-83 84-85 86-88 89-94 95-96 97-100   METERS
      M------------M D------D M---M D------D M-----------------------------------------M    GRADIENT

 183    BARE   SAVE  BARE  SAVE     BARE    SAVE  BARE   SAVE   BARE         SAVE           SPECIES
      01---05 06-08 09--12  13  14-----20 21-22 23-26 27--30 31-32 33-------------47        METERS
      M---------------------------------------------------------------------------M         GRADIENT

  183   BARE  ATCA  BARE       SAVE      GUSA    SAVE    BARE          SAVE       GUSA     SPECIES
      48---52 53-54 55-56 57-----------69  70   71-----77 78-79 80-----------------99 100   METERS
     D---------------D M----------------M D---D M----------------------------------M D--D   GRADIENT
```

Species codes are: ATCA = *Atriplex canescens*, ATCO = *Atriplex confertifolia*, BAAM = *Bassia americana*, BARE = bare ground, GUSA = *Gutierrezia sarothrae*, HAGL = *Halogeton glomeratus*, SAVE = *Sarcobatus vermiculatus*. Moisture gradient (GRADIENT) codes are: D = surface commonly dry, M = surface soil often saturated.

Figure 3-47
Spatial Heterogeneity (Most Abundant Species by Meter) along the Five Shrubland Transects (179-183) in Snake Valley in 2009

frequent dominant, being the dominant on 38 of the 98 segments, with combined lengths of 300 m (60 percent) out of the total 500 m along the five transects. *Gutierrezia sarothrae* was the second-most frequent dominant, being dominant on 11 segments with a combined length of 24 m. A large number of the segments (38) supported little or no vegetation and these bare segments had a combined length of 146 m (29 percent of the combined lengths of the transects).

3.8.4 VFRM Juniper Woodland Transects

Both of the VFRM Juniper woodlands (Middle Spring Valley and South Spring Valley) extended over areas ranging from wetlands to relatively dry uplands. The locations of the VFRM Juniper belt transects were selected so as to include both 1) the spatial coverage of the respective woodland community across the landscape and 2) the surface/subsurface soil moisture conditions as reflected by the composition of the understory vegetation. The species composition of each belt transect and each line transect within the belt transects are presented in Appendix B, Table B-3 through Table B-32. The data from these tables are summarized in this subsection overall, by site, and by typical surface moisture conditions (relatively wet or relatively dry), using the composition of the understory vegetation to estimate typical moisture conditions.

Mean cover of *Juniperus scopulorum* was 47 percent in 2009, averaged over all 32 belt transects (Table 3-61). Mean cover was about equal between the two sites (46 percent in Middle Spring Valley and 48 percent in South Spring Valley) and VFRM Juniper cover was higher on the wetter sites than on the drier sites, especially at the South Spring Valley site (50 percent and 42 percent, respectively at the Middle Spring Valley site; 59 percent and 38 percent, respectively at the South Spring Valley site).

Table 3-61
Mean Percent Cover, Overall and by Species, of Vegetation along the Five Snake Valley Phreatophytic Shrubland Transects in 2009

Species	Overall Mean	Transects				
		179	180	181	182	183
Achnatherum hymenoides	t	0	0	0	0.2	t
Atriplex canescens	0.2	0.4	0	0	0	0.4
Atriplex confertifolia	0.5	0	0.4	0.9	0.8	0.5
Bassia americana	0.4	0.1	2.1	0	0	0
Ephedra viridis	t	0	0	0	t	0
Gutierrezia sarothrae	0.6	0	0	1.5	1.1	0.6
Halogeton glomeratus	0.1	0.2	0	0	0.1	t
Krascheninnikovia lanata	0.2	0	0	0.4	0	0.4
Picrothamnus desertorum	0.2	0	0	0	0.3	0.6
Sarcobatus vermiculatus	15.4	26.9	16.3	11.7	10.1	11.9
Sphaeralcea coccinea	t	0	0	0	0	t
Suaeda moquinii	t	0.2	0	0	0	0
Tetradymia spinosa	0.3	1.4	0.2	0	0	0
Total	**17.9**	**29.2**	**19**	**14.5**	**12.6**	**14.4**
Number of Species	**13**	**6**	**4**	**4**	**7**	**9**

Transect means are averages by meter and overall mean is the average of the five transects.
A "t" indicates a trace amount (<0.05 percent).

Cover of understory species (total cover - cover of *Juniperus scopulorum*; Table 3-61) averaged 18 percent overall, with a higher mean at the Middle Spring Valley site than at the South site (24 percent and 13 percent, respectively). Both sites had substantially lower cover of understory species on the drier sites than on the wetter sites (14 percent and 34 percent, respectively at the Middle site; 6 percent and 20 percent, respectively at the South site).

A total of 75 species occurred on the transects in 2009, with almost 60 percent (42 species) occurring only in trace amounts (less than 0.05 percent mean cover, averaged over all transects)(Table 3-61). *Juniperus scopulorum* was the dominant species, comprising 72 percent of the total mean cover averaged over all sites. The understory species with the highest mean cover values overall were *Sporobolus airoides* (2.6 percent), *Leymus triticoides* (3.0 percent), *Ericameria nauseosa* (2.0 percent), and *Distichlis spicata* (1.2 percent). *Leymus triticoides* (5.6 percent), *Sporobolus airoides* (3.1 percent), *Puccinellia lemmonii* (2.9 percent), *Ericameria nauseosa* (2.8 percent), *Distichlis spicata* (1.4 percent), and *Spartina gracilis* (1.1 percent) had the highest cover values among the understory species at the Middle site, and *Sporobolus airoides* (2.1 percent), *Carex praegracilis* (1.3 percent), *Artemisia tridentata* (1.2 percent), *Bassia scoparia* (1.2 percent), *Ericameria nauseosa* (1.2 percent), and *Poa pratensis* (1.1 percent) had the highest values at the South site (Table 3-61).

Leymus triticoides had the highest mean cover value (10 percent) of the understory species on the wetter transects at the Middle Spring Valley site, followed by *Puccinellia lemmonii* (4 percent) and *Distichlis spicata* (3 percent)(Table 3-61). *Sporobolus airoides* (4 percent) and *Ericameria nauseosa* (4 percent) had the highest understory values on the drier transects. At the South Spring Valley site, *Carex praegracilis* and *Bassia scoparia* had the highest cover (2 percent each) of the understory

species on the wetter transects and *Artemisia tridentata* (2 percent), *Ericameria nauseosa* (1 percent), and *Sporobolus airoides* (1 percent) had the highest values on the drier transects.

Cover and composition of the understory vegetation varied substantially among transects at both sites. The most frequent species on the wetter transects at the Middle Spring Valley site were *Equisetum arvense*, *Hymenoxys lemmonii*, *Leymus triticoides*, *Puccinellia lemmonii*, and *Spartina gracilis* (Table 3-62). Of these five species, the last three also had relatively high cover values. A total of 48 species occurred on the wetter transects, compared to 27 species on the drier transects (Table 3-62 and Table 3-63). The most frequent understory species on the drier transects were *Equisetum arvense*, *Ericameria nauseosa*, *Hymenoxys lemmonii*, *Leymus triticoides*, *Puccinellia lemmonii*, and *Sporobolus airoides*, of which only *Ericameria nauseosa* and *Sporobolus airoides* had the highest cover values (4 percent each) (Table 3-63).

A total of 46 species occurred on the wetter transects at the South site and 21 occurred on the drier transects (Table 3-64 and Table 3-65). The most frequent understory species on the wetter transects at the South site were *Juncus arcticus* and *Sporobolus airoides*, followed by *Equisetum arvense* and *Leymus triticoides* (Table 3-64). *Artemisia tridentata* and *Sporobolus airoides* were the most frequent understory species on the drier transects (Table 3-66).

Table 3-62
Mean Percent Cover of Vegetation on VFRM Juniper Belt Transects at the Two Sampled Sites (Middle and South) in 2009
(Page 1 of 2)

Species	Mean Overall Transects	Middle Overall Mean	Spring Wet Sites	Valley Dry Sites	South Overall Mean	Spring Wet Sites	Valley Dry Sites
Achillea millefolium	0.1	---	---	---	0.2	0.3	---
Achnatherum hymenoides	t	---	---	---	t	---	t
Agrostis gigantea	0.2	---	---	---	0.5	0.9	---
Aquilegia formosa	t	---	---	---	t	t	---
Argentina anserina	0.1	0.1	0.2	---	t	0.1	---
Artemisia tridentata	0.7	0.2	---	0.3	1.2	0.3	2.1
Astragalus convallarius	t	---	---	---	t	t	---
Astragalus sp.	t	0.1	0.1	t	---	---	---
Atriplex micrantha	t	t	t	---	t	0.1	---
Atriplex serenana	t	t	---	t	---	---	---
Atriplex truncata	t	0.1	0.2	0.1	t	t	---
Bassia scoparia	0.8	0.5	1	---	1.2	2.4	---
Bromus tectorum	t	t	t	---	---	---	---
Carex nebrascensis	0.1	t	t	---	0.1	0.2	---
Carex praegracilis	0.7	0.2	0.3	0.1	1.3	2.4	0.1
Carex simulata	t	t	t	---	---	---	---
Carex sp.	0.1	0.1	0.2	---	t	t	t
Caulanthus sp.	t	---	---	---	t	t	---
Centaurium exaltatum	t	t	t	---	---	---	---
Chenopodium sp.	t	t	t	---	t	t	---
Chrysothamnus viscidiflorus	t	---	---	---	t	---	---
Cirsium scariosum	0.4	0.6	0.7	0.4	0.3	0.5	---
Cirsium vulgare	t	---	---	---	0.1	0.1	---
Cleomella plocasperma	t	t	t	---	t	t	---
Comandra umbellata	t	t	---	t	---	---	---
Conyza canadensis	t	---	---	---	t	t	---
Cordylanthus ramosus	t	t	---	t	---	---	---
Crepis runcinata	0.1	0.3	0.6	---	---	---	---
Descurainia sophia	t	t	t	---	---	---	---
Distichlis spicata	1.2	1.4	2.5	0.3	0.9	1.7	0.2
Dodecatheon pulchellum	0.2	0.5	0.9	t	---	---	---
Elymus elymoides	t	t	---	t	---	---	---
Equisetum arvense	0.3	0.5	0.9	0.1	0.1	0.1	---
Ericameria nauseosa	2	2.8	1.4	4.2	1.2	1.4	1.1
Eriogonum cernuum	t	---	---	---	t	---	t
Gentianella amarella	t	t	0.1	---	---	---	---
Glaux maritima	t	t	t	---	---	---	---
Hordeum jubatum	t	t	---	t	t	---	t
Hymenopappus filifolius	t	t	t	---	---	---	---

Table 3-62
Mean Percent Cover of Vegetation on VFRM Juniper Belt Transects at the Two Sampled Sites (Middle and South) in 2009
(Page 2 of 2)

Species	Mean Overall Transects	Middle Overall Mean	Spring Wet Sites	Valley Dry Sites	South Overall Mean	Spring Wet Sites	Valley Dry Sites
Hymenoxys lemmonii	0.2	0.4	0.4	0.4	t	t	t
Ipomopsis aggregata	t	---	---	---	t	t	---
Iris missouriensis	t	0.1	0.1	---	t	t	---
Iva axillaris	t	t	t	---	---	---	---
Ivesia kingii	0.1	0.2	0.3	t	---	---	t
Juncus arcticus	0.3	0.4	0.7	0.1	0.3	0.5	0.1
Juniperus scopulorum	47	45.7	49.6	41.7	48.4	59.3	37.6
Lactuca serriola	t	t	t	---	---	---	---
Leymus cinereus	t	---	---	---	t	---	t
Leymus triticoides	3	5.6	10.3	0.8	0.3	0.7	t
Maianthemum racemosum	0.1	0.2	0.3	---	---	---	---
Medicago polymorpha	t	---	---	---	t	t	---
Melilotus officinalis	t	---	---	---	t	t	---
Muhlenbergia asperifolia	t	t	0.1	---	---	---	---
Muhlenbergia richardsonis	t	t	0.1	---	0.1	0.1	---
Musineon divaricatum	t	t	t	0.1	t	t	---
Nitrophila occidentalis	0.2	0.3	0.7	---	---	---	---
Phlox pulvinata	t	t	---	t	---	---	---
Poa pratensis	0.6	0.1	0.1	---	1.1	2.3	---
Poa secunda	0.3	0.4	0.4	0.4	0.1	0.2	t
Polygonum aviculare	t	---	---	---	t	t	---
Puccinellia lemmonii	1.6	2.9	4.4	1.5	0.2	0.4	0.1
Pyrrocoma lanceolata	0.4	0.7	1.3	0.2	t	0.1	t
Raillardella argentea	t	---	---	---	t	t	---
Rosa woodsii	0.2	0.1	0.2	---	0.4	0.8	---
Sarcobatus vermiculatus	0.5	0.5	0.8	0.3	0.4	0.2	0.6
Schedonorus pratensis	0.1	---	---	---	0.1	0.3	---
Sisyrinchium halophilum	0.1	0.1	0.2	---	---	---	---
Solidago nana	t	t	0.1	---	---	---	---
Spartina gracilis	0.7	1.1	2.2	0.1	0.2	0.3	0.1
Sporobolus airoides	2.6	3.1	2	4.2	2.1	3.1	1.2
Symphyotrichum eatonii	t	t	0.1	---	t	t	---
Symphyotrichum spathulatum	t	---	---	---	t	t	---
Taraxacum officinale	0.1	---	---	---	0.2	0.5	---
Trifolium repens	0.1	---	---	---	0.2	0.4	---
Triglochin maritima	t	t	t	---	---	---	---
Total	65.2	69.3	83.5	55.3	61.2	79.7	43.2

Table 3-63
Mean Percent Cover of Vegetation along the Wet-Site VFRM Juniper Transects in Middle Spring Valley in 2009
(Page 1 of 2)

Species	Overall Mean	Transects							
		098	104	105	107	108	110	111	112
Argentina anserina	0.2	---	1.8	---	---	---	---	0.1	---
Astragalus sp.	0.1	---	0.7	---	---	---	---	---	---
Atriplex micrantha	t	---	---	---	0.1	---	---	---	---
Atriplex truncata	0.2	---	---	---	1.5	0.2	---	---	---
Bassia scoparia	1	---	---	---	5.6	2.3	---	---	---
Bromus tectorum	t	---	---	---	0.3	---	---	---	---
Carex nebrascensis	t	---	t	---	---	---	---	---	---
Carex praegracilis	0.3	1.9	0.4	---	---	---	---	---	---
Carex simulata	t	---	---	---	---	---	---	t	---
Carex sp.	0.2	1.9	---	---	---	---	t	---	---
Centaurium exaltatum	t	---	---	---	---	---	---	0.1	---
Chenopodium sp.	t	---	---	---	---	---	t	---	---
Cirsium scariosum	0.7	---	0.2	---	---	0.6	1.6	3.2	---
Cleomella plocasperma	t	---	---	---	---	0.2	---	---	---
Crepis runcinata	0.6	0.8	0.2	0.1	---	0.5	2	1	---
Descurainia sophia	t	---	---	---	0.2	---	---	---	---
Distichlis spicata	2.5	6.3	0.7	---	0.4	1.5	10.8	---	---
Dodecatheon pulchellum	0.9	3	0.2	---	---	1.3	0.4	2.4	0.1
Equisetum arvense	0.9	0.2	2.2	0.1	0.3	0.5	0.3	3	0.3
Ericameria nauseosa	1.4	---	0.7	4.8	---	---	2.8	---	2.7
Gentianella amarella	0.1	---	0.6	---	---	---	---	---	---
Glaux maritima	t	---	t	---	---	---	---	---	---
Hymenopappus filifolius	t	---	---	0.1	---	---	---	---	---
Hymenoxys lemmonii	0.4	0.5	0.1	0.5	0.1	0.6	0.4	0.5	0.3
Iris missouriensis	0.1	0.8	---	0.3	---	---	---	---	---
Iva axillaris	t	---	---	---	---	---	---	0.2	---
Ivesia kingii	0.3	1.8	---	t	---	---	0.1	0.2	0.1
Juncus arcticus	0.7	2.1	0.2	0.1	0.5	0.1	t	2.7	---
Juniperus scopulorum	49.6	65.3	31.8	43.6	54.4	51.5	54.4	56.2	39.9
Lactuca serriola	t	---	---	---	---	0.1	---	---	---
Leymus triticoides	10.3	4.9	0.7	0.1	31.3	15.9	20.8	8.9	0.1
Maianthemum racemosum	0.3	2.7	---	---	---	---	---	---	---

Table 3-63
Mean Percent Cover of Vegetation along the Wet-Site VFRM Juniper Transects in Middle Spring Valley in 2009
(Page 2 of 2)

Species	Overall Mean	Transects							
		098	104	105	107	108	110	111	112
Muhlenbergia asperifolia	0.1	---	0.7	---	---	---	---	---	---
Muhlenbergia richardsonis	0.1	0.5	---	---	---	---	---	---	---
Musineon divaricatum	t	---	---	t	---	---	---	---	---
Nitrophila occidentalis	0.7	0.5	---	---	---	---	4.8	---	---
Poa pratensis	0.1	---	---	---	0.9	---	---	0.1	---
Poa secunda	0.4	---	1.2	0.2	1.3	---	0.5	---	---
Puccinellia lemmonii	4.4	8.3	5	1.3	0.9	3	5.2	1.2	10.2
Pyrrocoma lanceolata	1.3	6	0.8	0.5	---	0.1	0.1	2.7	0.3
Rosa woodsii	0.2	---	1.2	---	---	---	---	---	---
Sarcobatus vermiculatus	0.8	---	---	---	---	1.9	4	---	0.1
Sisyrinchium halophilum	0.2	t	1.4	t	---	---	---	---	---
Solidago nana	0.1	---	---	---	---	---	---	0.6	---
Spartina gracilis	2.2	1	6.2	---	0.9	4.7	0.3	4.1	0.1
Sporobolus airoides	2	---	---	2.8	---	10	---	---	2.9
Symphyotrichum eatonii	0.1	---	0.6	---	0.1	---	---	---	---
Triglochin maritima	t	0.1	---	---	---	---	---	---	---
Total	**83.5**	**108.6**	**57.6**	**54.5**	**98.8**	**95**	**108.5**	**87.2**	**57.1**
Number of Species	**48**	**20**	**24**	**16**	**16**	**18**	**19**	**18**	**12**

Belt transect means are averages of three 20-m line transects per belt transect and overall mean in the average of the belt transects.
Dashed lines (---) indicate zero values
A “t” indicates a trace amount (<0.05%).

Table 3-64
Mean Percent Cover of Vegetation along the Dry-Site VFRM Juniper Transects in Middle Spring Valley in 2009

Species	Overall Mean	Transects 99	100	101	102	103	106	109	113
Artemisia tridentata	0.3	0.1	---	---	---	---	---	---	2.7
Astragalus sp.	t	---	---	t	---	0.1	---	0.1	---
Atriplex serenana	t	0.1	---	---	---	---	---	---	---
Atriplex truncata	0.1	---	---	0.4	t	t	---	---	---
Carex praegracilis	0.1	---	---	---	---	---	---	---	0.9
Cirsium scariosum	0.4	---	---	---	2	0.3	0.4	0.5	0.2
Comandra umbellata	t	---	---	---	0.2	---	---	---	0.1
Cordylanthus ramosus	t	0.1	---	---	---	---	---	---	0.1
Distichlis spicata	0.3	1.6	---	---	---	0.1	0.2	---	0.7
Dodecatheon pulchellum	t	---	t	---	---	---	---	---	---
Elymus elymoides	t	0.1	---	---	---	---	---	---	---
Equisetum arvense	0.1	0.1	0.1	t	0.1	0.2	---	0.2	0.4
Ericameria nauseosa	4.2	8	4.5	3	5	1.3	9.3	0.8	1.8
Hordeum jubatum	t	---	---	---	---	0.2	t	---	0.1
Hymenoxys lemmonii	0.4	t	1.2	0.2	1.4	0.1	0.1	0.5	t
Ivesia kingii	t	---	---	0.1	---	t	---	0.1	---
Juncus arcticus	0.1	---	---	t	0.1	0.2	0.1	0.1	---
Juniperus scopulorum	41.7	38.9	43.2	37.9	49.7	48.7	28.3	54.8	31.8
Leymus triticoides	0.8	0.2	1.8	0.2	2	0.9	0.5	0.6	0.4
Musineon divaricatum	0.1	---	---	---	---	---	---	0.4	---
Phlox pulvinata	t	---	0.1	---	---	0.1	---	0.1	---
Poa secunda	0.4	---	0.1	1	1	0.6	---	0.6	---
Puccinellia lemmonii	1.5	---	1.7	0.1	3.5	2.7	1.8	0.6	1.3
Pyrrocoma lanceolata	0.2	---	0.3	0.1	0.5	0.1	---	0.1	0.1
Sarcobatus vermiculatus	0.3	0.1	---	---	---	0.6	1.6	---	---
Spartina gracilis	0.1	---	---	0.9	---	---	---	0.1	---
Sporobolus airoides	4.2	1.6	0.3	1.6	4.1	11	4.5	6.1	4.5
Total	**55.3**	**50.9**	**53.3**	**45.5**	**69.6**	**67.2**	**46.8**	**65.7**	**45.1**
Number of Species	**27**	**12**	**11**	**14**	**13**	**18**	**11**	**16**	**15**

Belt transect means are averages of three 20-m line transects per belt transect and overall mean in the average of the belt transects.
Dashed lines (---) indicate zero values
A “t” indicates a trace amount (<0.05%).

Table 3-65
Mean Percent Cover of Vegetation along the Wet-Site
(Page 1 of 2)

Species	Overall Mean	Transects							
		115	122	123	124	125	126	127	128
Achillea millefolium	0.3	2.3	---	---	---	---	0.2	---	t
Agrostis gigantea	0.9	0.3	---	---	---	---	7	---	---
Aquilegia formosa	t	---	---	---	---	---	t	---	---
Argentina anserina	0.1	0.6	---	---	---	---	---	---	---
Artemisia tridentata	0.3	---	---	2.1	---	0.1	---	---	---
Astragalus convallarius	t	---	---	---	---	---	---	0.2	---
Atriplex micrantha	0.1	---	---	---	---	---	0.5	t	---
Atriplex truncata	t	---	---	---	---	---	---	---	t
Bassia scoparia	2.4	---	---	---	---	1.8	---	17	---
Carex nebrascensis	0.2	1.5	---	---	---	---	0.4	---	---
Carex praegracilis	2.4	9.3	t	---	0.3	---	9.9	---	---
Carex sp.	t	---	0.1	---	---	---	---	---	---
Caulanthus sp.	t	---	---	---	---	---	---	---	0.1
Chenopodium sp.	t	---	---	---	---	0.1	0.1	---	---
Cirsium scariosum	0.5	0.4	---	---	---	0.1	3.7	---	---
Cirsium vulgare	0.1	---	---	---	---	---	1.1	---	---
Cleomella ploasperma	t	---	---	---	---	0.2	---	---	---
Conyza canadensis	t	---	---	---	---	----	0.1	---	---
Distichlis spicata	1.7	---	---	---	---	6.8	---	6.5	---
Equisetum arvense	0.1	---	---	0.1	0.2	0.1	0.2	t	0.2
Ericameria nauseosa	1.4	---	---	---	---	7.4	---	3.4	---
Hymenoxys lemmonii	t	---	---	---	---	---	---	---	0.2
Ipomopsis aggregata	t	---	---	---	---	---	---	---	t
Iris missouriensis	t	---	---	---	0.1	---	---	---	---
Juncus arcticus	0.5	2.5	0.1	0.6	0.1	---	0.2	0.3	0.4
Juniperus scopulorum	59.3	54.1	56.6	52.6	77.2	58.5	86.7	34.7	53.9
Leymus triticoides	0.7	---	0.2	1.2	0.7	1.5	---	0.8	0.8
Medicago polymorpha	t	---	---	---	---	---	t	---	---
Melilotus officinalis	t	---	---	---	---	---	0.2	---	---
Muhlenbergia richardsonis	0.1	---	0.1	---	0.8	---	---	---	---
Musineon divaricatum	t	---	---	---	---	---	---	---	0.1
Poa pratensis	2.3	12.8	t	---	---	---	5.4	---	---
Poa secunda	0.2	---	t	---	---	---	t	---	1.3

Table 3-65
Mean Percent Cover of Vegetation along the Wet-Site
(Page 2 of 2)

Species	Overall Mean	Transects							
		115	122	123	124	125	126	127	128
Polygonum aviculare	t	---	---	---	---	---	0.1	---	---
Puccinellia lemmonii	0.4	---	0.1	0.1	---	---	---	0.1	2.9
Pyrrocoma lanceolata	0.1	0.3	---	---	---	---	---	---	0.4
Raillardella argentea	t	---	---	---	---	---	---	---	0.1
Rosa woodsii	0.8	---	---	---	---	---	6.5	---	---
Sarcobatus vermiculatus	0.2	---	---	---	---	1	---	0.7	---
Schedonorus pratensis	0.3	---	---	---	---	---	2	---	---
Spartina gracilis	0.3	---	---	---	---	---	---	1	1.4
Sporobolus airoides	3.1	---	1.8	6.6	1.3	5.4	---	8	1.5
Symphyotrichum eatonii	t	---	---	---	---	---	---	---	t
Symphyotrichum spathulatum	t	---	---	---	---	---	t	---	---
Taraxacum officinale	0.5	0.9	---	---	---	---	2.8	---	0.1
Trifolium repens	0.4	3.3	---	---	---	---	t	---	---
Total	**79.7**	**88.3**	**59**	**63.3**	**80.7**	**83**	**127.1**	**72.7**	**63.4**
Number of Species	**46**	**12**	**10**	**7**	**8**	**12**	**23**	**13**	**18**

Belt transect means are averages of three 20-m line transects per belt transect and overall mean in the average of the belt transects.
Dashed lines (---) indicate zero values
A “t” indicates a trace amount (<0.05%).

Table 3-66
Mean Percent Cover of Vegetation along the Dry-Site VFRM Juniper Transects in South Spring Valley in 2009

Species	Overall Mean	Transects							
		114	116	117	118	119	120	120	129
Achnatherum hymenoides	t	0.1	t	---	---	---	---	---	---
Artemisia tridentata	2.1	---	5.9	0.2	7.2	0.9	2.8	---	0.1
Carex praegracilis	0.1	---	---	---	---	---	0.1	---	0.4
Carex sp.	t	---	---	---	---	---	---	t	---
Chrysothamnus viscidiflorus	t	---	0.3	---	---	---	---	---	---
Distichlis spicata	0.2	---	---	0.3	0.7	---	0.2	---	0.2
Ericameria nauseosa	1.1	---	0.1	2.6	---	1	5.2	---	t
Eriogonum cernuum	t	---	0.1	---	---	---	---	---	---
Hordeum jubatum	t	---	---	t	0.1	---	t	---	---
Hymenoxys lemmonii	t	---	---	---	---	---	---	---	t
Ivesia kingii	t	---	---	---	---	---	---	---	t
Juncus arcticus	0.1	---	---	---	---	0.1	---	---	0.4
Juniperus scopulorum	37.6	51.6	40.4	52.1	34.6	30.5	25.9	45	20.5
Leymus cinereus	t	0.3	---	---	---	---	---	---	---
Leymus triticoides	t	---	---	t	---	---	---	---	0.1
Poa secunda	t	---	---	---	---	---	---	0.2	---
Puccinellia lemmonii	0.1	---	---	---	---	---	0.4	---	---
Pyrrocoma lanceolata	t	---	---	---	---	---	---	---	t
Sarcobatus vermiculatus	0.6	---	0.6	---	3.6	---	0.7	0.2	---
Spartina gracilis	0.1	---	---	0.1	---	---	0.1	0.3	---
Sporobolus airoides	1.2	1.1	---	0.1	2.2	0.2	2	2.3	1.4
Total	**43.2**	**53.1**	**47.4**	**55.4**	**48.4**	**32.7**	**37.4**	**48**	**23.1**
Number of Species	**21**	**4**	**7**	**8**	**6**	**5**	**10**	**6**	**11**

Belt transect means are averages of three 20-m line transects per belt transect and overall mean in the average of the belt transects.
Dashed lines (---) indicate zero values
A “t” indicates a trace amount (<0.05%).

3.9 Valley Floor Rocky Mountain Juniper (*Juniperus scopulorum*) (VFRM Juniper)

3.9.1 Tree Counts and Sizes

Tree count and size data were collected at 32 VFRM Juniper transects in the north and south Spring Valley populations during August 2009. The data are summarized in Table 3-49. At this time, only general observations about variation between transects and populations can be made. Juvenile tree counts per transect ranged from 0 to 649, with a mean juvenile tree count across all transects of 58. The data suggest recent seedling establishment has been stronger in the south population (north population, mean juvenile tree count = 26; south population, mean = 82). Mature tree counts per transect ranged from 2 to 95, with a mean mature tree count across all transects of 12 (north population, mean = 11; south population, mean = 12). Juvenile tree height did not vary greatly across populations (north population, mean = 18 cm; south population, mean = 15 cm), with a mean juvenile tree height across all transects of 17 cm. The mean mature tree height across all transects was 507 cm (north population, mean = 546 cm; south population, mean = 450 cm), and the mean mature tree circumference across all transects was 102 cm (north population, mean = 94 cm; south population, mean = 113 cm).

The intent of collecting VFRM Juniper tree measurements is to monitor growth and reproduction. Because height and circumference for mature trees greater than about 700 cm in height was difficult to measure for some trees, future analyses should take into account that some error is expected in those measurements. This first year of data provides a baseline to compare future changes in tree counts and sizes across the two populations.

3.9.2 Stem Elongation

Baseline stem lengths were recorded for tagged VFRM Juniper trees in August 2009 (four trees per transect, 10 branches per tree). These data are available in the final data set. Stem lengths of the tagged trees will be recorded in future years to track stem elongation and monitor growth. Growth data will be available starting in 2010.

3.10 Site Assessments

Qualitative site assessments were conducted at all spring, creek and pond sites during fall (September) 2009. Overall disturbance ratings and presence/absence of diversion, ungulate and recreational disturbances are shown in Table 3-51. Most sites were slightly (11 of 21) or moderately (8) disturbed, and almost all sites were disturbed by ungulate use (20 of 21).

3.11 Fixed Station Photography

Photographs taken in 2009 are available upon request. Examples are provided in Appendix G to demonstrate the different types of habitat captured on camera, and the ability of photographs to qualitatively show change across seasons and years.

3.12 Pahrump Poolfish

On July 23, 2009, fish were captured, measured, and marked at the Shoshone South, Middle, North, and Stock Ponds using minnow traps (NDOW, 2009). On July 30, 2009, fish were again captured at these four ponds, and all marked and unmarked fish were counted. Using the mark-recapture data, the following population estimates were derived for Pahrump poolfish: Stock Pond: 3,695, North Pond: 246, and Middle Pond: 260. In the South Pond, the population estimate for relict dace was 547. NDOW's complete field trip report for this survey effort is attached as Appendix H.

4.0 ANTICIPATED BIOLOGICAL MONITORING PLAN-RELATED ACTIVITIES IN 2010

SNWA-anticipated Biological Monitoring Plan activities in 2010 are summarized below. Some activities are contingent upon access to private land.

- Finish development of a Relational Database Management System.
- Make available a schedule of field activities to the BWG and State participants to allow interested parties to participate in field activities.
- Conduct spring, summer, and fall monitoring as required by the *Plan.*
- Conduct aquatic monitoring in spring and fall 2010.
- Conduct vegetation monitoring in summer 2010.
- Conduct Big Springs Creek/Lake Creek monitoring in fall 2010.
- Further explore rapid prototype modelling.
- Continue development of statistical protocols.
- Implement changes to the Plan as agreed upon by the BWG during the annual meeting on January 11 and 12, 2010.
    - Collect springsnail presence/absence data instead of abundance and distribution data at Unnamed 5 Spring, springheads A-D of Stonehouse Complex, and springheads A2-A4 and C2-C4 of Stateline Springs, where there is no linear springsnail extent. Continue to count springsnails along transects at springhead E of Stonehouse Complex and springheads A1 and C1 of Stateline Springs, where linear springsnail extents occur.
    - Evaluate appropriateness of the intensity of the springsnail sampling effort after collecting springsnail data at the 2009 intensity level.
    - Reduce number of fixed station photographs to increase efficiency while maintaining the ability to meet goals.
    - Collect northern leopard frog breeding habitat data (percent emergence vegetation/open water) within a 1-m area of each egg mass at the time of the first observation (instead of

along a line transect at the end of the breeding season) to better capture habitat conditions at the time of breeding.

- Record presence/absence of standing water instead of producing physical habitat maps where there are no clear boundaries for pool and channel polygon delineations, including the northern portion of the Stonehouse monitoring site. Channel E (where a linear springsnail extent occurs) and the southern pond will continue to be mapped, as the aquatic boundaries are mappable.

- Collect turbidity data only at water-quality springhead, midpoint, and endpoint locations, eliminating the collection of samples at springsnail transects due to shallow water and dense vegetation.

- Evaluate the use of an acoustic Doppler velocity meter for measurements in shallow water systems.

- Anchor temperature loggers differently to improve the probability of logger retrieval.

- Discontinue the classification of vegetation transects as aquatic or wetland/meadow to better allow data analysis and interpretation for those transects that cross ecotones.

- Designate vegetation species as typically emergent or submergent to use for analysis purposes. Discontinue line-intercept data collection of emergent and submergent variables during vegetation cover and composition field surveys.

- Add a sixth reach on Big Springs Creek/Lake Creek between Reaches 1 and 2, as requested by NDOW. Evaluate effectiveness of reach locations and determine if Reaches 2 or 3 should be permanently replaced by Reach 6.

- Continue to stratify macroinvertebrate sampling locations across habitat types as determined by the physical habitat mapping, but replace digital, random generation of points with spatial and ecological stratification of points within polygon areas by biologists in the field.

- Tag VFRM juniper trees to follow height and circumference measurements through time. Collect size measurements on up to 25 trees per size class per belt transect, avoiding mature trees that exceed 800 cm if possible. Continue to collect height data every year, but reduce circumference data collection to once every five years.

5.0 REFERENCES

Biological Work Group, 2009, Biological Monitoring Plan for the Spring Valley Stipulation. February 2009.

BIO-WEST, 2007, Ecological Evaluation of Selected Aquatic Ecosystems in the Biological Resources Study Area for the Southern Nevada Water Authority's Proposed Clark, Lincoln, and White Pine Counties Groundwater Development Project. Final Report. Volume 1.

BIO-WEST, 2009, Ecological Evaluation of Selected Springs within Spring Valley and Southern Snake Valley, Nevada and Utah. Final Report.

Brown, D., 1954, Methods of Surveying and Measuring Vegetation. Commonwealth Agricultural Bureau of Pastures and Field Crops Bulletin 42. Farnham Royal, England.

Nevada Department of Wildlife, 2009, Field Trip Report for Shoshone Ponds, July 2009.

Nevada State Engineer (The Office of the State Engineer of The State of Nevada), 2007, The ruling (#5726) in the matter of applications 54003 through 54021, inclusive, filed to appropriate the underground waters of the Spring Valley hydrographic basin (184), White Pine County, Nevada.

Sada, D.W., and Pohlmann K.F., 2006, U.S. National Park Service Mojave Inventory and Monitoring Network Spring Survey Protocols: Level I and Level II. Desert Research Institute, Nevada, USA. Final draft.

SNWA, see Southern Nevada Water Authority.

Southern Nevada Water Authority, 2009, Clark, Lincoln, and White Pine Counties Groundwater Development Project: 2008 Wildlife Surveys. Final Report August 2009.

Southern Nevada Water Authority, 2009, Spring Valley hydrologic monitoring and mitigation plan (Hydrographic Area 184): Southern Nevada Water Authority, Las Vegas, Nevada, Doc. No. WRD-ED-0003, 38 p.

USDA-FSA, see USDA Farm Service Agency.

USDA-FSA, 2006, National Agriculture Imagery Program (NAIP) 1-meter Aerial Imagery.

This Page Left Intentionally Blank

Appendix A

Greasewood Transect and Monitoring Well Proximity

Table A-1
Proximity of Greasewood Transects to Existing or Planned Spring Valley Stipulation Hydrologic Monitoring Program Monitoring Wells (Spring Site Piezometers and Basin Fill Wells) and SNWA ET Research Monitoring Wells
(Page 1 of 2)

IBMA Zone	Transect	Distance to Well (miles)	Well Type	Stipulation Monitoring Well	Station number (common site name)	Monitoring Frequency	Well Depth (ft bgs)[a]	DTW (ft bgs)[a]
Spring Valley North	153	<0.5	Piezometer	X	Willow	Continuous	<50	
Spring Valley North	154	<0.5	Piezometer	X	Willow	Continuous	<50	
Spring Valley North	157	<3	Piezometer	X	Stonehouse	Continuous	<50	
Spring Valley North	158	<0.75	Piezometer	X	Stonehouse	Continuous	<50	
Spring Valley North	185	<2	Piezometer	X	Willow	Continuous	<50	
Spring ValleyMid.	151	<0.75	Basin fill well[b]		184 N17 E67 06BD2 SV2b (SV2b)	Continuous		5
		<4	Piezometer	X	West Spring Valley	Continuous	<50	
Spring ValleyMid.	152	<2	Basin fill well[b]		184 N19 E66 13DC4 SV3b (SV3)	Continuous		18
		<3	Basin fill well	X	184 N19 E66 11B 1 (393211114320701)	Quarterly	400	42
		<3	Piezometer	X	Keegan	Continuous	<50	
Spring ValleyMid.	155	<0.25	Piezometer	X	Unnamed 5	Continuous	<50	
Spring ValleyMid.	156	<3	Piezometer	X	Unnamed 5	Continuous	<50	
Spring ValleyMid.	184	<3	Piezometer	X	West Spring Valley	Continuous	<50	
		<4	Piezometer	X	South Millick	Continuous	<50	
Spring Valley S	130	<2	Basin fill well	X	184 N13 E67 33DDA 1 (385636114265501)	Quarterly	6	5
Spring Valley S	136	<2	Basin fill well[b]		184 N11 E67 32AD3 SV1 (SV1)	Continuous		16
		<2	Piezometer	X	Blind	Continuous	<50	
		<4	Basin fill well	X	184 N11 E68 19DCDC1 (384745114224401 USGS-MX)	Continuous	200	96
Spring Valley S	137	<0.25	Piezometer	X	Blind	Continuous	<50	
		<3	Piezometer	X	Minerva	Continuous	<50	
		<4	Basin fill well	X	184 N15 E67 26 CD 2 (SPR7008M)	Continuous	946	14
Spring Valley S	138	<0.25	Piezometer	X	Blind	Continuous	<50	
		<3	Piezometer	X	Minerva	Continuous	<50	
		<4	Basin fill well	X	184 N15 E67 26 CD 2 (SPR7008M)	Continuous	946	14

Table A-1
Proximity of Greasewood Transects to Existing or Planned Spring Valley Stipulation Hydrologic Monitoring Program Monitoring Wells (Spring Site Piezometers and Basin Fill Wells) and SNWA ET Research Monitoring Wells
(Page 2 of 2)

IBMA Zone	Transect	Distance to Well (miles)	Well Type	Stipulation Monitoring Well	Station number (common site name)	Monitoring Frequency	Well Depth (ft bgs)[a]	DTW (ft bgs)[a]
Spring Valley South	149	<3	Basin fill well	X	184 N14 E66 24BDDD1 (390352114305401 USGS-MX)	Continuous	160	40
Hamlin Valley North	159	<0.5	Basin fill well	X	196 N08 E69 15B 1 (383325114134901, Hyde)	Quarterly	110	71
Hamlin Valley North	160	<0.5	Basin fill well	X	196 N08 E70 06B 1 (383533114102901 USBLM - Monument)	Quarterly	164	90
Hamlin Valley North	161	<4	Basin fill well	X	196 N08 E70 06B 1 (383533114102901 USBLM - Monument)	Quarterly	164	90
Hamlin Valley North	162	<5	Basin fill well	X	196 N08 E70 06B 1 (383533114102901 USBLM - Monument)	Quarterly	164	90
Hamlin Valley North	163	<5	Basin fill well	X	196 N08 E70 06B 1 (383533114102901 USBLM - Monument)	Quarterly	164	90
		<4	Basin fill well[b]		195 N10 E70 35AD3 SNV1 (SNV1)	Continuous		19
Snake Valley South	179	<3	Basin fill well[b]		195 N10 E70 35AD3 SNV1 (SNV1)	Continuous		19
		<3	Basin fill well	X	196 N95 E70 32 AAD 1 (HAM1006M)	Continuous		
Snake Valley South	180	<1	Basin fill well[b]		195 N10 E70 35AD3 SNV1	Continuous		19
		<3	Basin fill well	X	196 N95 E70 32 AAD 1 (HAM1006M)	Continuous		
Snake Valley South	181	>5	Basin fill wells	X				
Snake Valley South	182	>5	Basin fill wells	X				
Snake Valley South	183	>5	Basin fill wells	X				

Appendix B

Maps and Associated Data for Aquatic Sites (Springs, Ponds, and Creek Reaches)

B.1.0 INTRODUCTION

Physical habitat polygons and water quality sample points (springhead, midpoint, endpoint) are shown for spring and fall 2009, with fixed photography stations and permanent vegetation transects overlaid on both seasonal maps. Underlying imagery is NAIP 1-meter Aerial Imagery (USDA-FSA, 2006). Exact locations of northern leopard frog presence surveys, egg masses and breeding habitat transects; relict dace traps; Pahrump poolfish surveys; and springsnail transects are not depicted due to the sensitive nature of the biological data. Areal calculations were made from digitized physical habitat map polygons in ArcMap 9.3.1 (ESRI).

Table B-1
Mapped Area at Creek Reaches Summarized by Physical Habitat Type

Site	HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Big Spring/Lake Creek Reach #1	Channel	0.2 - 1	>0.5	<30	458
Big Spring/Lake Creek Reach #2	Channel	0.2 - 1	0.1 - 0.5	<30	249
Big Spring/Lake Creek Reach #3	Channel	0.2 - 1	0.1 - 0.5	<30	245
Big Spring/Lake Creek Reach #4	Channel	0.2 - 1	>0.5	<30	354
Big Spring/Lake Creek Reach #5	Channel	0.2 - 1	0.1 - 0.5	<30	204

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

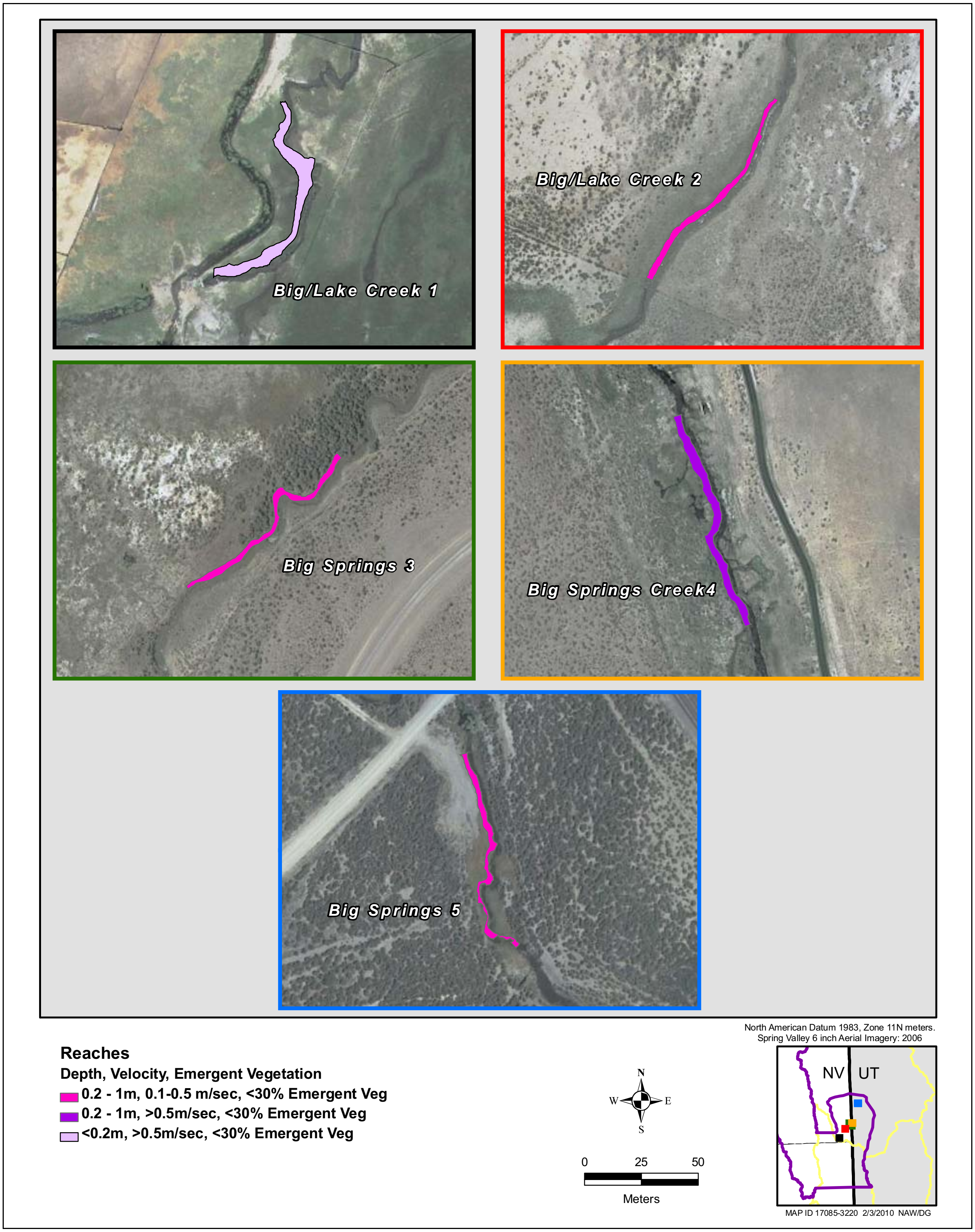


Figure B-1
Big Springs/Lake Creek Reaches #1-5 Physical Habitat Maps for Fall 2009

Table B-2
Spring Season Mapped Area at Big Springs Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	0.2 - 1	0.1 - 0.5	EmVeg	322
Channel	<0.2	0.1 - 0.5	EmVeg	88
			Total Channels	**410**
			Total Pools	**0**
			Total Aquatic Mapped Area	**410**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-3
Fall Season Mapped Area at Big Springs Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	0.2 - 1	0.1 - 0.5	<30	152
Channel	<0.2	0.1 - 0.5	>90	69
Channel	<0.2	0.1 - 0.5	30 - 90	82
			Total Channels	**303**
			Total Pools	**---**
			Total Aquatic Mapped Area	**303**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.
Mapping in the fall season did not extend as far downstream as the mapping in the spring season due to site conditions that made that portion of the site inaccessible. Hence, differences in area measurements from spring to fall are not a result of actual differences in the physical habitat.

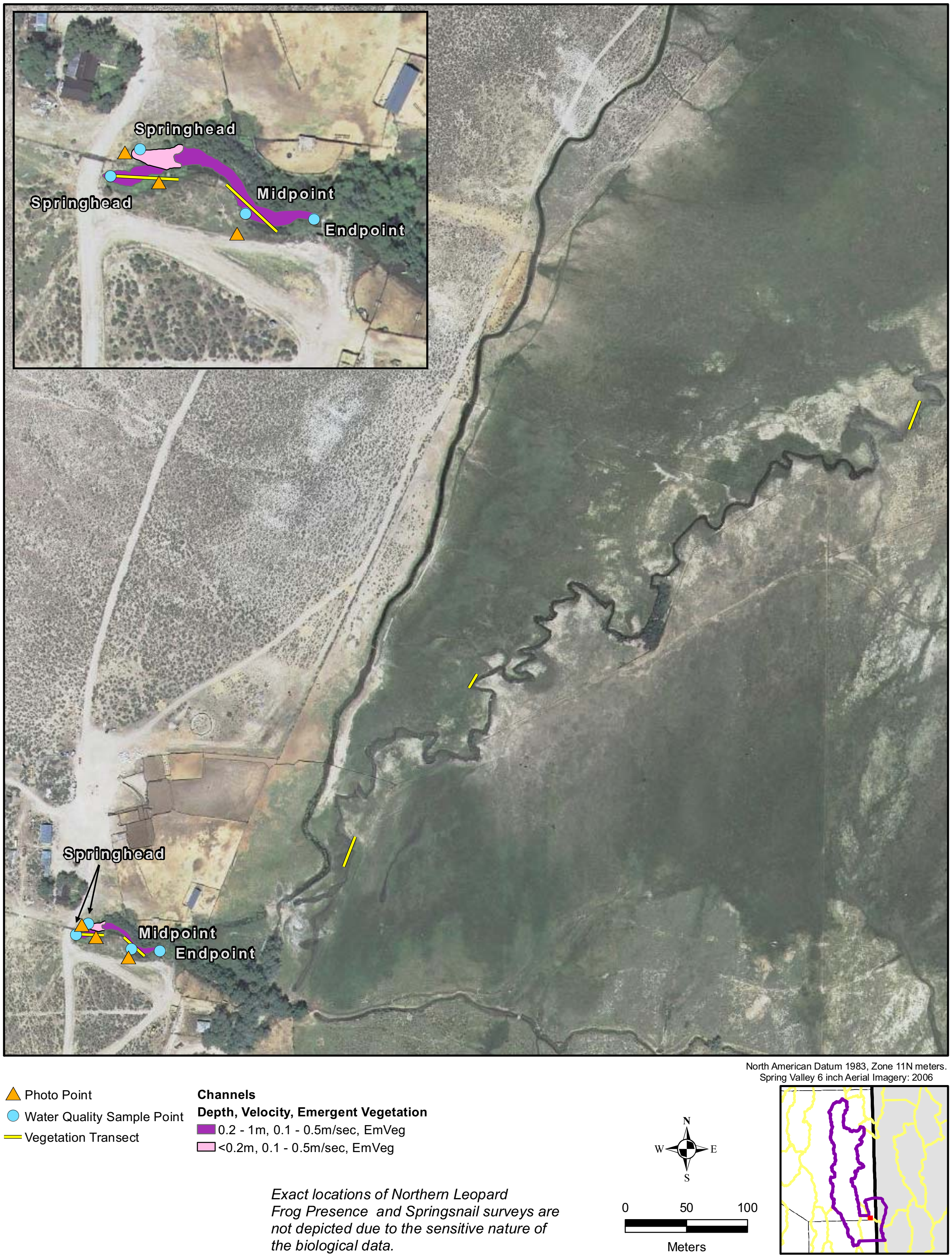


Figure B-2
Big Spring Physical Habitat Map for Spring 2009

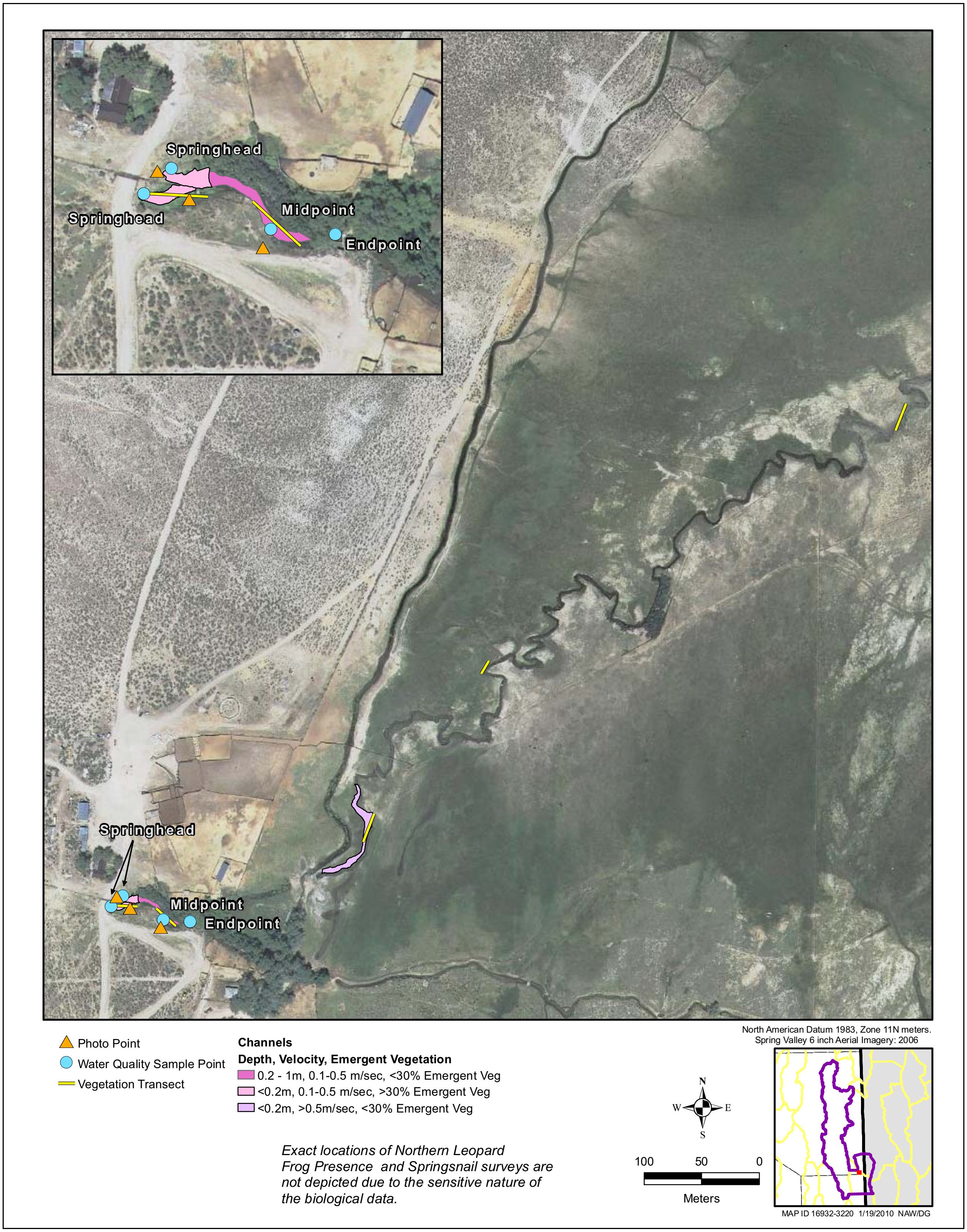


Figure B-3
Big Spring Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-4
Spring Season Mapped Area at Four Wheel Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	<0.1	EmVeg	40
Pool	0.2 - 1	<0.1	EmVeg	66
Pool	<0.2	<0.1	EmVeg	113
			Total Channels	**40**
			Total Pools	**179**
			Total Aquatic Mapped Area	**219**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-5
Fall Season Mapped Area at Four Wheel Drive Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Pool	<0.2	<0.01	>90	140
Channel	<0.2	N/A	>90	101
			Total Channels	**101**
			Total Pools	**140**
			Total Aquatic Mapped Area	**241**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.
Springbook length was 32 m. Springbrook length is only measured for springs where the entire aquatic system is mapped.

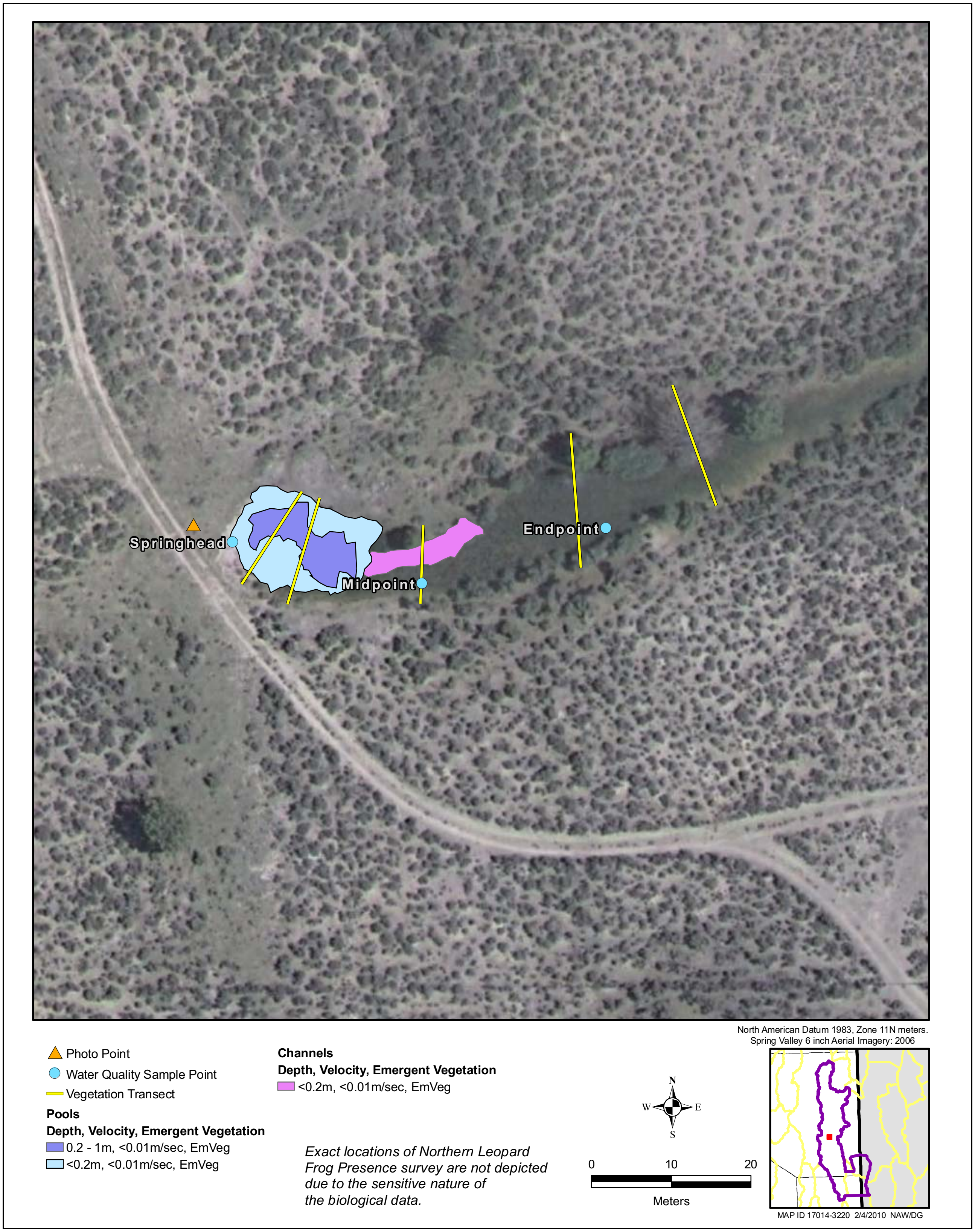


Figure B-4
Four Wheel Drive Physical Habitat Map for Spring 2009

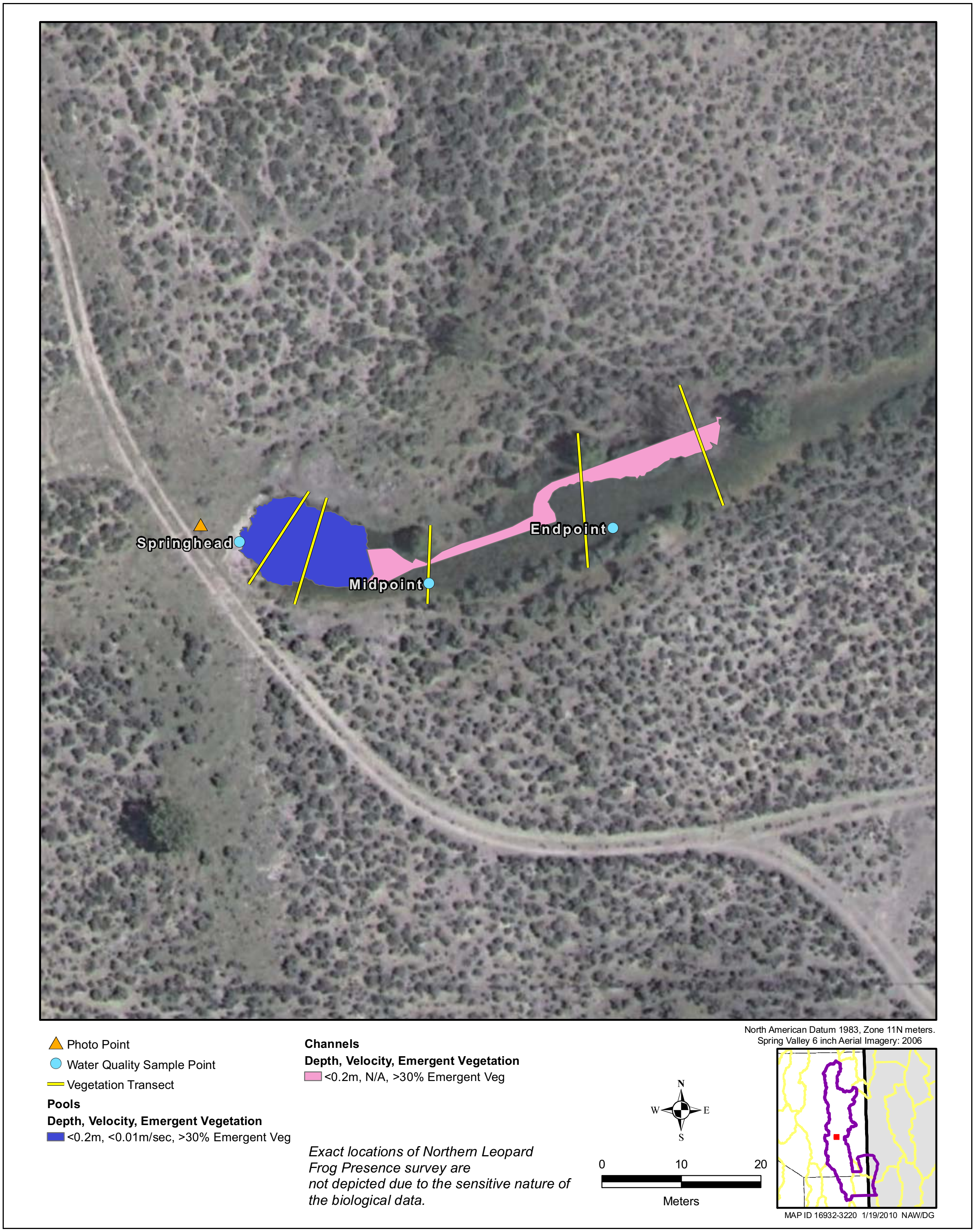


Figure B-5
Four Wheel Drive Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-6
Spring Season Mapped Area at Keegan Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	0.2 - 1m	>0.5m/sec	NoEmVeg	4
Channel	<0.2m	0.1 - 0.5m/sec	NoEmVeg	502
Channel	<0.2m	0.01 - 0.1m/sec	EmVeg	154
Channel	0.2 - 1m	0.01 - 0.1m/sec	EmVeg	32
Channel	<0.2m	<0.01m/sec	EmVeg	172
Channel	<0.2m	0.1 - 0.5m/sec	EmVeg	1,736
Pool	<0.2m	<0.01m/sec	EmVeg	7,207
Pool	0.2-1m	<0.01m/sec	EmVeg	335
Pool	>1m	<0.01m/sec	NoEmVeg	63
Pool	0.2 - 1	<0.01/msec	NoEmVeg	1,979
			Total Channels	**2,600**
			Total Pools	**9,584**
			Total Aquatic Mapped Area	**12,184**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-7
Fall Season Mapped Area at Keegan Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	<0.2	0.01 - 0.1	>90	759
Channel	<0.2	0.01 - 0.1	30 - 90	142
Channel	<0.2	0.01 - 0.1	<30	46
Channel	<0.2	0.1 - 0.5	<30	857
Pool	>1	<0.01	<30	1,167
Pool	0.2 - 1	<0.01	>90	7,411
Pool	0.2 - 1	<0.01	<30	97
			Total Channels	**1,804**
			Total Pools	**8,675**
			Total Aquatic Mapped Area	**10,479**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

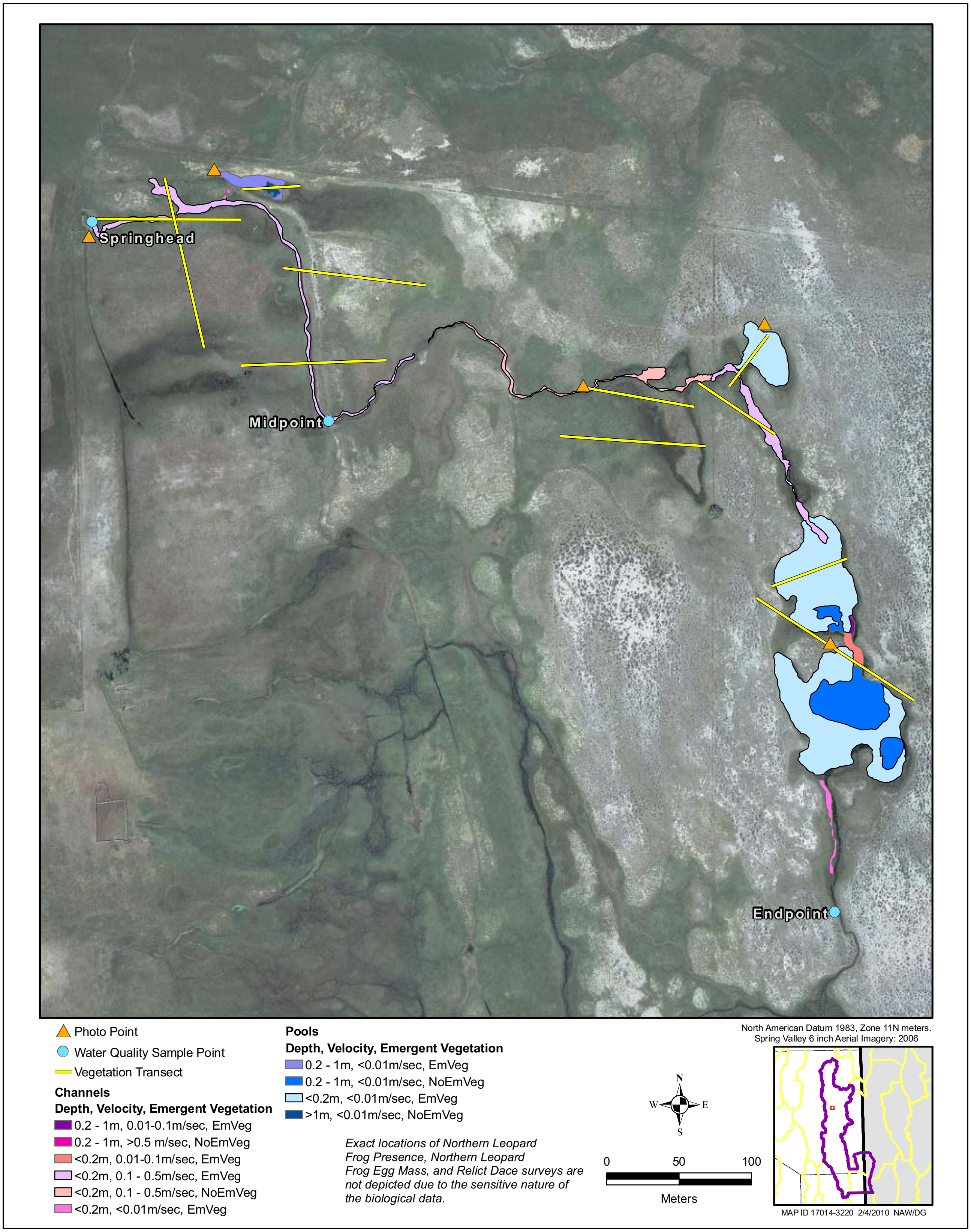


Figure B-6
Keegan Spring Complex North Physical Habitat Map for Spring 2009

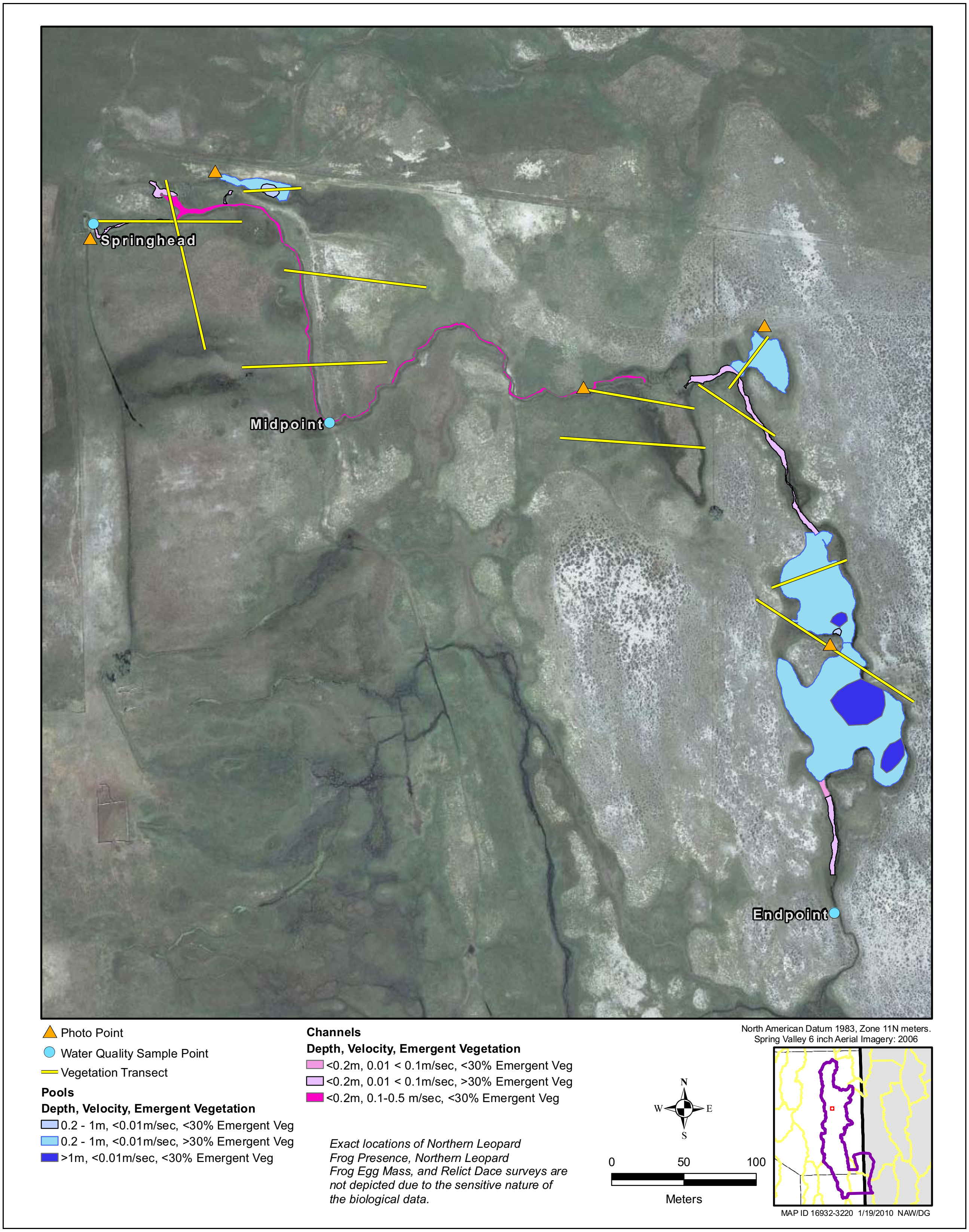


Figure B-7

Keegan Spring Complex North Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-8
Spring Season Mapped Area at Minerva Middle Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	0.1 - 0.5	EmVeg	27
Channel	0.2 - 1	0.1 - 0.5	EmVeg	32
Channel	<0.2	0.01-0.1	EmVeg	85
Channel	0.2 - 1	0.01-0.1	EmVeg	241
Channel	<0.2	N/A	EmVeg	32
Pool	<0.2	<0.01	EmVeg	23
Pool	0.2 - 1	<0.01	EmVeg	138
			Total Channels	**417**
			Total Pools	**161**
			Total Aquatic Mapped Area	**578**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-9
Fall Season Mapped Area at Minerva Middle Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	<0.2	<0.01	30 - 90	212
Channel	<0.2	<0.01	>90	17
Channel	<0.2	0.01 - 0.1	<30	17
Channel	<0.2	0.01 - 0.1	30 - 90	129
Channel	<0.2	0.1 - 0.5	<30	16
Channel	<0.2	N/A	<30	10
Pool	<0.2	<0.01	30 - 90	21
Pool	0.2 - 1	<0.01	<30	27
Pool	0.2 - 1	<0.01	30 - 90	88
			Total Channels	**401**
			Total Pools	**136**
			Total Aquatic Mapped Area	**537**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

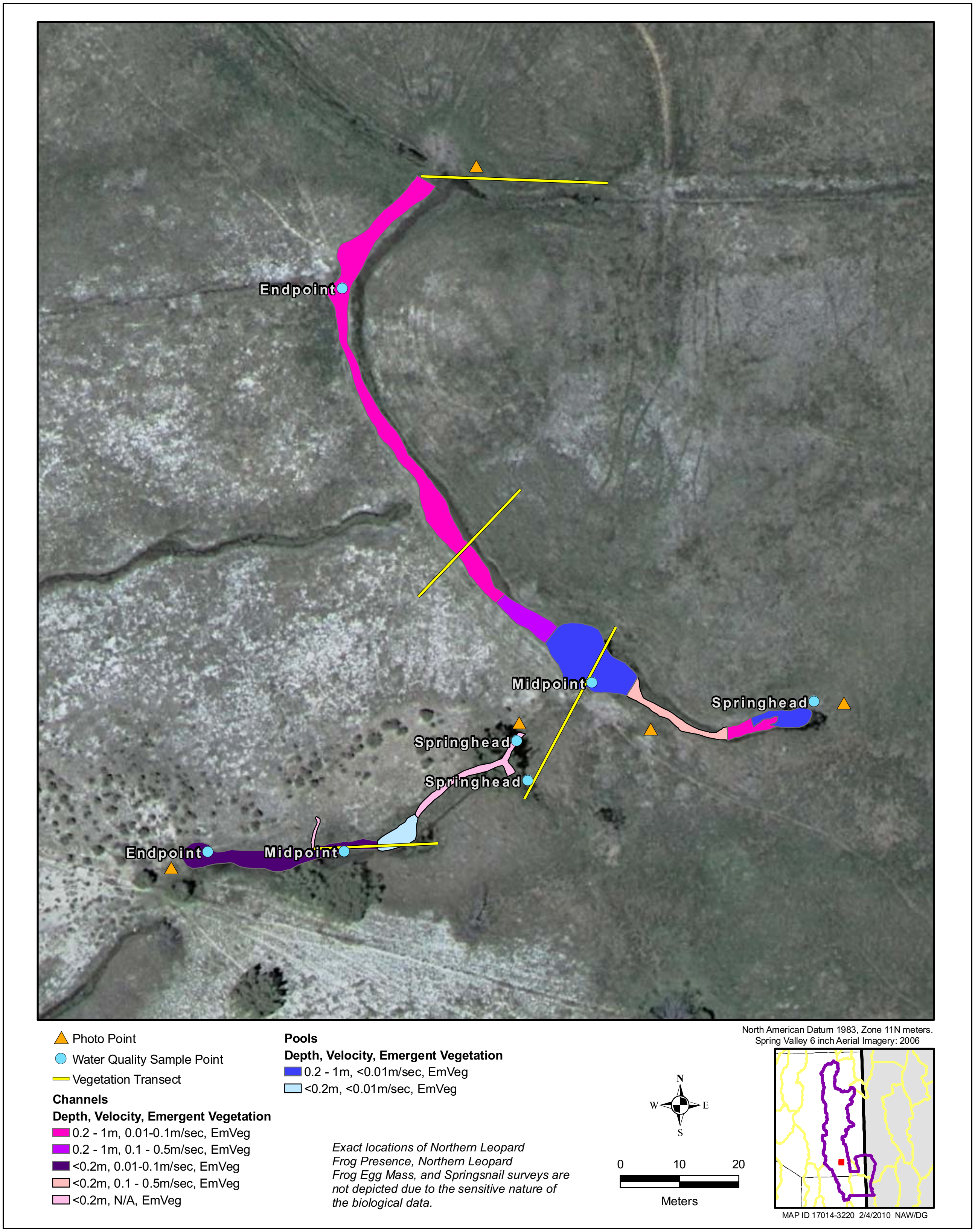


Figure B-8
Minerva Spring Complex Middle Physical Habitat Map for Spring 2009

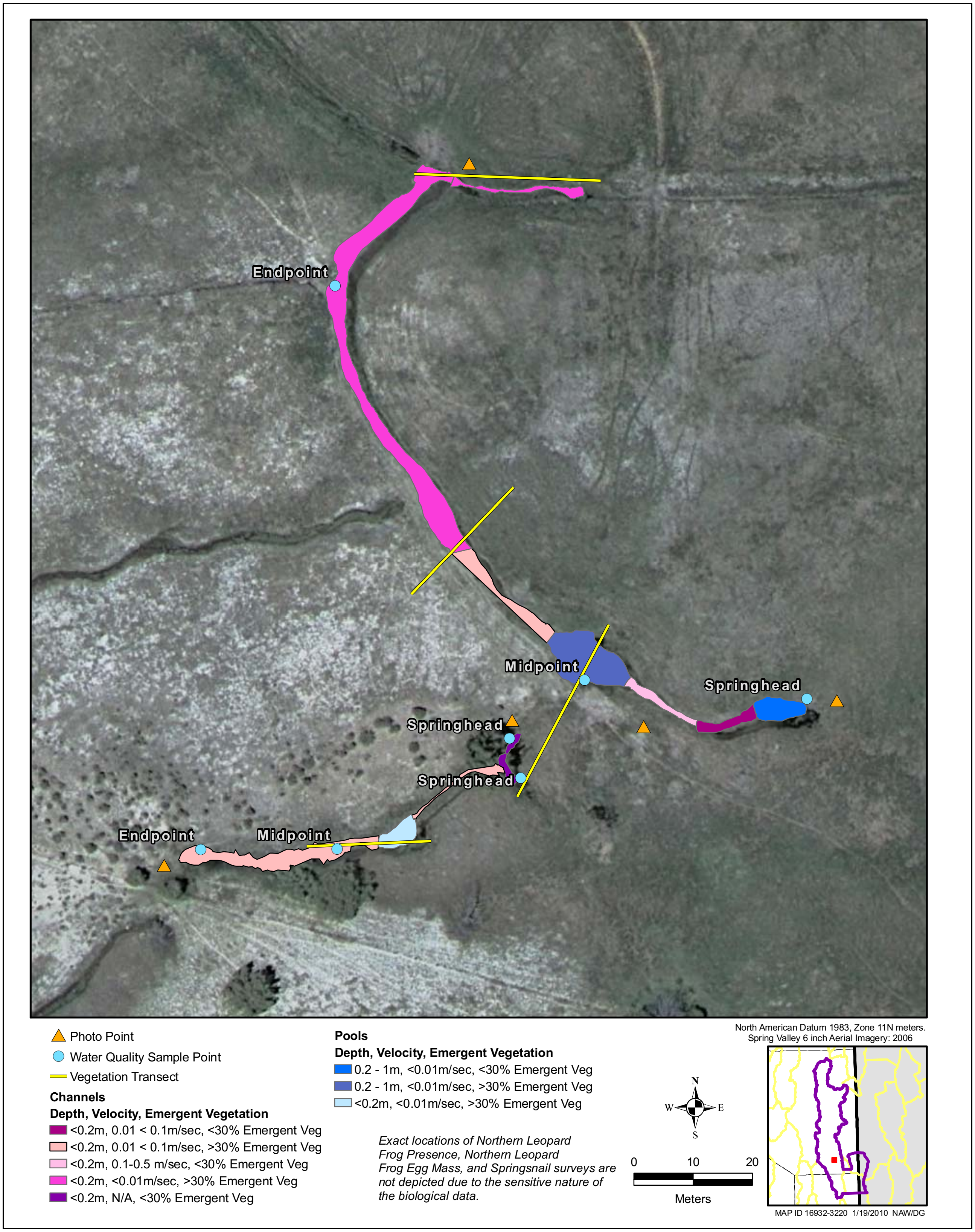


Figure B-9
Minerva Spring Complex Middle Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-10
Spring Season Mapped Area at Minerva North Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	0.2 - 1	0.01 - 0.1	EmVeg	11
Channel	<0.2	0.01 - 0.1	EmVeg	227
Channel	<0.2	0.1 - 0.5	EmVeg	194
Channel	<0.2	N/A	EmVeg	20
Pool	0.2 - 1	<0.01	EmVeg	251
Pool	>1	<0.01	EmVeg	946
Pool	<0.2	<0.01	EmVeg	62
Pool	<0.2	N/A	EmVeg	48
			Total Channels	**452**
			Total Pools	**1,307**
			Total Aquatic Mapped Area	**1,759**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-11
Fall Season Mapped Area at Minerva North Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	<0.2	0.01 - 0.1	30 - 90	320
Channel	<0.2	0.1 - 0.5	<30	26
Channel	<0.2	N/A	30 - 90	4
Channel	0.2 - 1	0.01 - 0.1	<30	9
Pool	<0.2	<0.01	30 - 90	51
Pool	<0.2	<0.01	>90	52
Pool	<0.2	0.01 - 0.1	<30	9
Pool	0.2 - 1	<0.01	<30	1,089
			Total Channels	**359**
			Total Pools	**1,201**
			Total Aquatic Mapped Area	**1,560**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

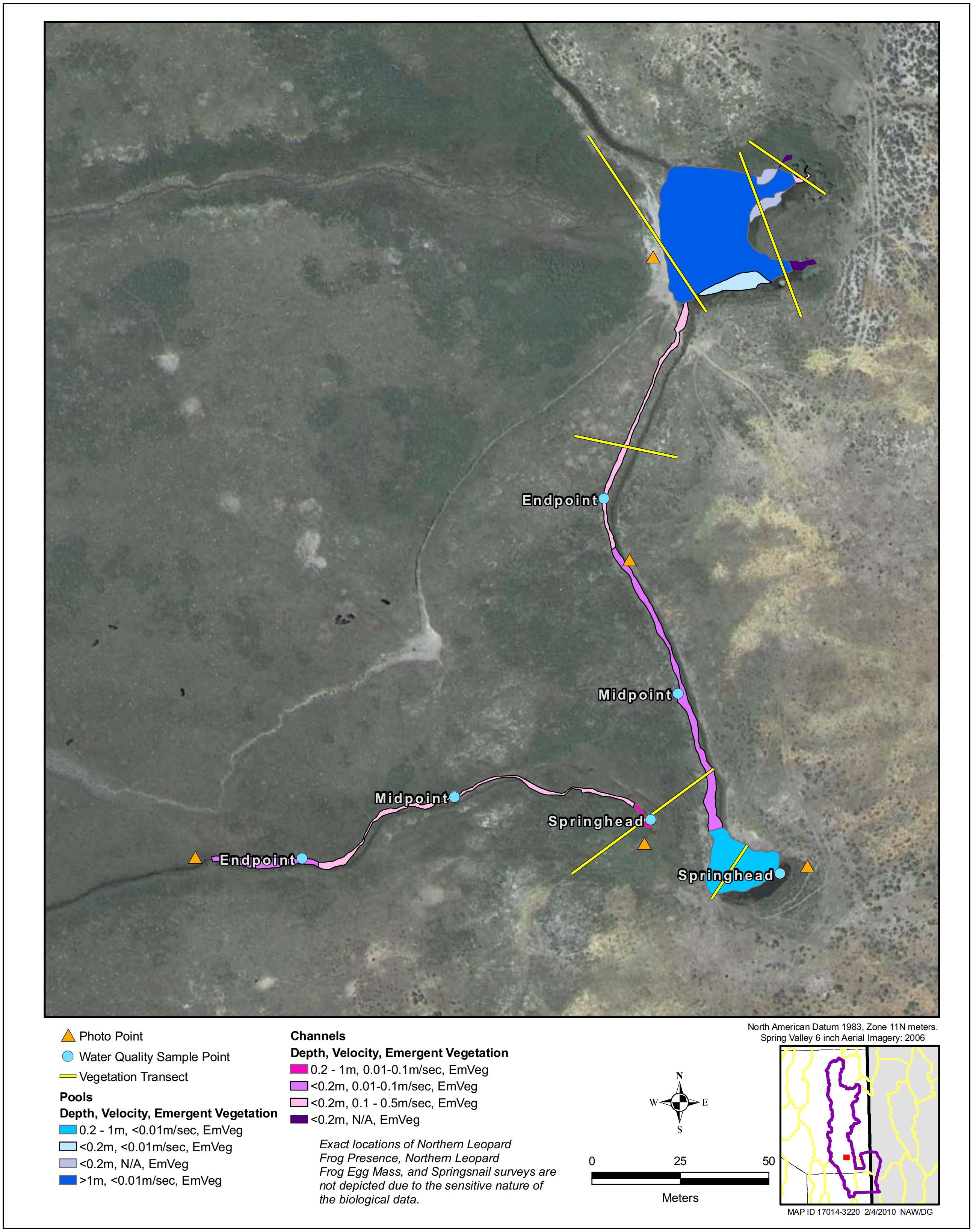


Figure B-10
Minerva Spring Complex North Physical Habitat Map for Spring 2009

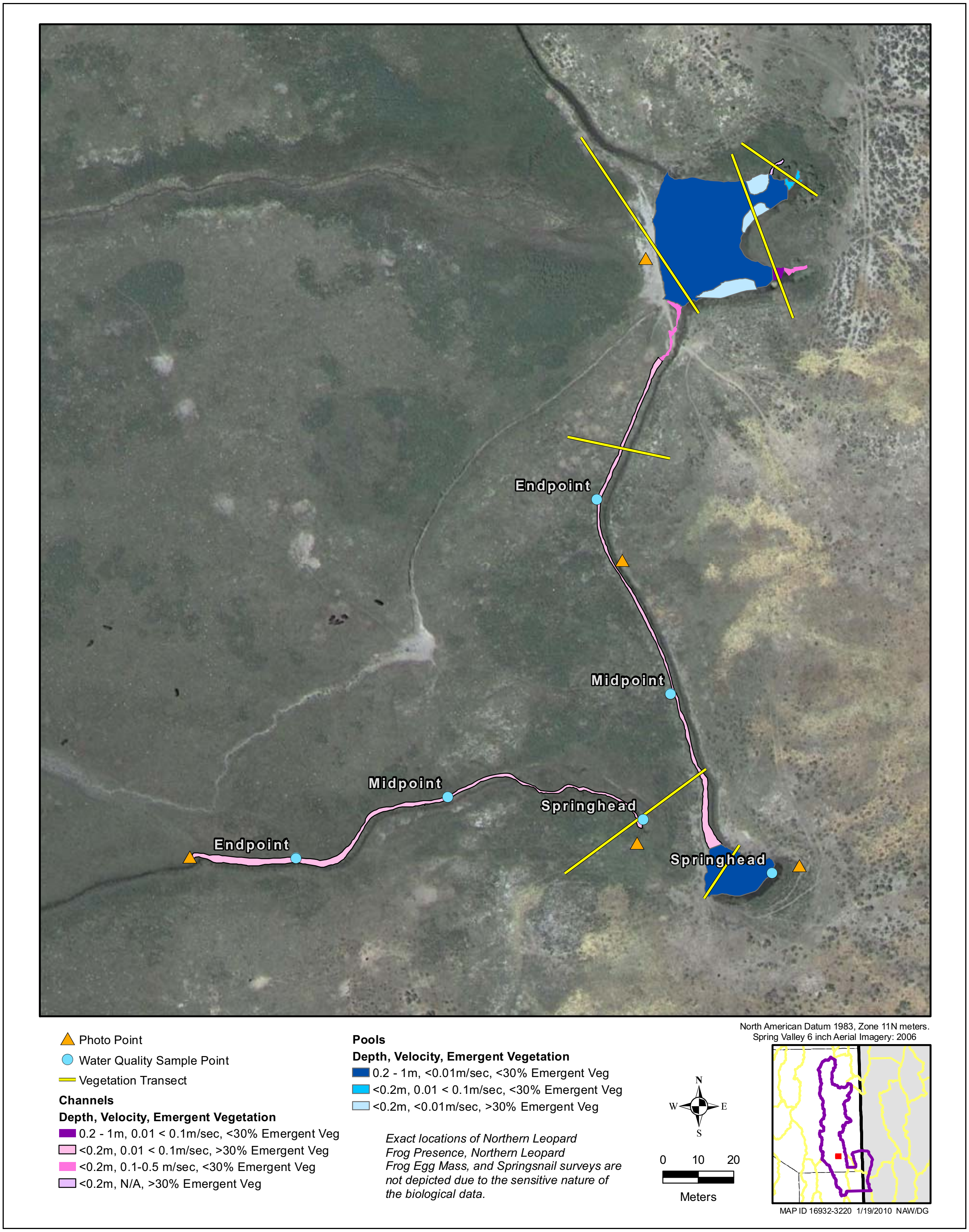


Figure B-11
Minerva Spring Complex North Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-12
Spring Season Mapped Area at North Little Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	<0.01	EmVeg	109
Pool	<0.2 - 1	<0.01	EmVeg	74
			Total Channels	**109**
			Total Pools	**74**
			Total Aquatic Mapped Area	**183**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-13
Fall Season Mapped Area at North Little Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Pool	0.2 - 1	<0.01	30 - 90	60
Channel	<0.2	<0.01	>90	40
			Total Channels	**40**
			Total Pools	**60**
			Total Aquatic Mapped Area	**100**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

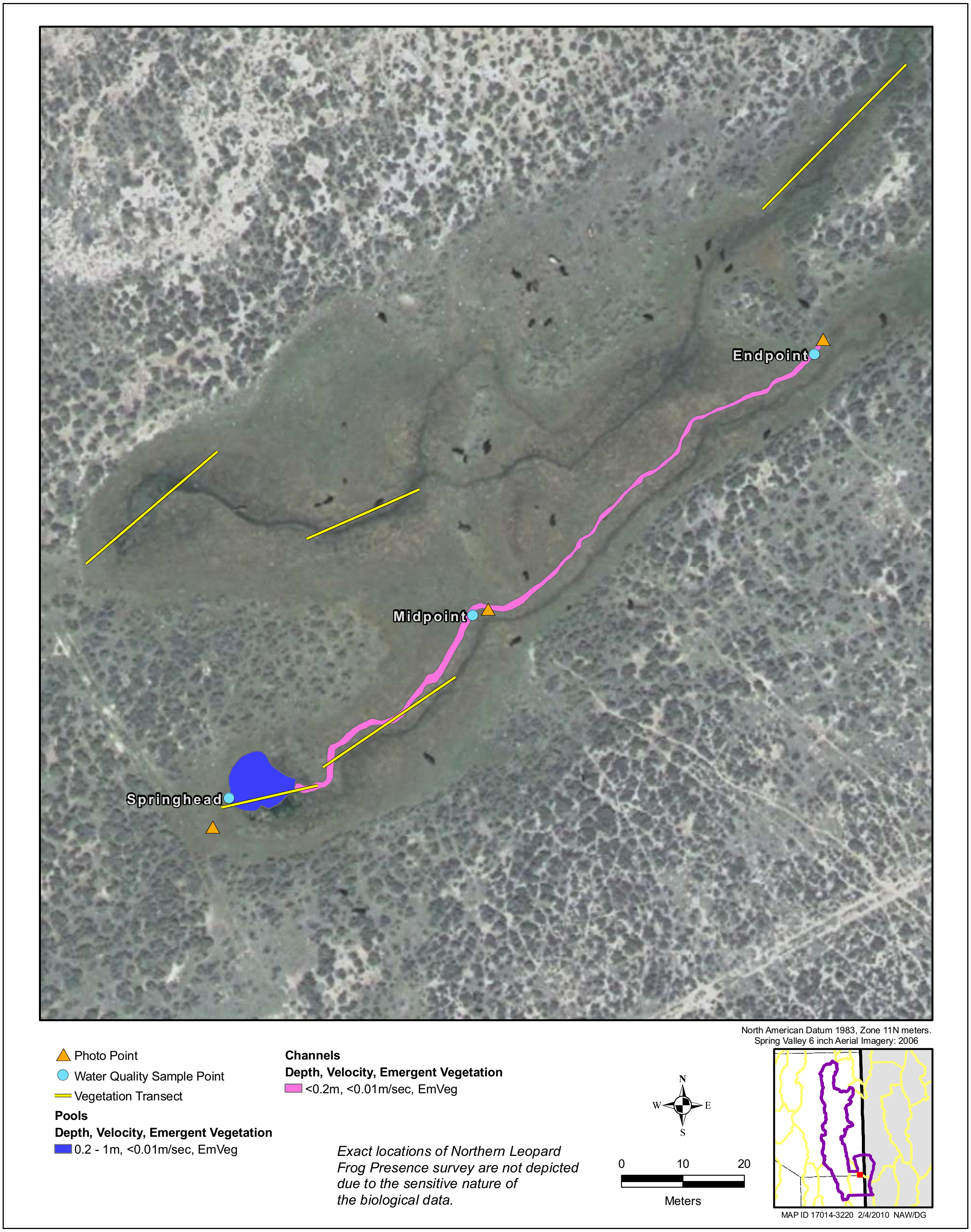


Figure B-12
North Little Physical Habitat Map for Spring 2009

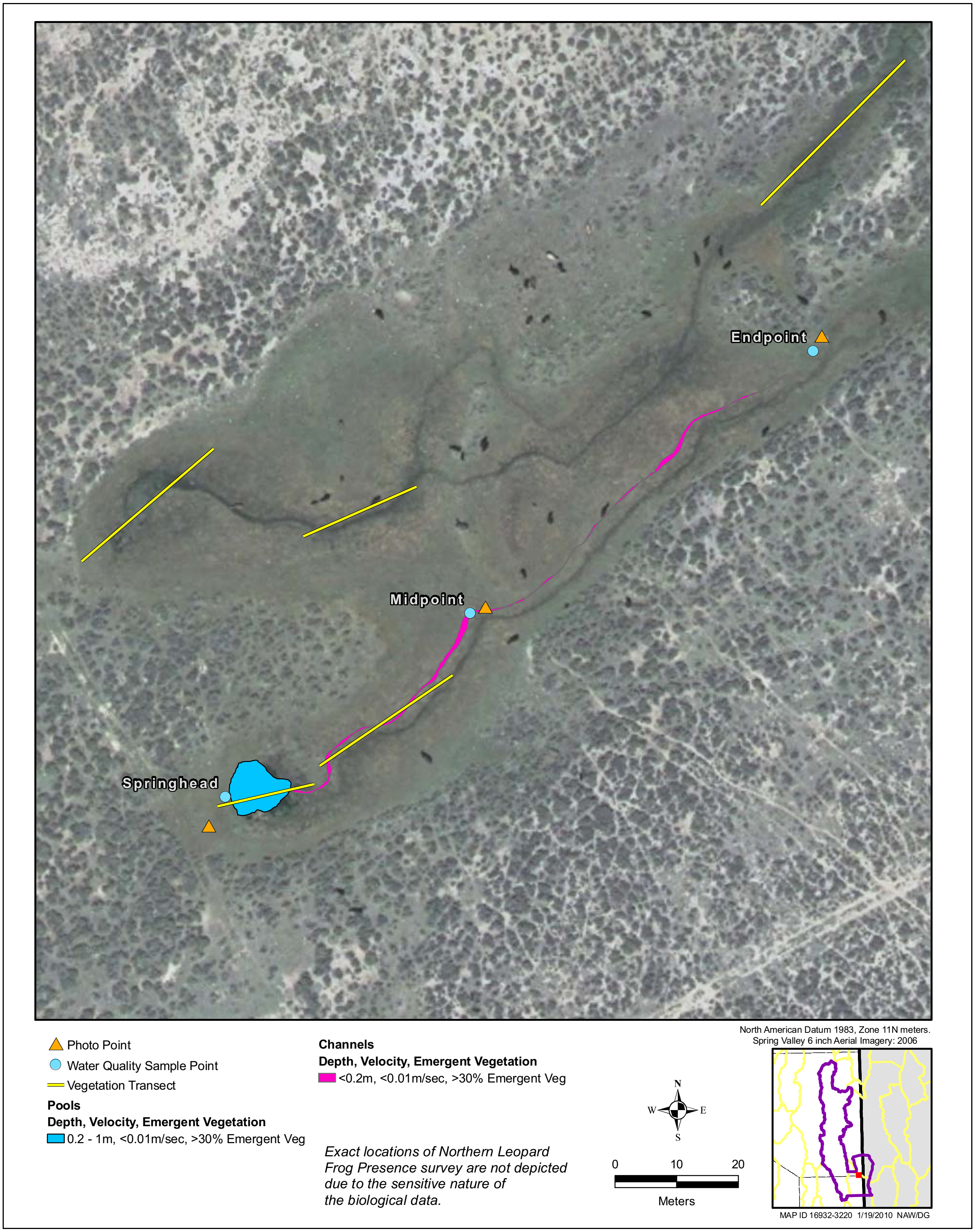


Figure B-13
North Little Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-14
Spring Season Mapped Area at Shoshone Ponds Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Pool	N/A	N/A	EmVeg	663
Pool	N/A	N/A	EmVeg	16
			Total Channels	**---**
			Total Pools	**679**
			Total Aquatic Mapped Area	**679**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-15
Fall Season Mapped Area at Shoshone Ponds Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Pool	>1	N/A	<30	629
			Total Channels	**---**
			Total Pools	**629**
			Total Aquatic Mapped Area	**629**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

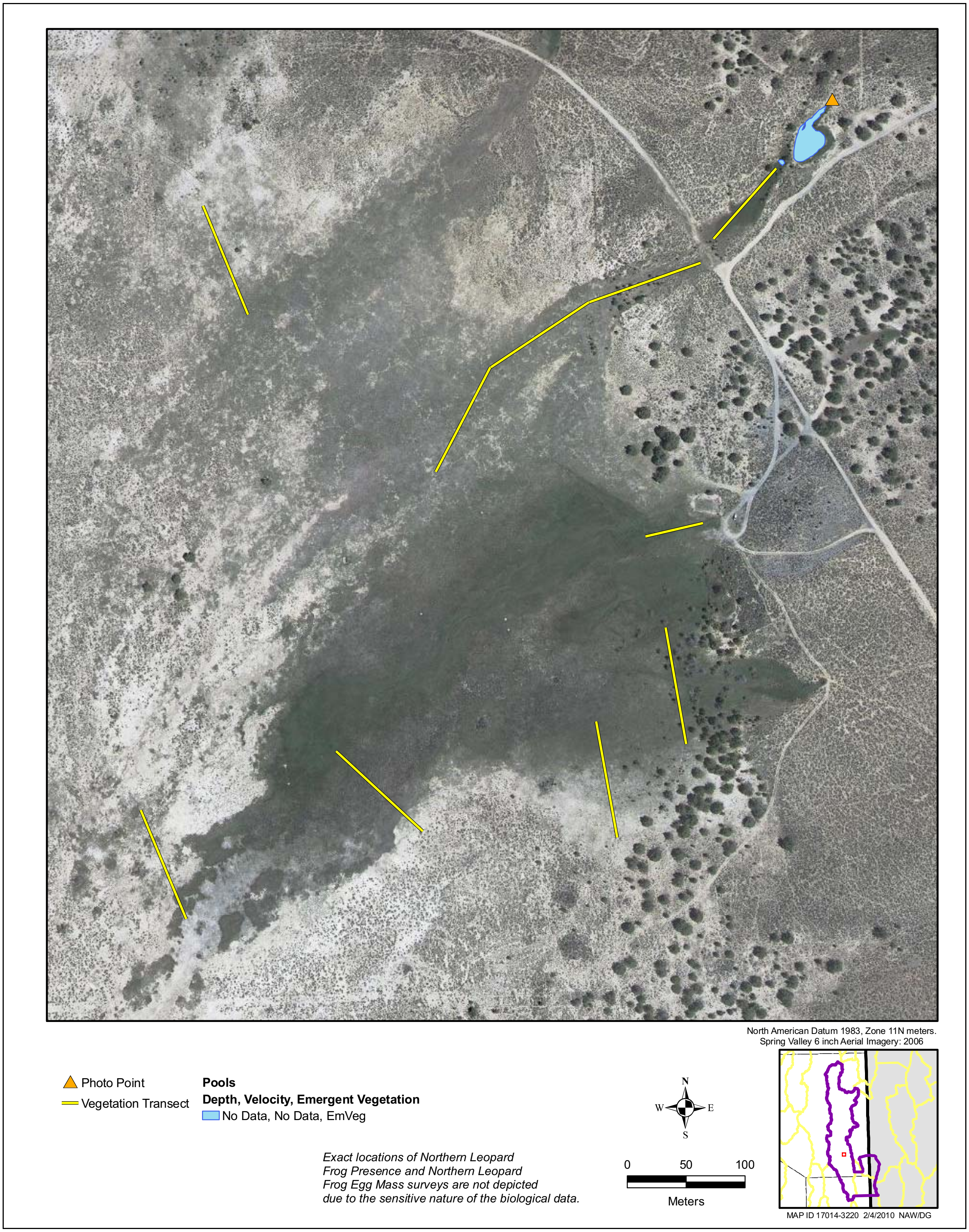


Figure B-14
Shoshone Ponds Physical Habitat Map for Spring 2009

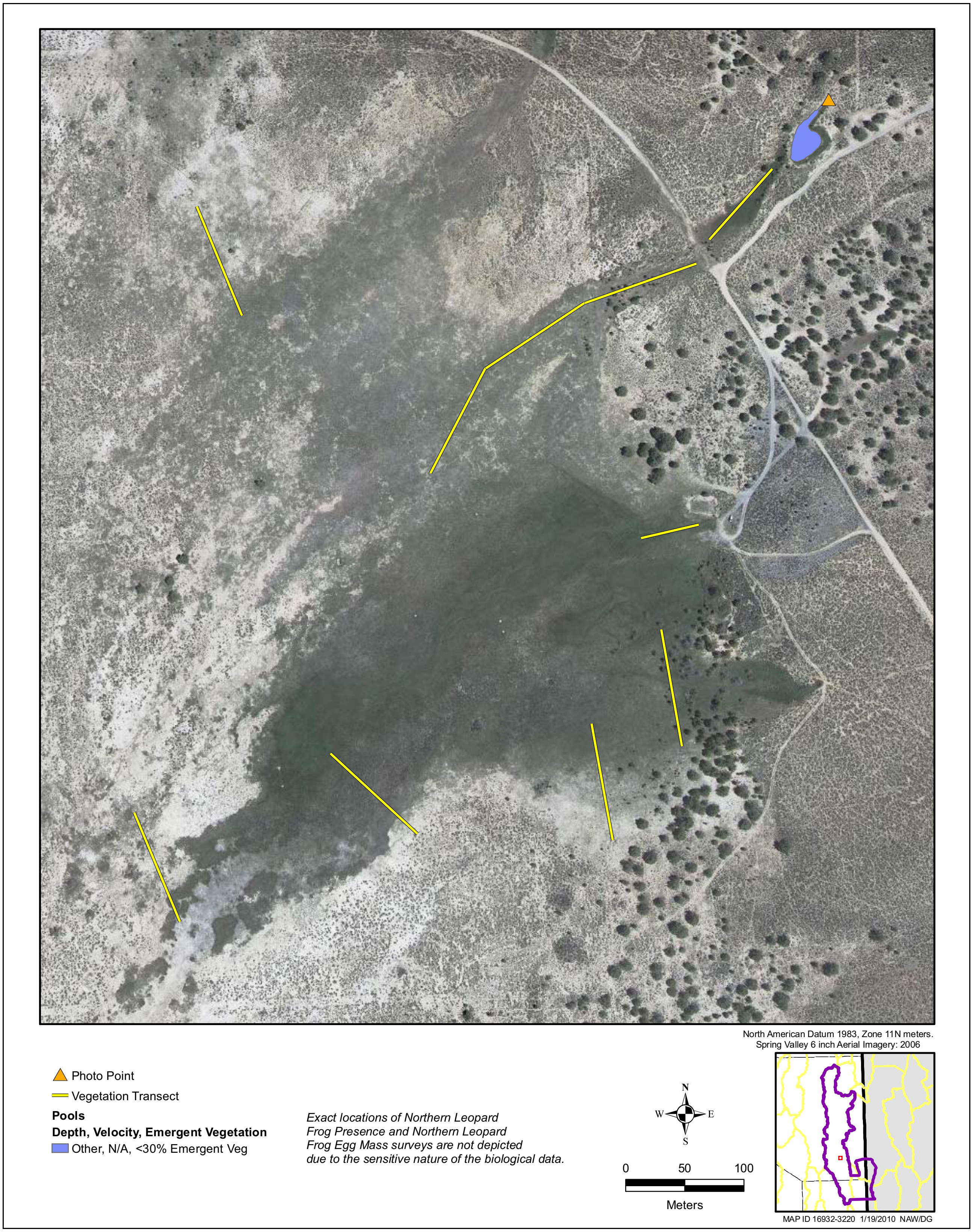


Figure B-15
Shoshone Ponds Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-16
Spring Season Mapped Area at South Millick Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	0.01 - 0.1	EmVeg	196
Channel	0.2 - 1	0.01 - 0.1	EmVeg	355
Channel	0.2 - 1	0.1 - 0.5	EmVeg	203
Channel	<0.2	N/A	EmVeg	597
			Total Channels	**1,351**
			Total Pools	**---**
			Total Aquatic Mapped Area	**1,351**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-17
Fall Season Mapped Area at South Millick Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	<0.2	<0.01	30 - 90	463
Channel	<0.2	<0.01	>90	134
Channel	<0.2	<0.01	<30	276
Channel	<0.2	0.01 - 0.1	<30	105
Channel	<0.2	0.01 - 0.1	30 - 90	150
Channel	<0.2	0.01 - 0.1	>90	36
Channel	0.2 - 1	0.01 - 0.1	30 - 90	335
Pool	<0.2	0.01 - 0.1	<30	71
			Total Channels	**1,499**
			Total Pools	**71**
			Total Aquatic Mapped Area	**1,570**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

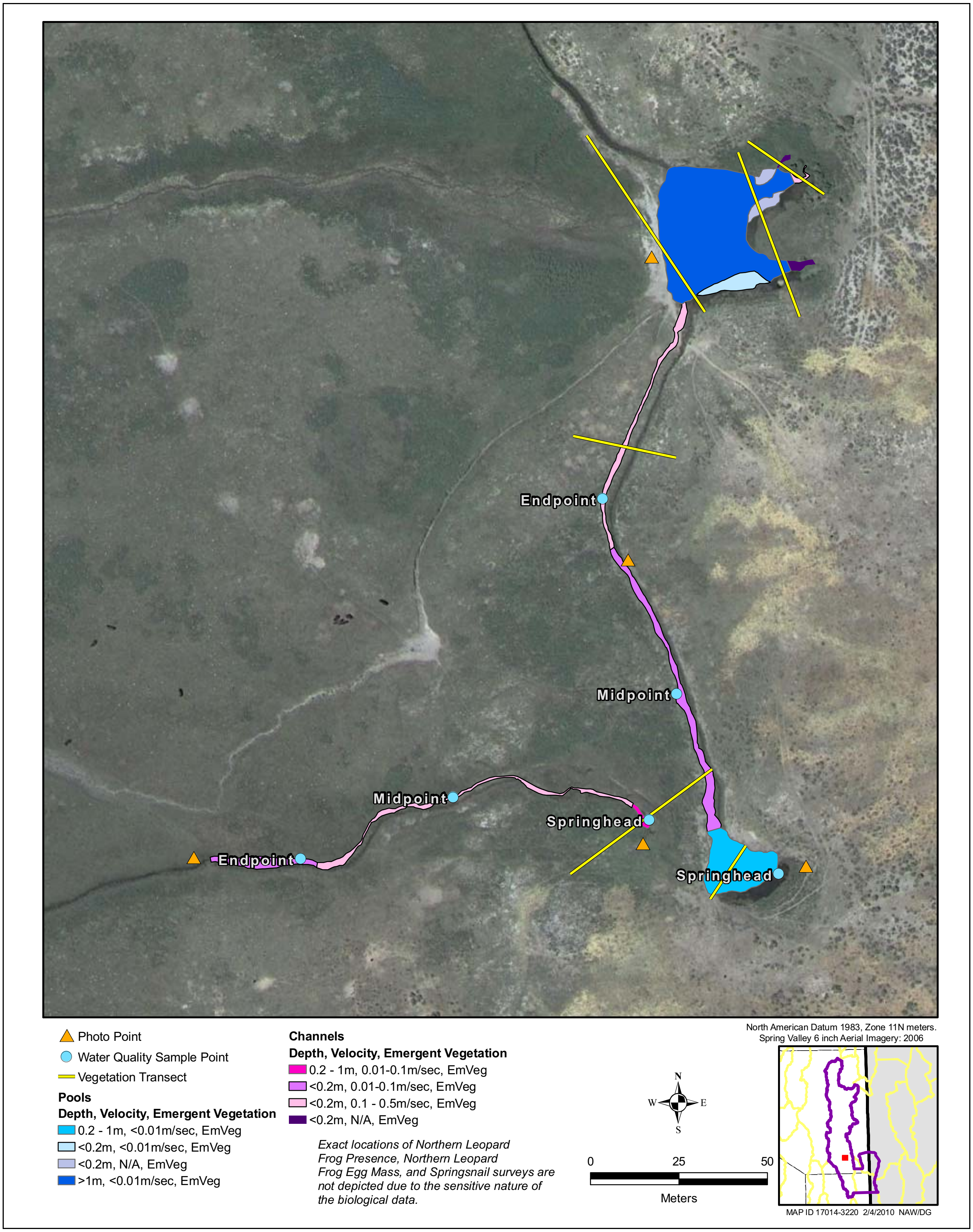


Figure B-16
South Millick Physical Habitat Map for Spring 2009

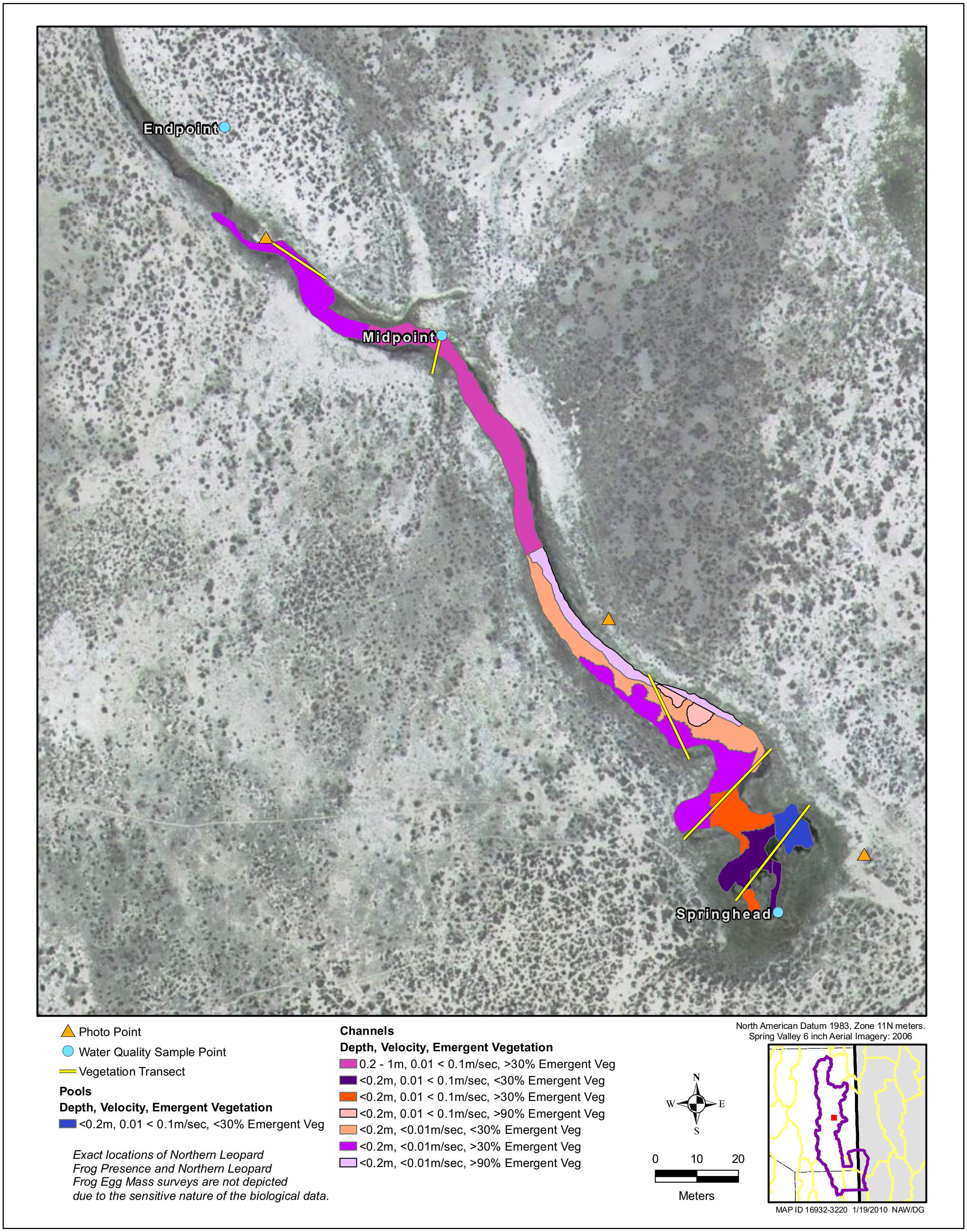


Figure B-17
South Millick Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-18
Spring Season Mapped Area at Stateline Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	0.01 - 0.1	NoEmVeg	11
Channel	<0.2	0.01 - 0.1	EmVeg	10
Channel	<0.2	N/A	EmVeg	18
Channel	<0.2	0.1 - 0.5	EmVeg	92
			Total Channels	**131**
			Total Pools	**---**
			Total Aquatic Mapped Area	**131**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-19
Fall Season Mapped Area at Stateline Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	<0.2	0.01 - 0.1	>90	39
Channel	<0.2	0.1 - 0.5	30 - 90	21
Channel	<0.2	0.1 - 0.5	>90	36
Channel	<0.2	0.1 - 0.5	<30	8
Channel	<0.2	0.1 - 0.5	30 - 90	18
Pool	<0.2	<0.01	30 - 90	9
			Total Channels	**122**
			Total Pools	**9**
			Total Aquatic Mapped Area	**131**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

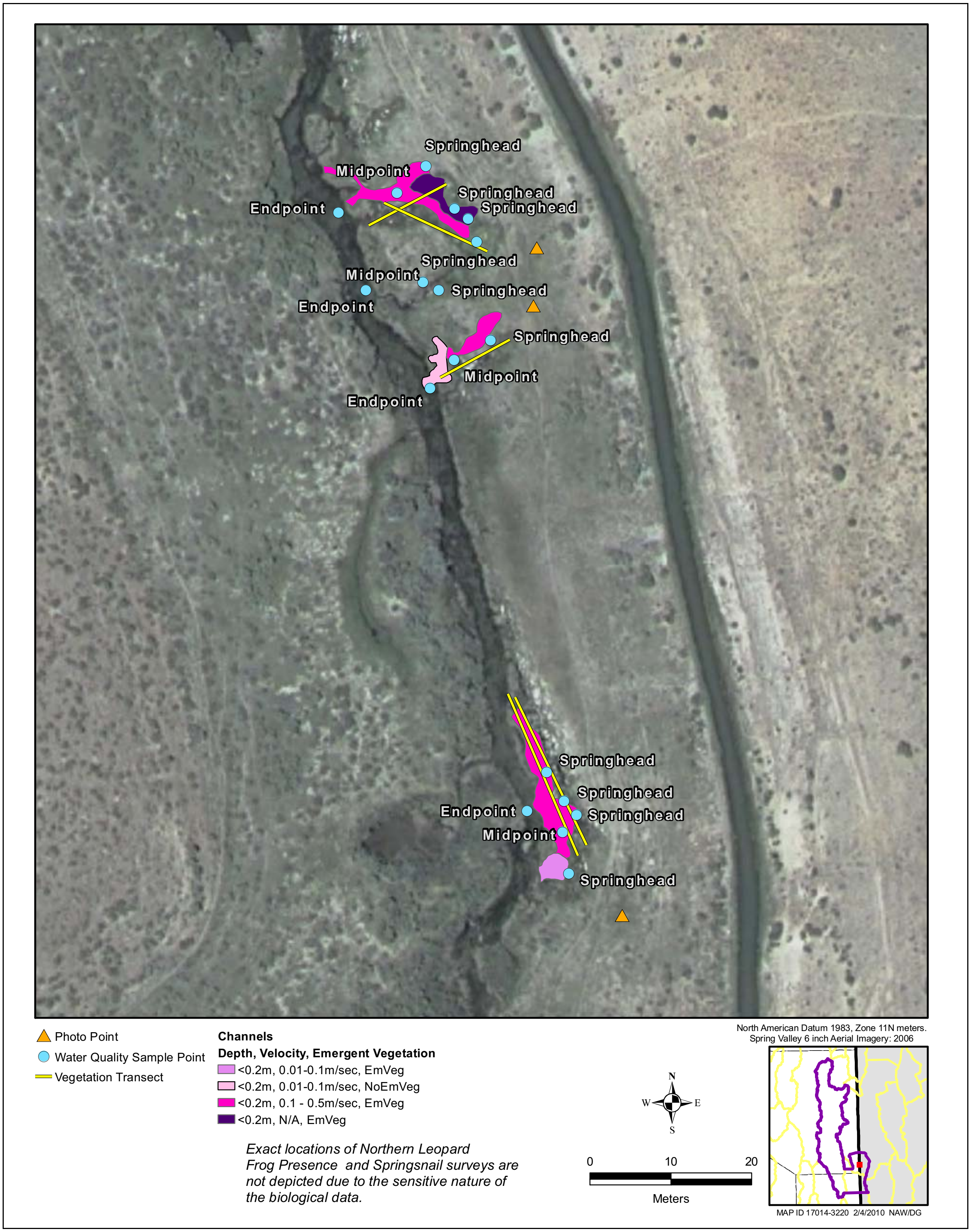


Figure B-18
Stateline Springs Physical Habitat Map for Spring 2009

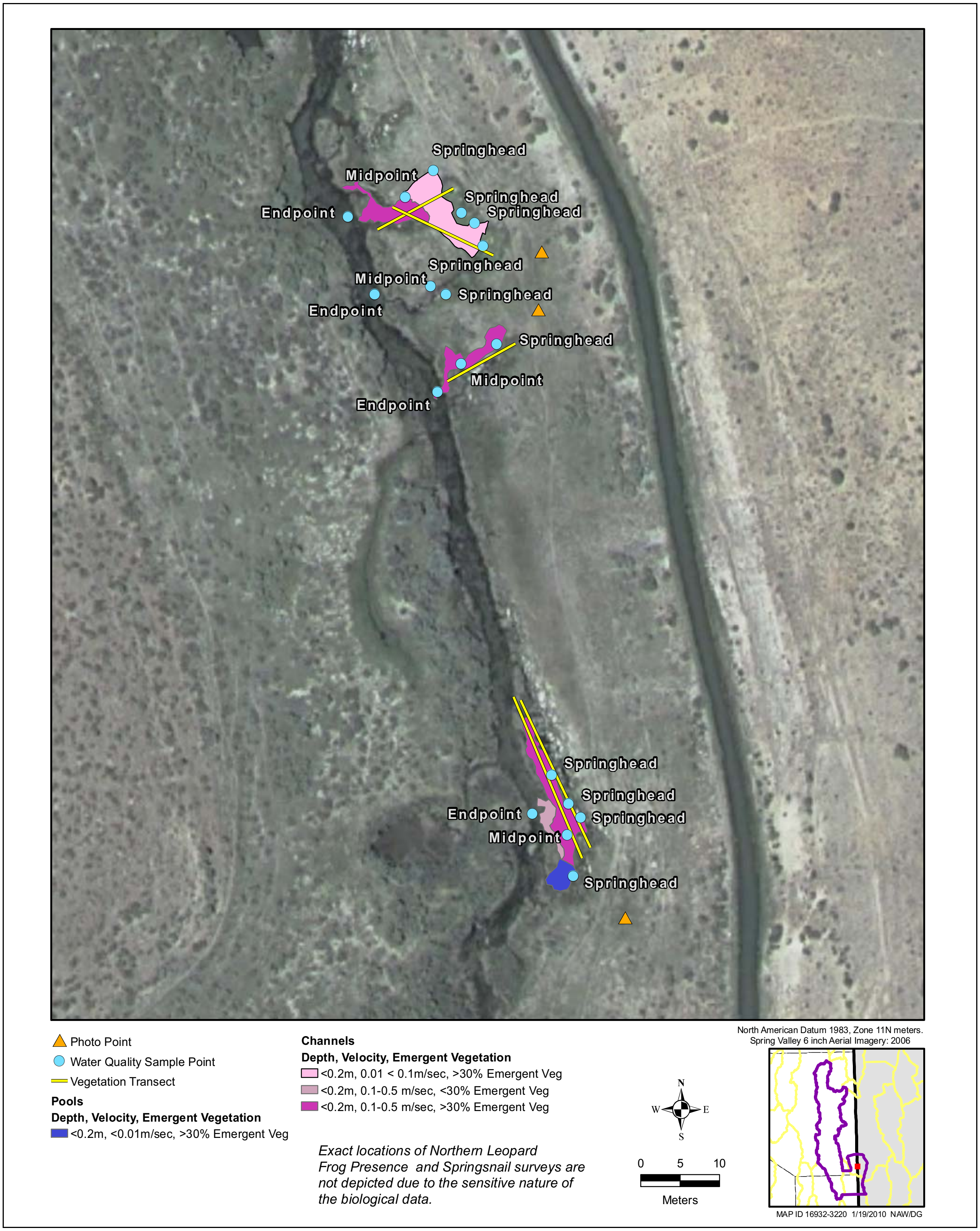


Figure B-19
Stateline Springs Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-20
Spring Season Mapped Area at Stonehouse Spring Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	0.2 - 1	0.01 - 0.1	EmVeg	107
Channel	<0.2	<0.01	EmVeg	251
Channel	<0.2	0.01 - 0.1	EmVeg	449
Pool	<0.2	<0.01	EmVeg	648
Pool	>1	<0.01	NoEmVeg	135
Pool	0.2 - 1	<0.01	EmVeg	289
			Total Channels	**807**
			Total Pools	**1,072**
			Total Aquatic Mapped Area	**1,879**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-21
Fall Season Mapped Area at Stonehouse Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	<0.2	<0.01	>90	51
Channel	<0.2	<0.01	30 - 90	55
Channel	<0.2	0.01 - 0.1	<30	30
Channel	0.2 - 1	<0.01	>90	62
Channel	0.2 - 1	<0.01	<30	16
Pool	<0.2	<0.01	<30	36
Pool	<0.2	<0.01	>90	48
Pool	>1	<0.01	<30	133
Pool	>1	<0.01	<30	29
			Total Channels	**214**
			Total Pools	**246**
			Total Aquatic Mapped Area	**460**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

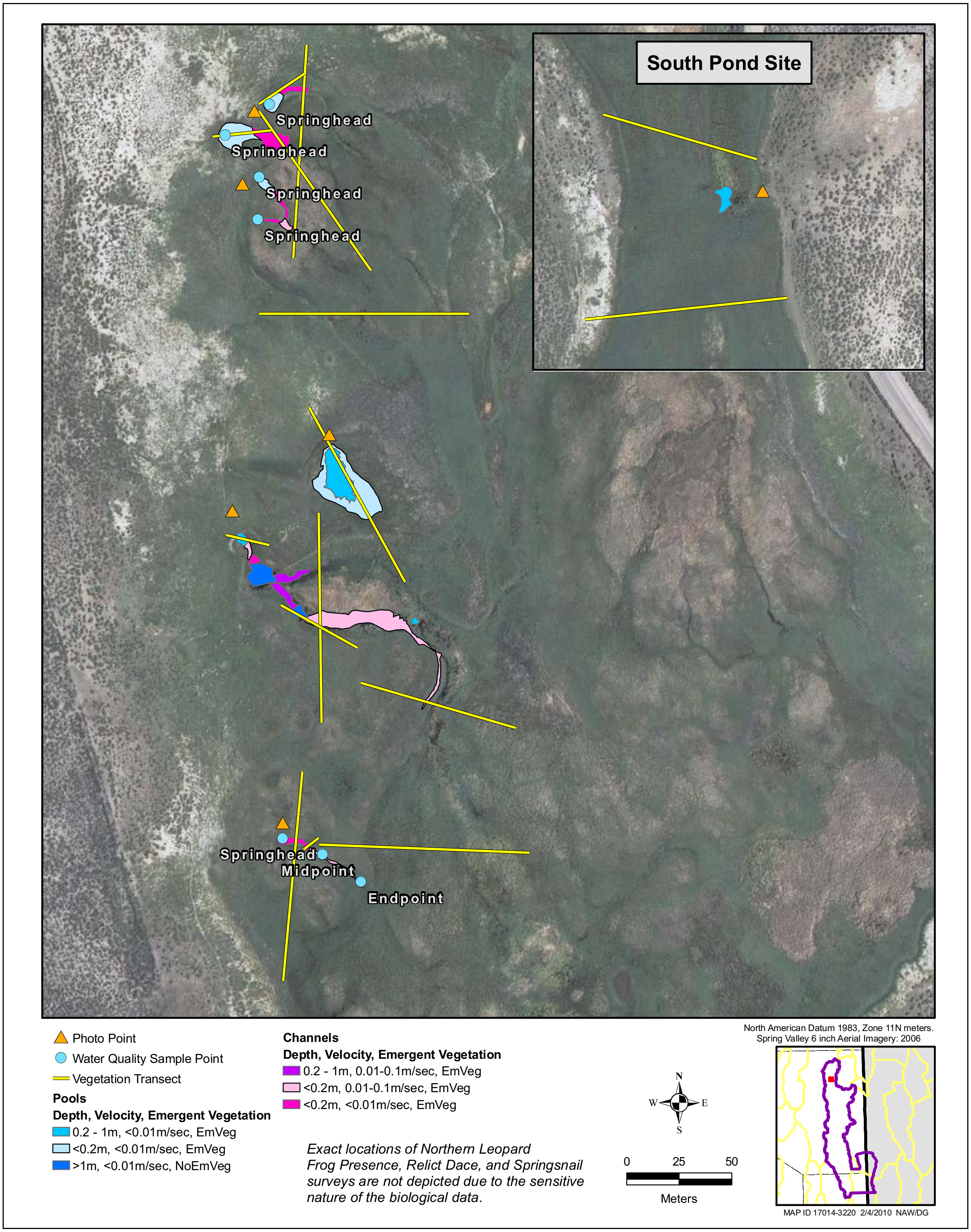


Figure B-20
Stonehouse Physical Habitat Map for Spring 2009

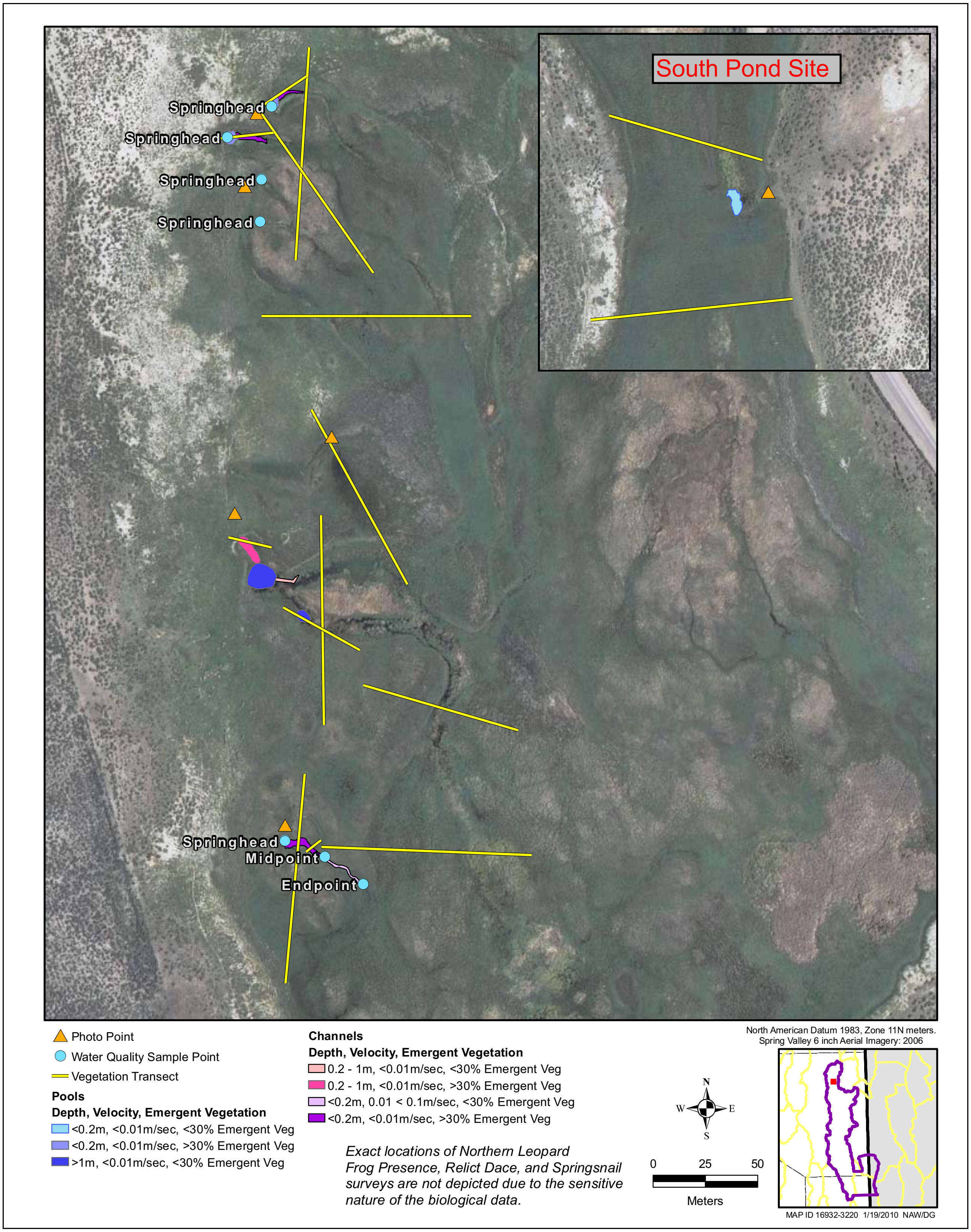


Figure B-21
Stonehouse Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-22
Spring Season Mapped Area at Swallow Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	N/A	EmVeg	<1
Channel	<0.2	>0.5	EmVeg	436
Channel	<0.2	0.01 - 0.1	EmVeg	26
Channel	<0.2	0.1 - 0.5	EmVeg	338
Pool	<0.2	<0.01	EmVeg	28
Pool	0.2 - 1	<0.01	EmVeg	74
			Total Channels	**800**
			Total Pools	**102**
			Total Aquatic Mapped Area	**902**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-23
Fall Season Mapped Area at Swallow Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	<0.2	>0.5	<30	101
Channel	<0.2	0.1 - 0.5	30 - 90	371
Channel	<0.2	0.1 - 0.5	<30	226
Channel	0.2 - 1	0.1 - 0.5	<30	11
Pool	0.2 - 1	<0.01	30 - 90	100
			Total Channels	**709**
			Total Pools	**100**
			Total Aquatic Mapped Area	**809**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Figure B-22
Swallow Creek Physical Habitat Map for Spring 2009

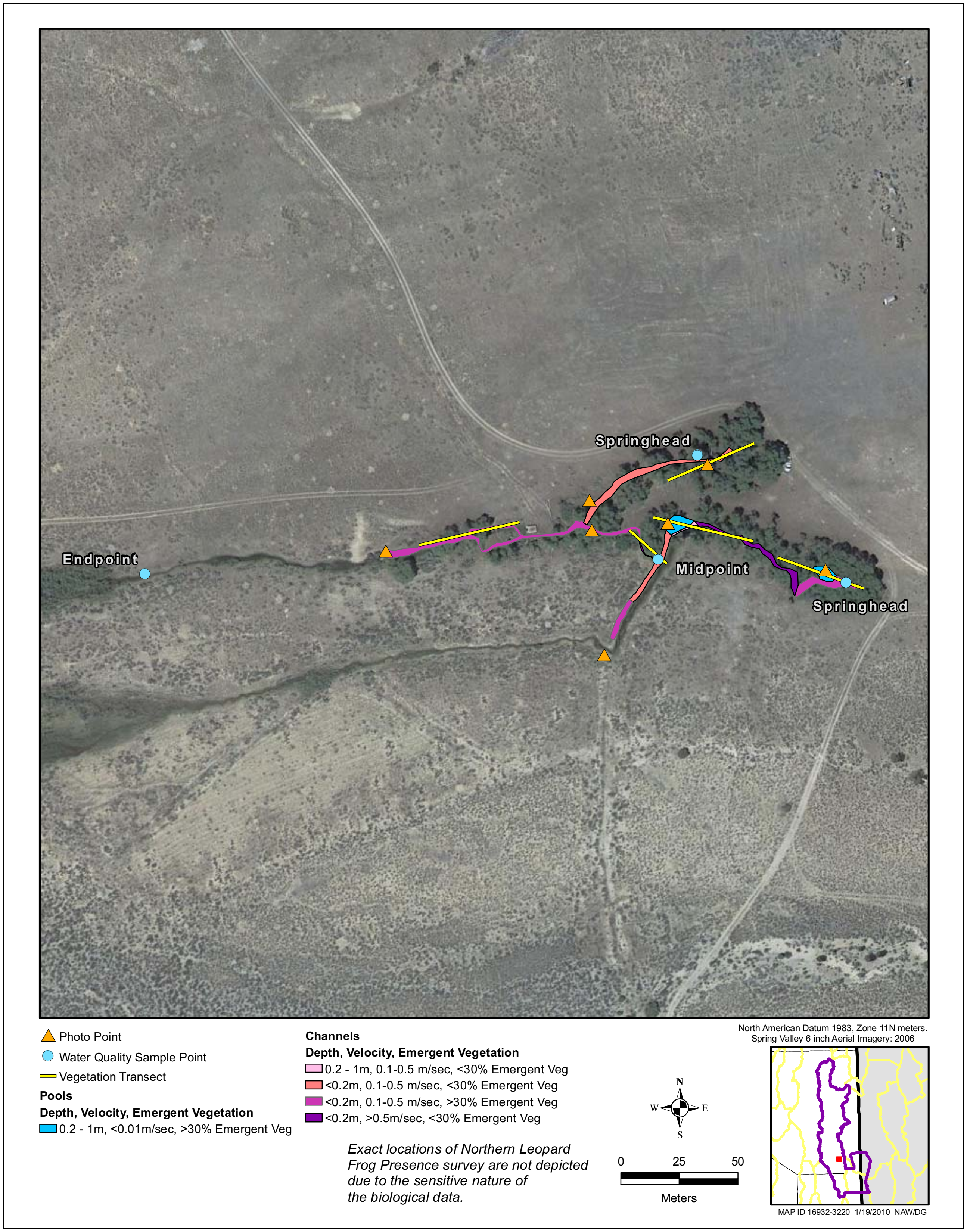


Figure B-23
Swallow Creek Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-24
Spring Season Mapped Area at Unnamed 1 Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	N/A	EmVeg	197
Pool	<0.2	N/A	EmVeg	10
			Total Channels	**197**
			Total Pools	**10**
			Total Aquatic Mapped Area	**207**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-25
Fall Season Mapped Area at Unnamed 1 Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Pool	<0.2	0.01 - 0.1	>90	7
Channel	<0.2	0.01 - 0.1	>90	123
			Total Channels	**123**
			Total Pools	**7**
			Total Aquatic Mapped Area	**130**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

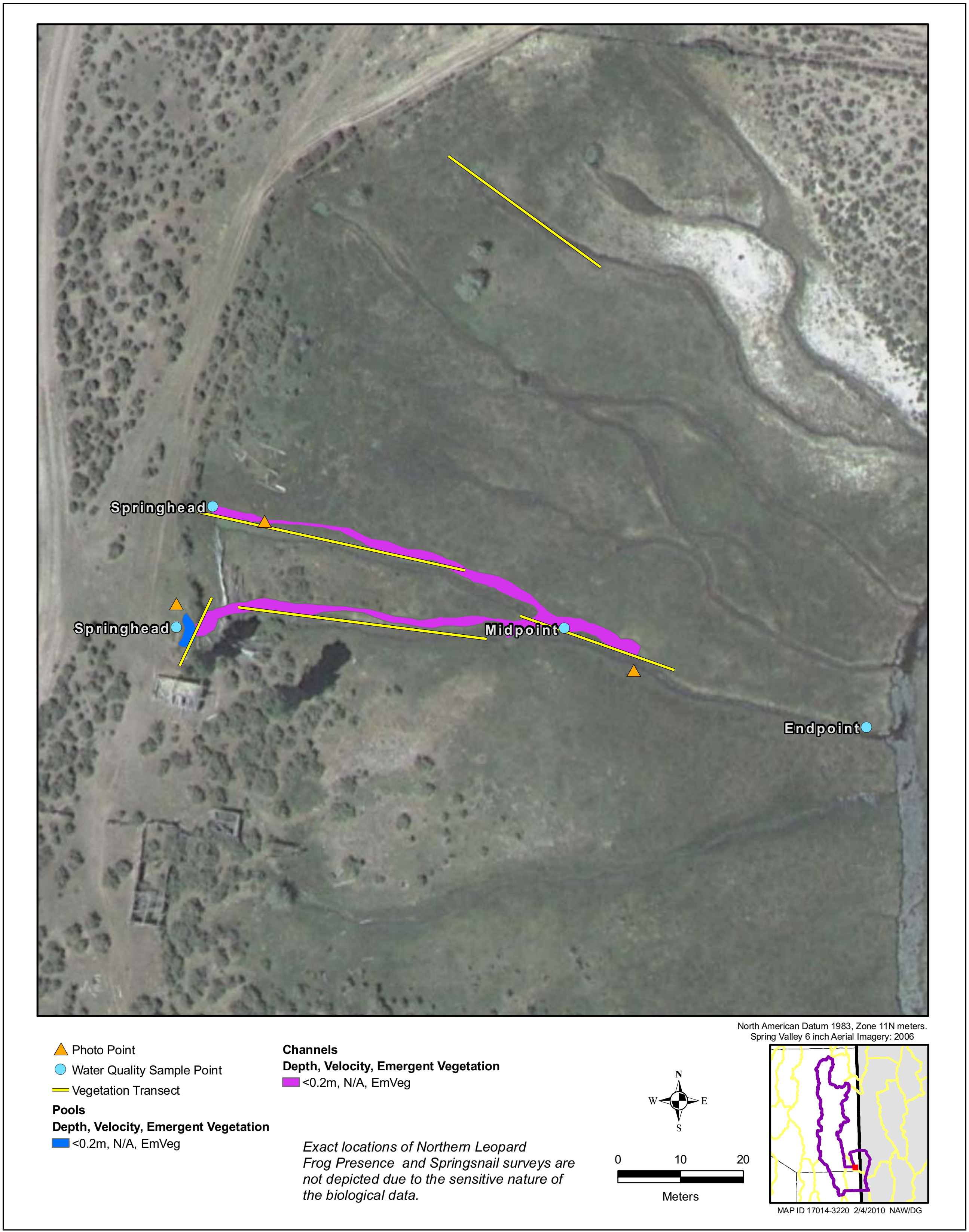


Figure B-24
Unnamed 1 Spring North of Big Physical Habitat Map for Spring 2009

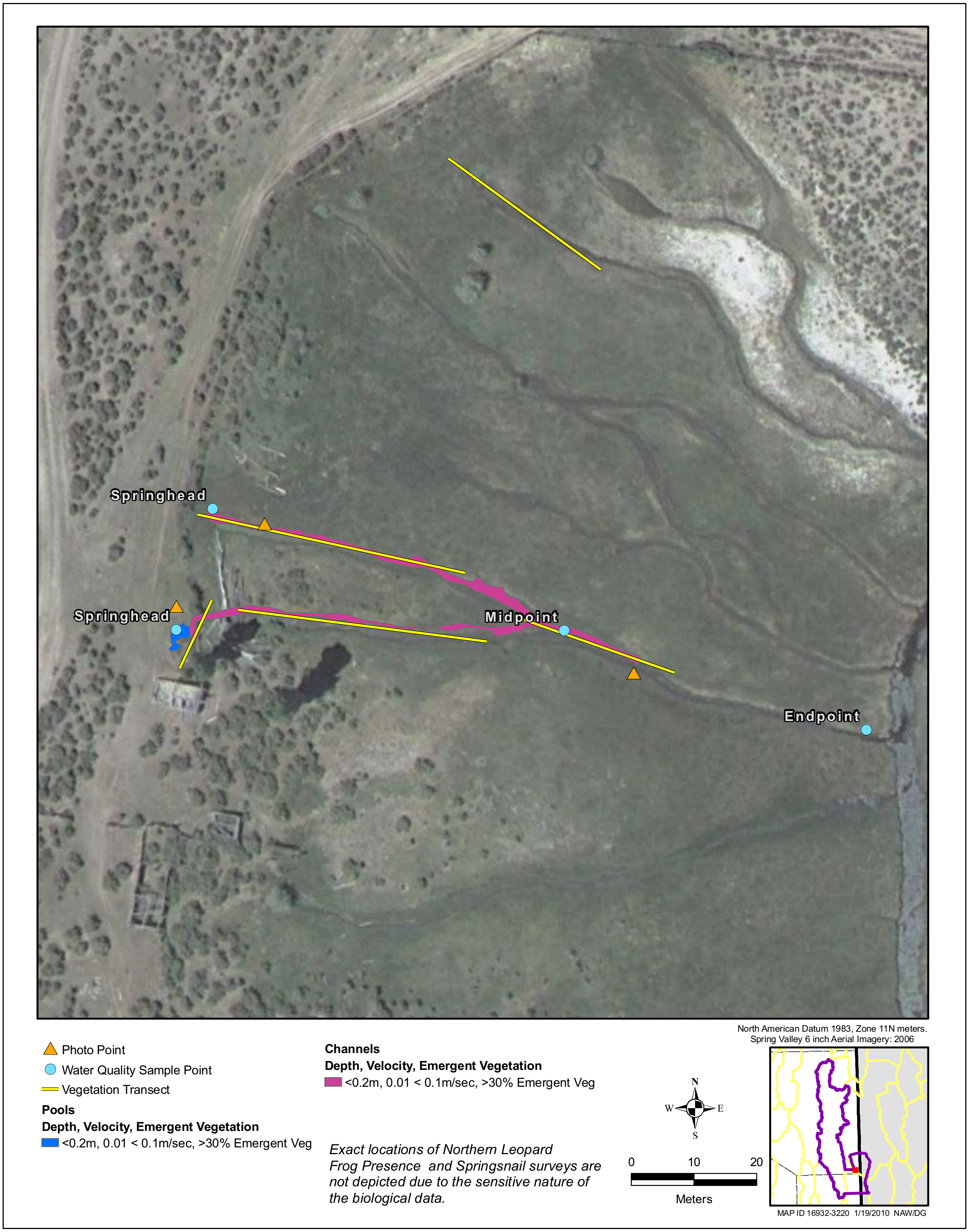


Figure B-25
Unnamed 1 Spring North of Big Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-26
Spring Season Mapped Area at Unnamed 5 Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	<0.01	EmVeg	528
Channel	<0.2	0.1 - 0.5	EmVeg	721
Pool	0.2 - 1	<0.01	EmVeg	42
Pool	<0.2	<0.01	EmVeg	1,360
			Total Channels	**1,249**
			Total Pools	**1,402**
			Total Aquatic Mapped Area	**2,651**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-27
Fall Season Mapped Area at Unnamed 5 Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	<0.2	<0.01	30 - 90	865
Channel	<0.2	0.01 - 0.1	30 - 90	241
Pool	<0.2	<0.01	30 - 90	722
Pool	0.2 - 1	<0.01	>90	929
			Total Channels	**1,106**
			Total Pools	**1,651**
			Total Aquatic Mapped Area	**2,757**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

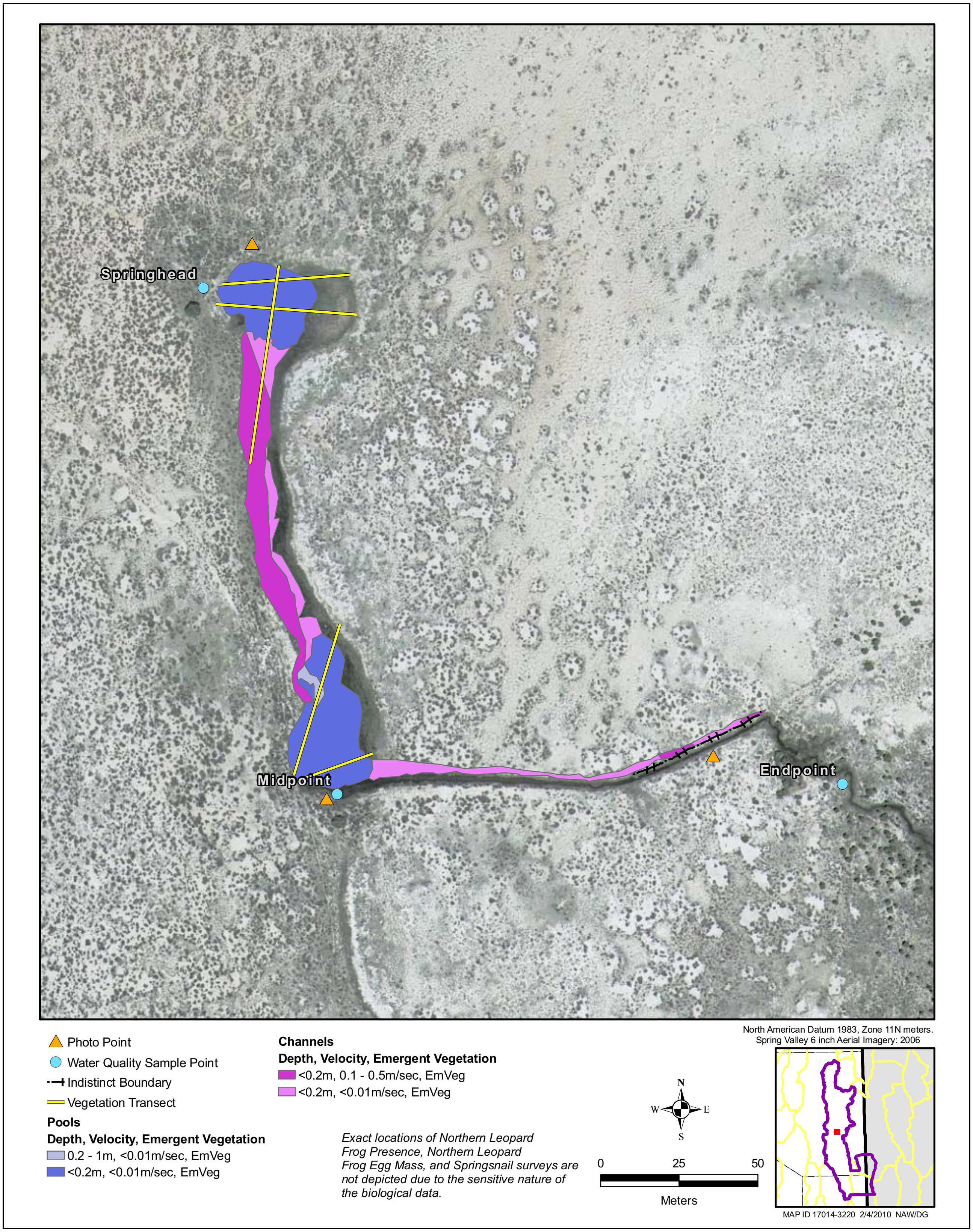


Figure B-26
Unnamed 5 Physical Habitat Map for Spring 2009

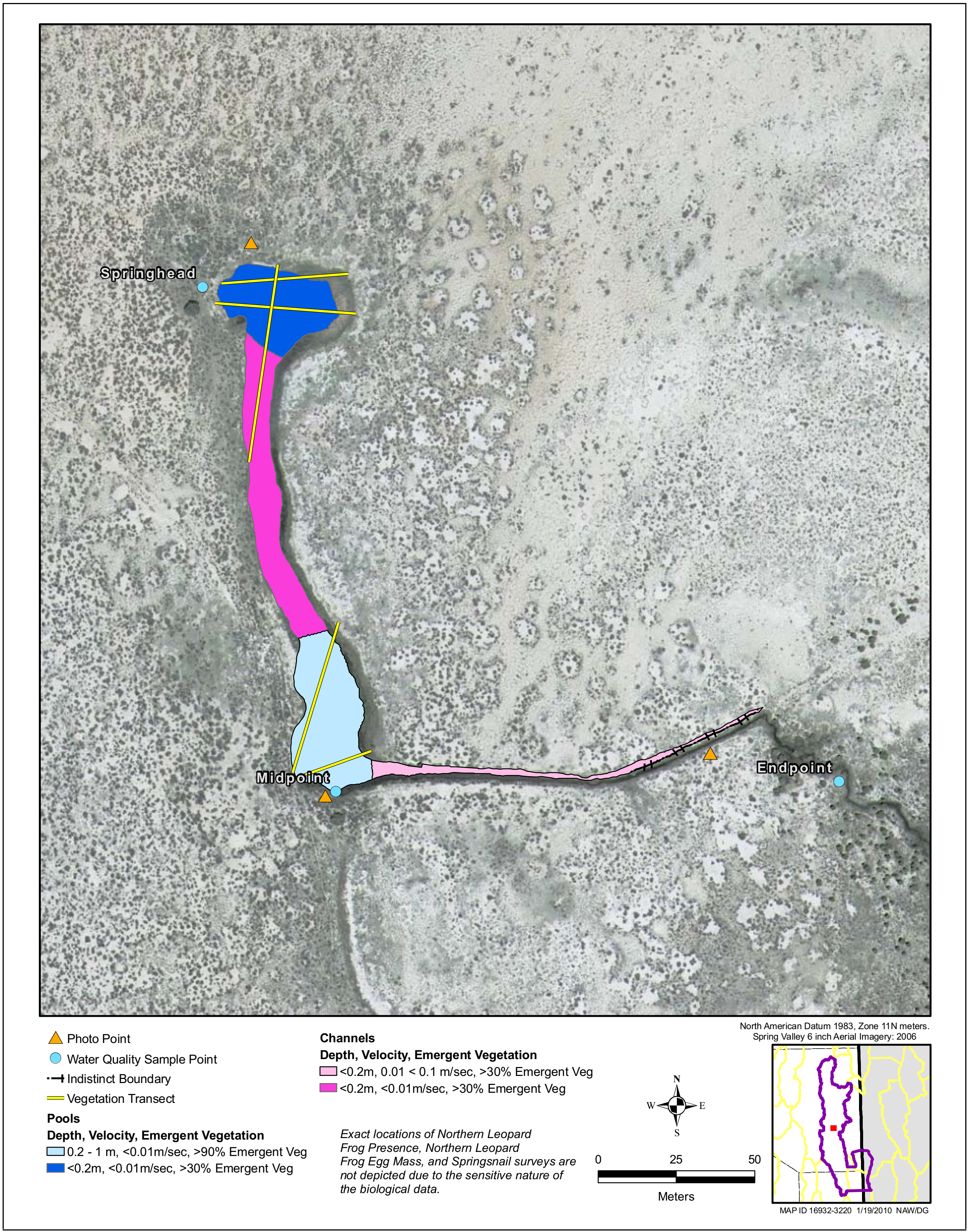


Figure B-27
Unnamed 5 Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-28
Spring Season Mapped Area at West Spring Valley Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	<0.01	EmVeg	96
Channel	<0.2	N/A	EmVeg	26
Channel	<0.2	0.01 - 0.1	EmVeg	67
Channel	<0.2	0.1 - 0.5	EmVeg	573
Pool	0.2 - 1	<0.01	EmVeg	96
Pool	<0.2	<0.01	EmVeg	346
Pool	>1	<0.01	EmVeg	71
			Total Channels	**762**
			Total Pools	**513**
			Total Aquatic Mapped Area	**1,275**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

Table B-29
Fall Season Mapped Area at West Spring Valley Complex Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Channel	<0.2	<0.01	>90	115
Channel	<0.2	0.01 - 0.1	>90	177
Channel	<0.2	0.01 - 0.1	30 - 90	408
Pool	<0.2	<0.01	>90	107
Pool	<0.2	<0.01	<30	110
Pool	>1	<0.01	<30	34
Pool	0.2 - 1	<0.01	<30	96
			Total Channels	**700**
			Total Pools	**347**
			Total Aquatic Mapped Area	**1,047**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

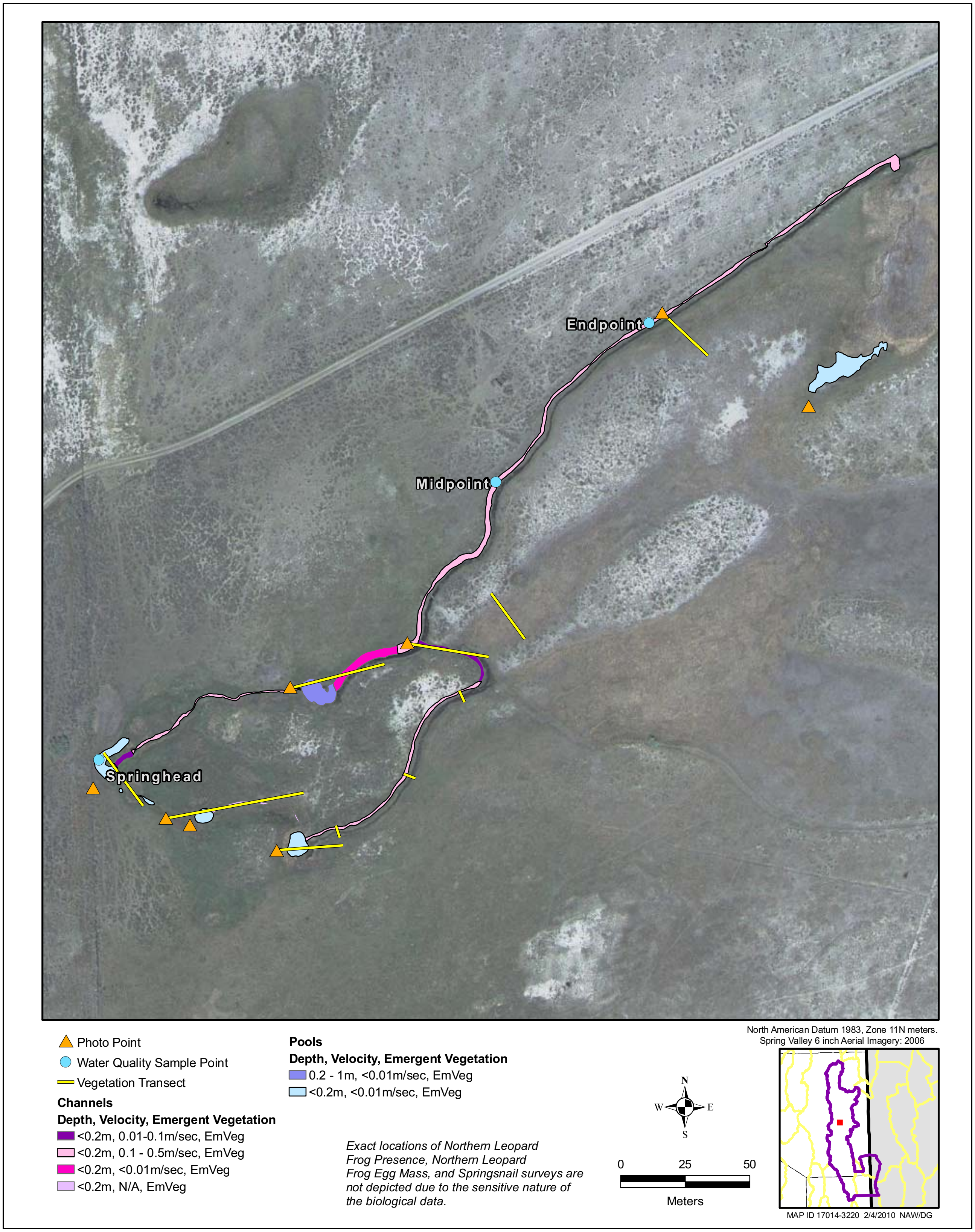


Figure B-28
West Spring Valley Complex 1 Physical Habitat Map for Spring 2009

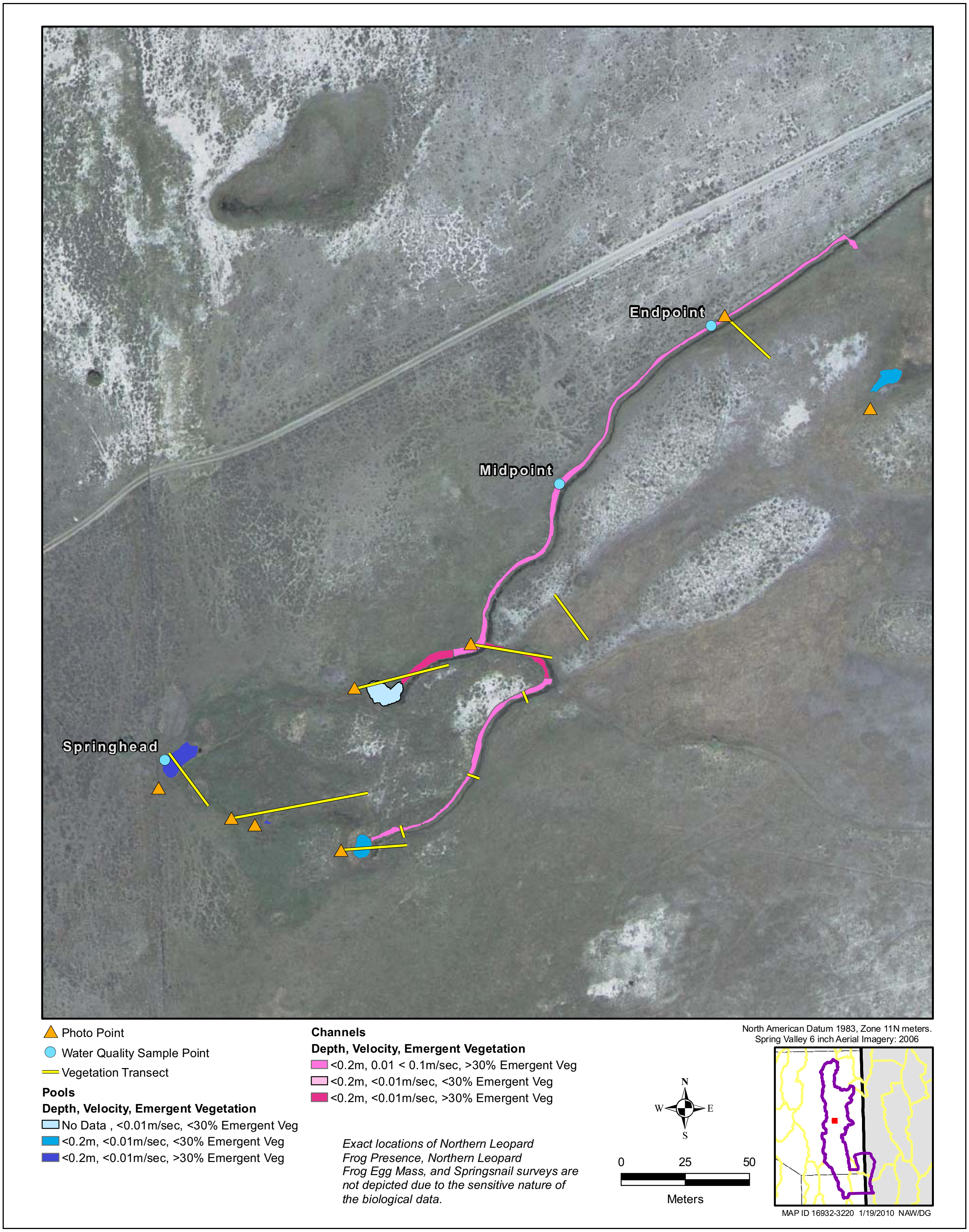


Figure B-29
West Spring Valley Complex 1 Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Table B-30
Spring Season Mapped Area at Willard Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	<0.01	EmVeg	6
Pool	<0.2	<0.01	EmVeg	30
			Total Channels	**6**
			Total Pools	**30**
			Total Aquatic Mapped Area	**36**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

In the fall season, Willard Spring was dry.

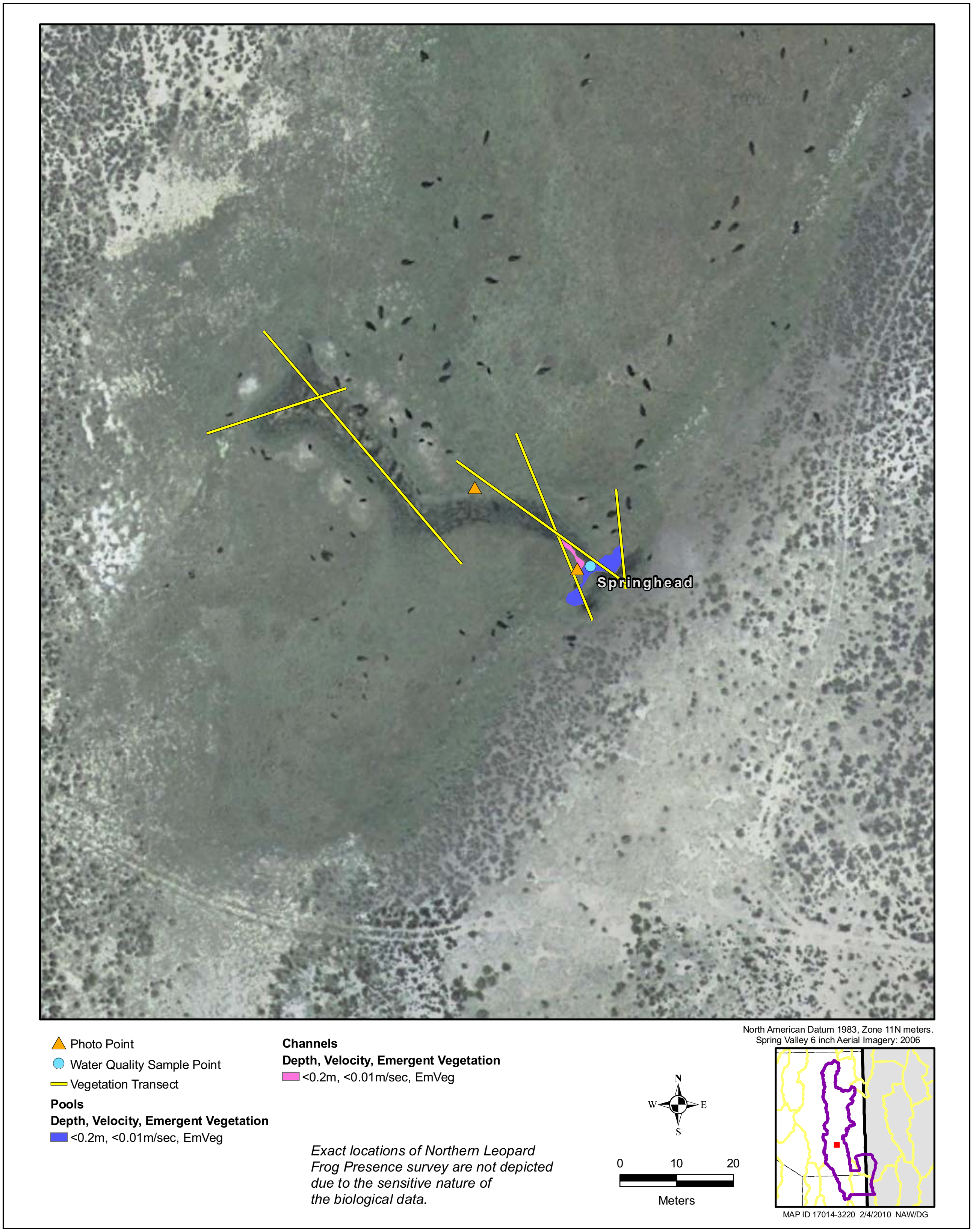


Figure B-30
Willard Physical Habitat Map for Spring 2009

Table B-31
Spring Season Mapped Area at Willow Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation (Presence or Absence)	Area (m^2)
Channel	<0.2	N/A	EmVeg	173
Pool	<0.2	N/A	EmVeg	209
			Total Channels	**173**
			Total Pools	**209**
			Total Aquatic Mapped Area	**382**

N/A = Not applicable – unable to measure velocity due to shallow or muddy water, extensive aquatic vegetation, or wind.
Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.
Springbrook length was 89 m.

Table B-32
Fall Season Mapped Area at Willow Spring Valley Complex Summarized by Physical Habitat Type, HMU Type, and Total Aquatic Mapped Area

HMU	Depth (m)	Velocity (m/sec)	Emergent Vegetation	Area (m^2)
Pool	<0.2	<0.01	>90	34
Channel	<0.2	0.01 - 0.1	>90	20
Channel	<0.2	<0.01	>90	116
			Total Channels	**136**
			Total Pools	**34**
			Total Aquatic Mapped Area	**170**

Note: Interpretations and conclusions made from this data need to take into consideration the margin of error associated with boundary demarcation and associated area measurements.

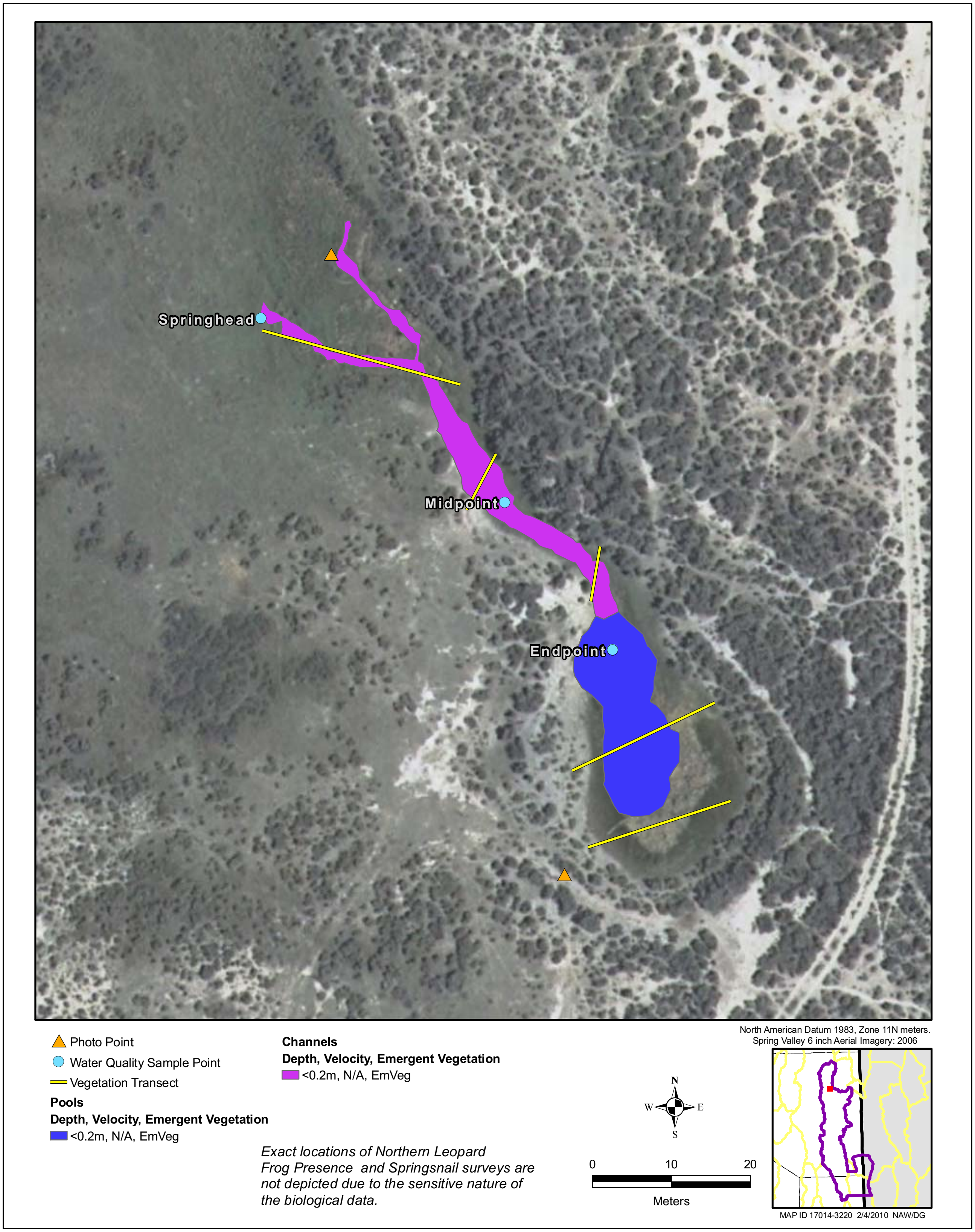


Figure B-31
Willow Spring Physical Habitat Map for Spring 2009

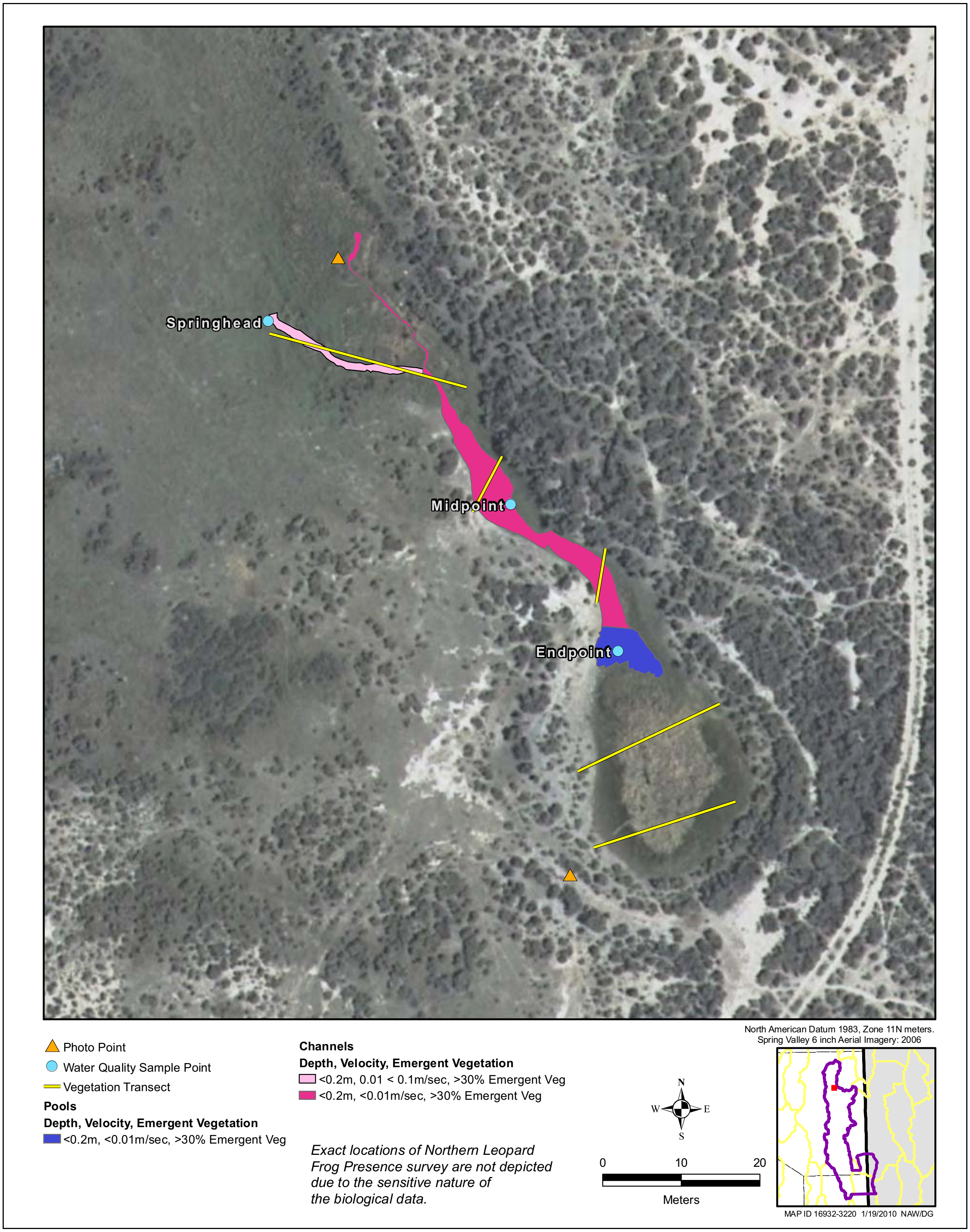


Figure B-32
Willow Spring Physical Habitat Map for Fall 2009

This Page Left Intentionally Blank

Appendix C

Water Quality Data

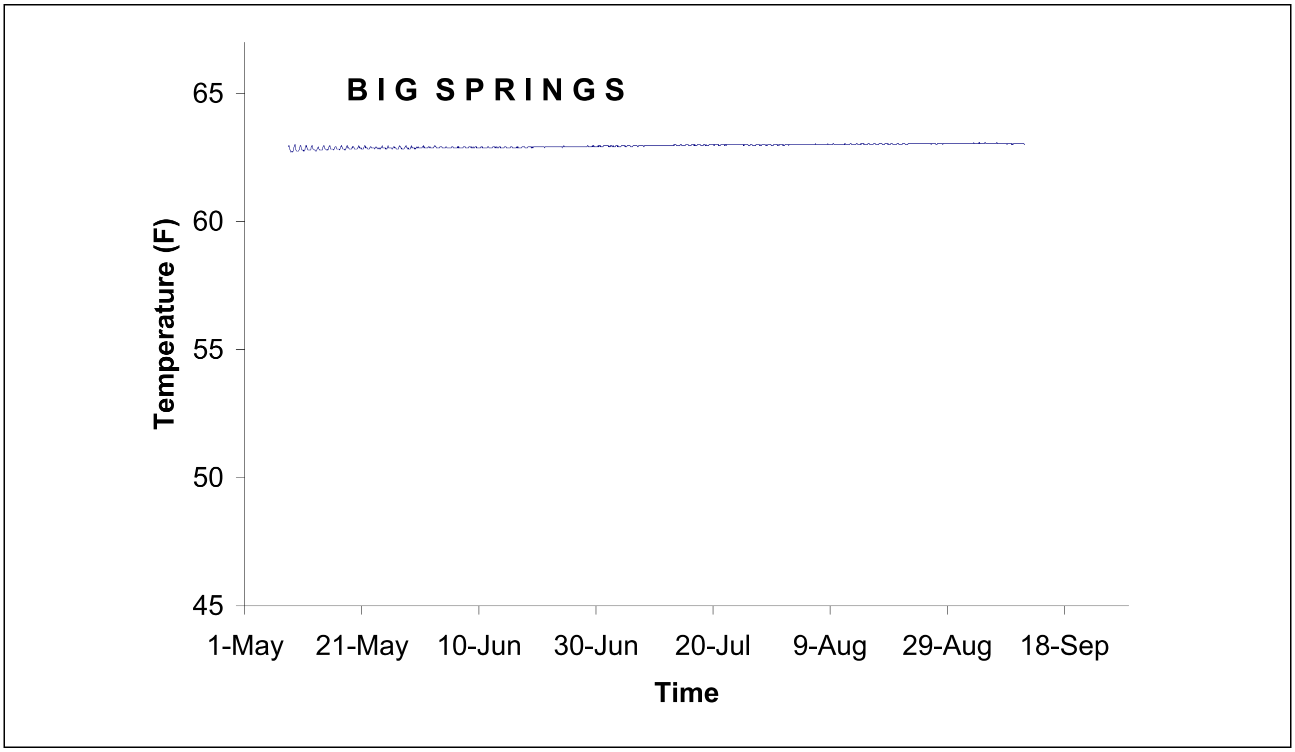


Figure C-1
Big Springs Hourly Temperature Measurements at Springheads

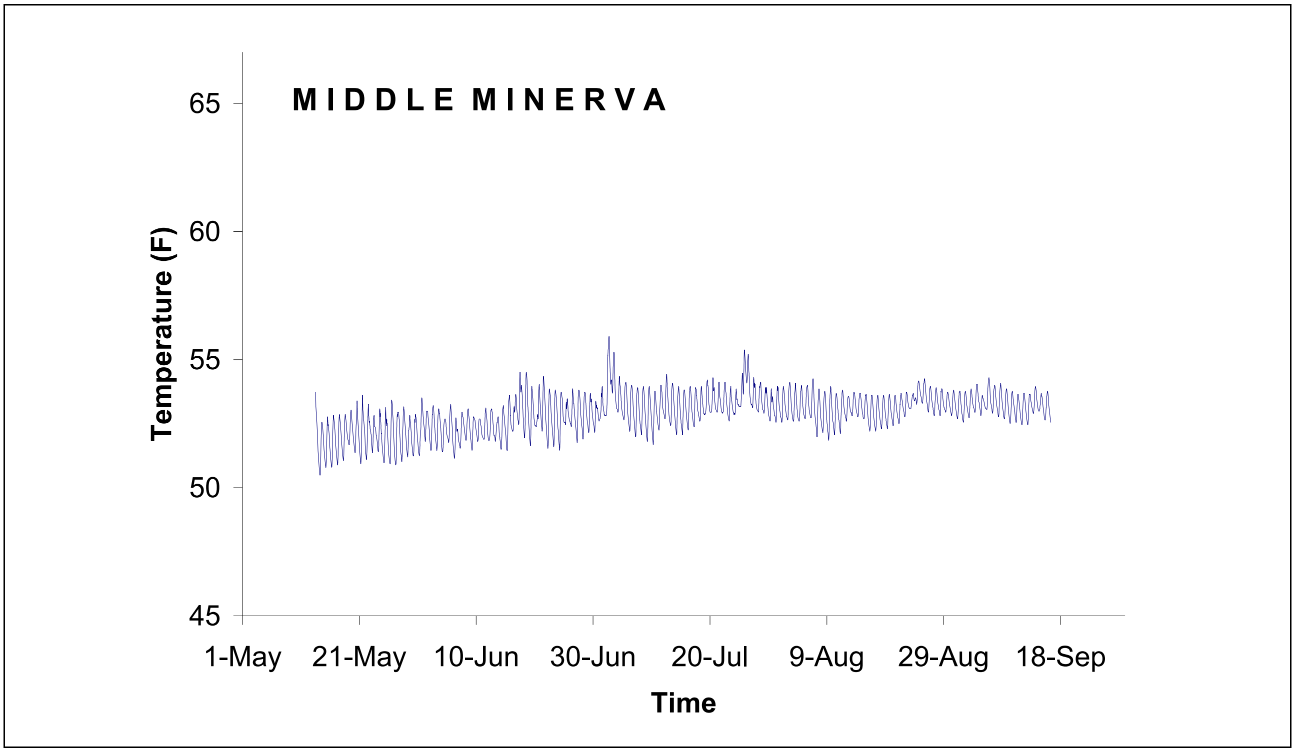


Figure C-2
Middle Minerva Hourly Temperature Measurements at Springheads

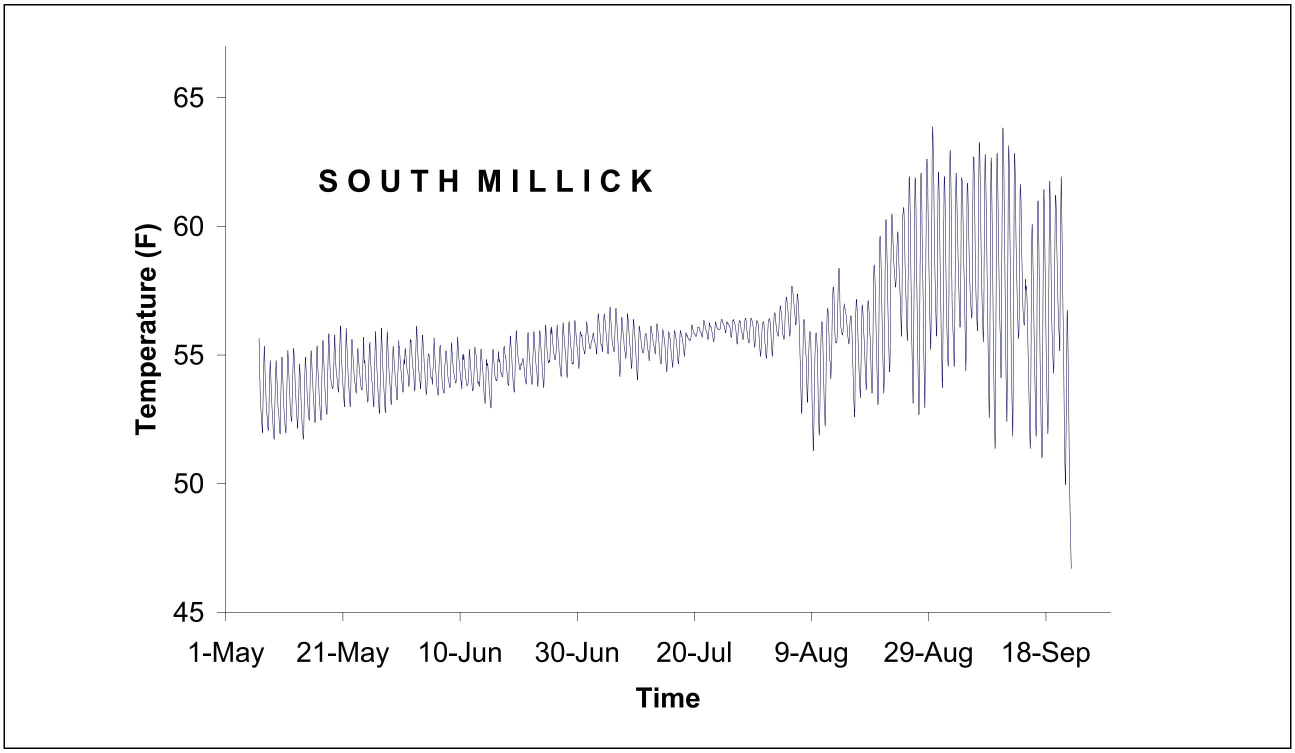


Figure C-3
South Millick Hourly Temperature Measurements at Springheads

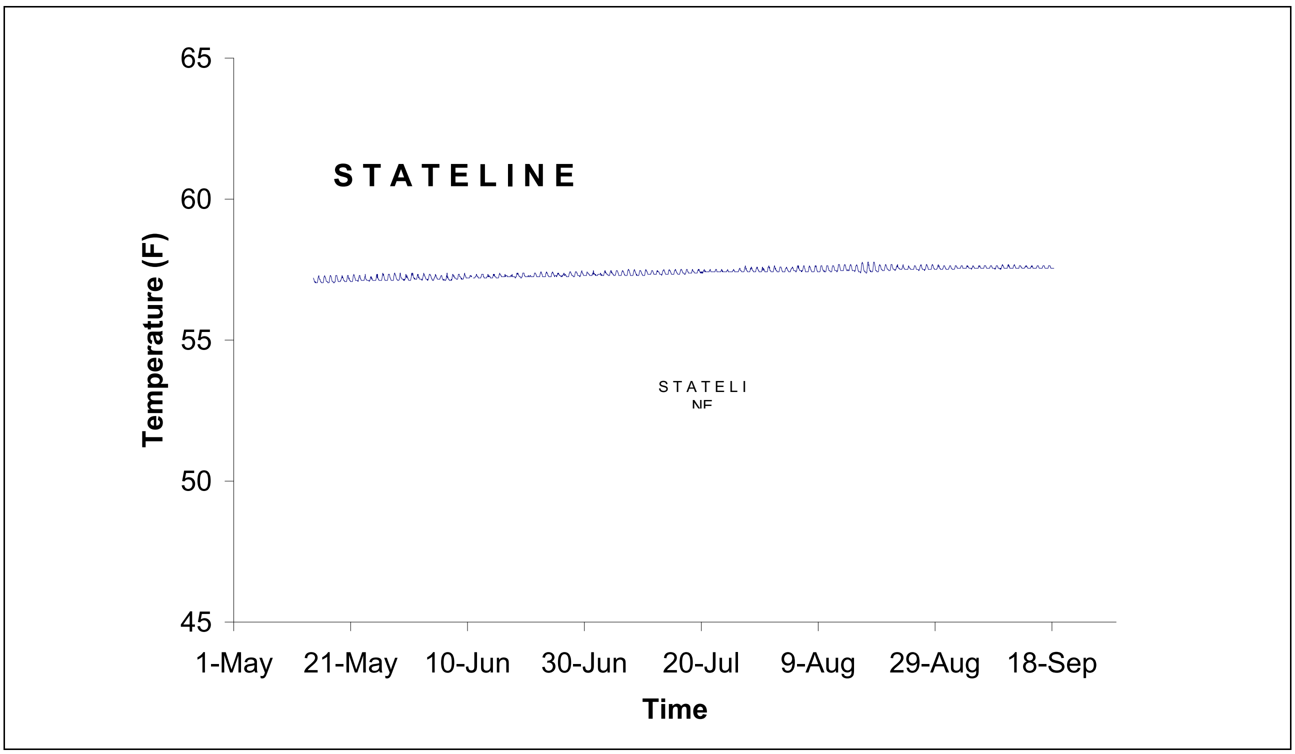


Figure C-4
Stateline Hourly Temperature Measurements at Springheads

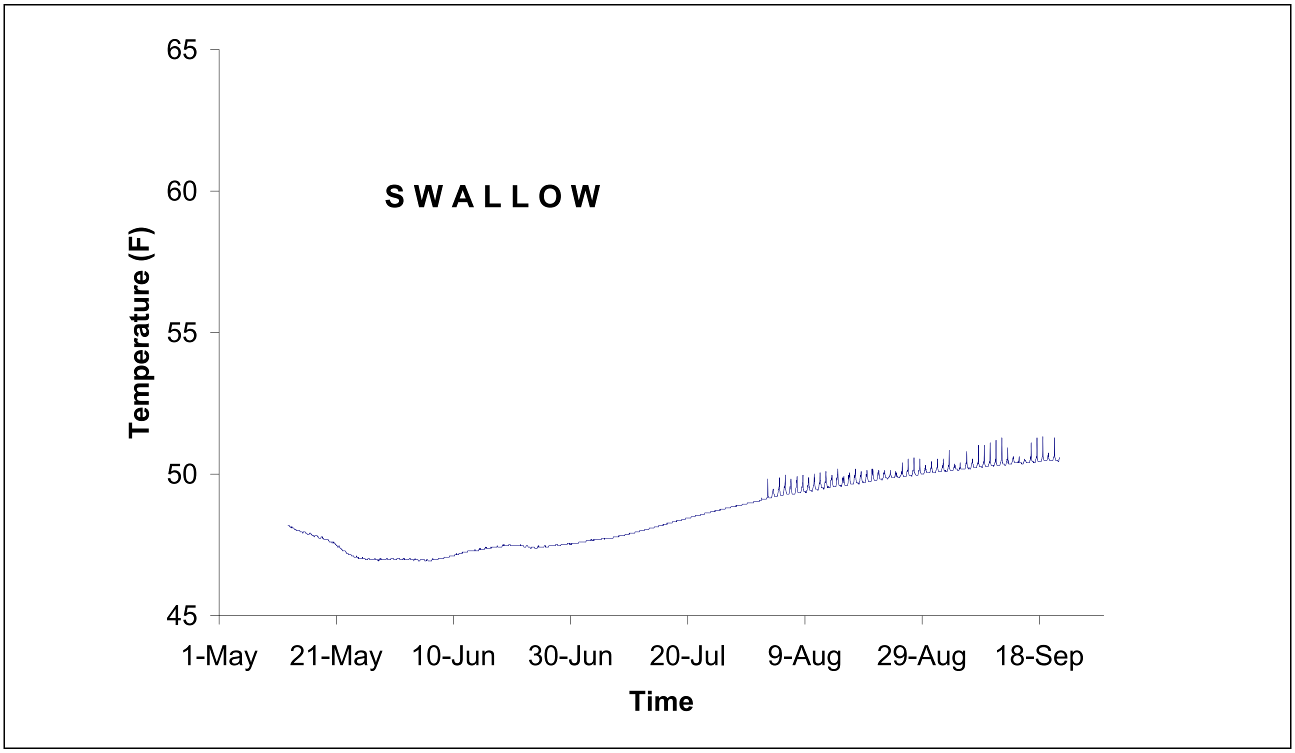


Figure C-5
Swallow Hourly Temperature Measurements at Springheads

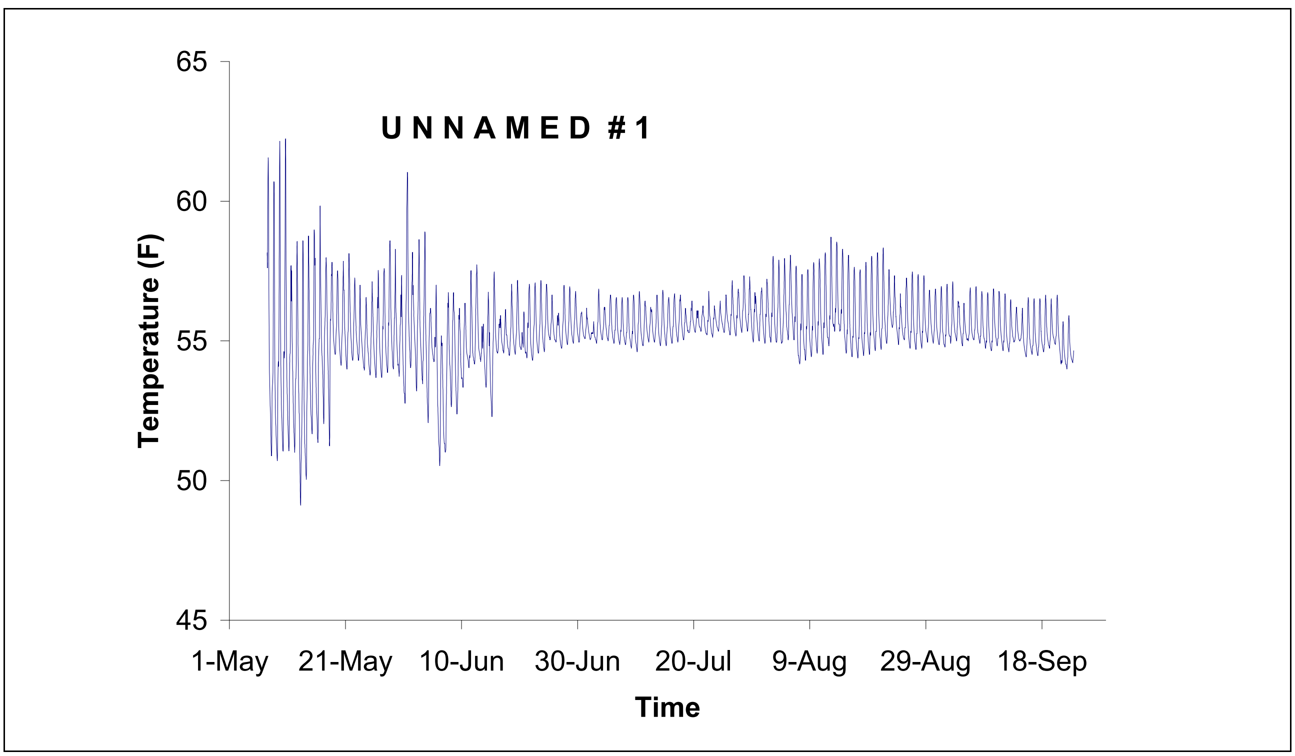


Figure C-6
Unnamed 1 Hourly Temperature Measurements at Springheads

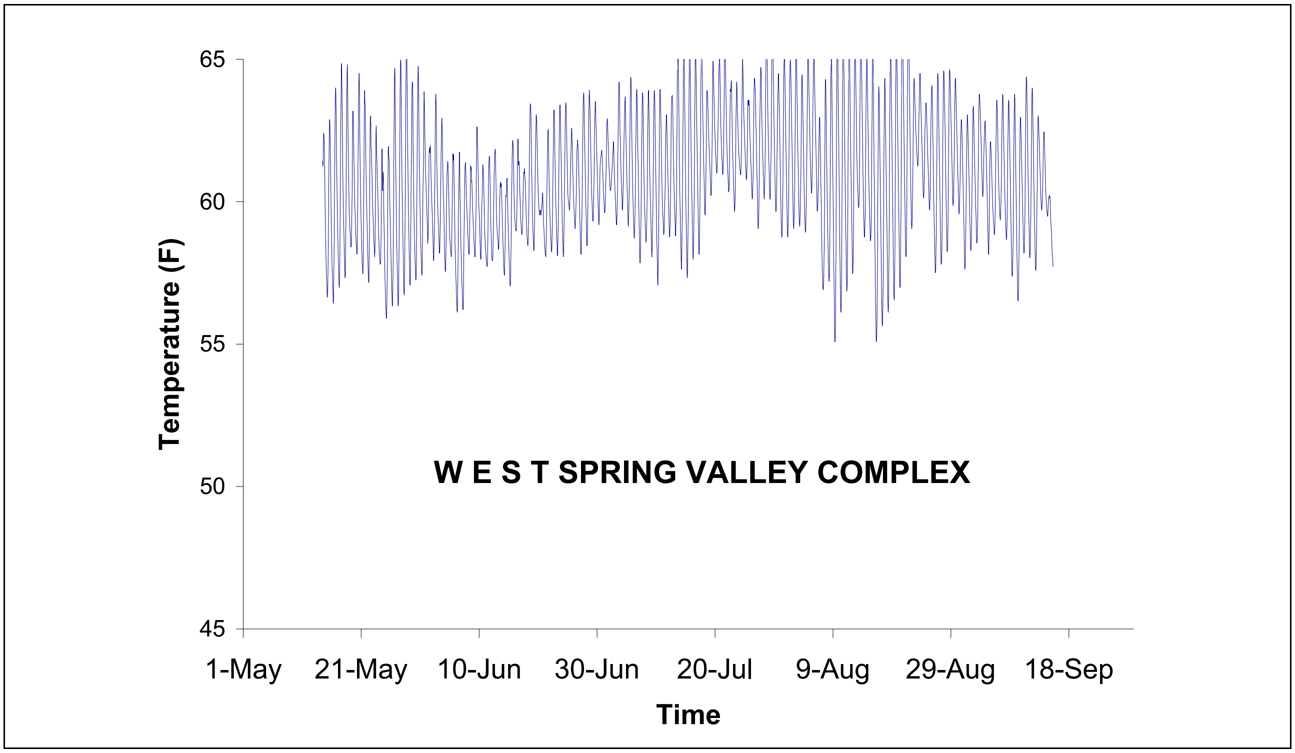


Figure C-7
West Spring Valley Complex Hourly Temperature Measurements at Springheads

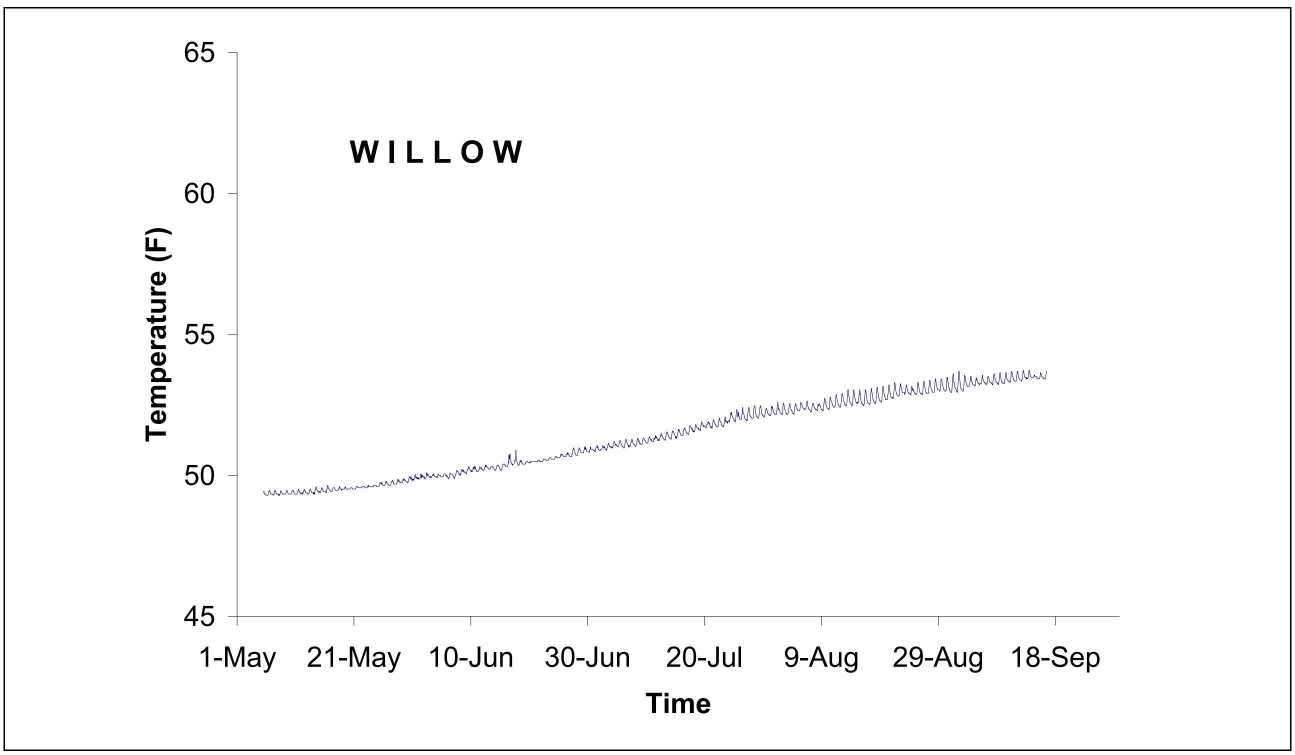


Figure C-8
Willow Hourly Temperature Measurements at Springheads

Appendix D

Springsnail Distribution Graphs
Spring and Fall 2009

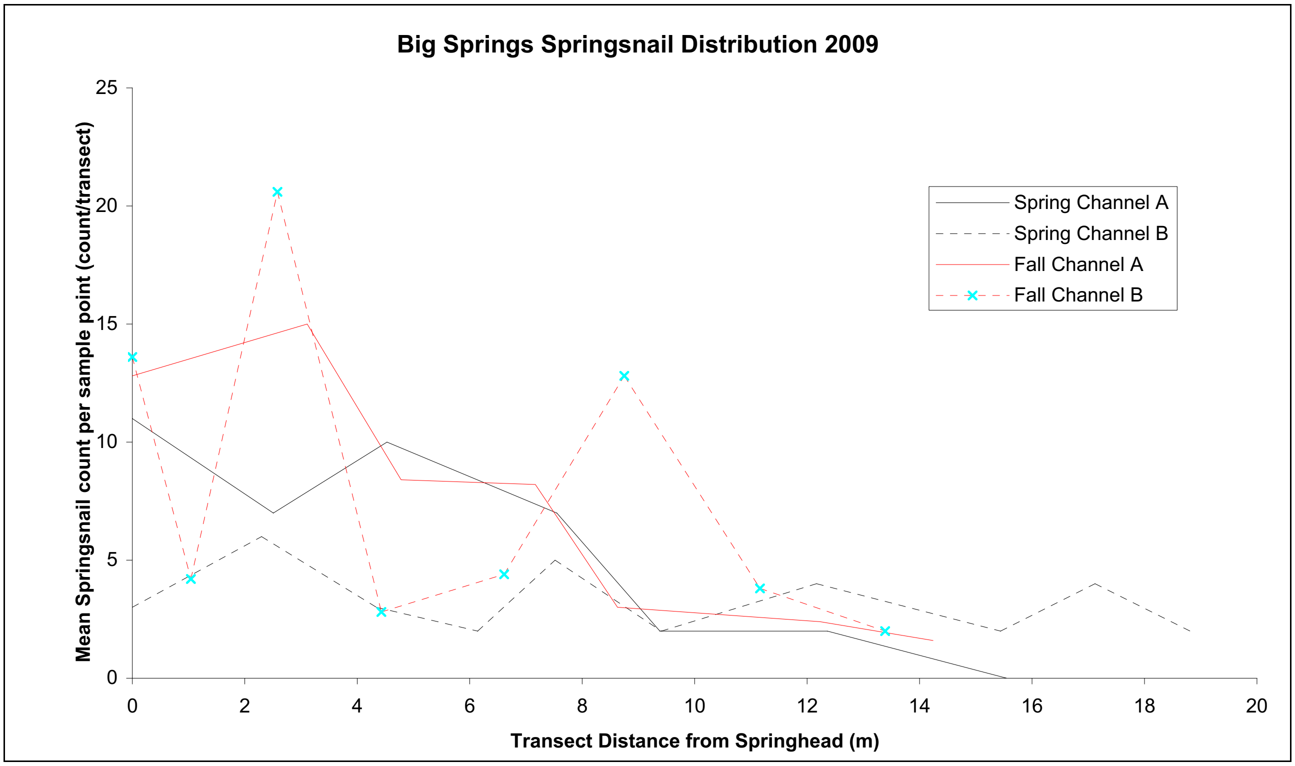


Figure D-1
Big Spring Springsnail Distribution, 2009

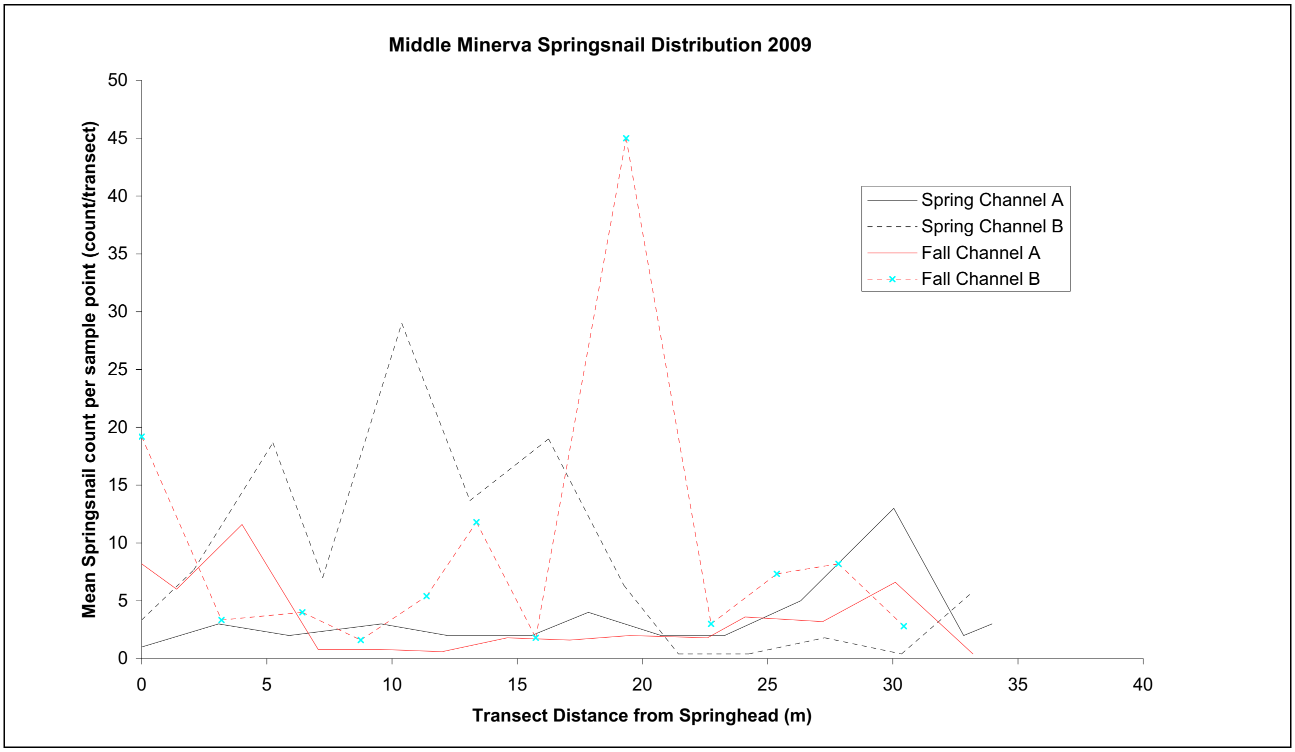


Figure D-2
Middle Minerva Springsnail Distribution, 2009

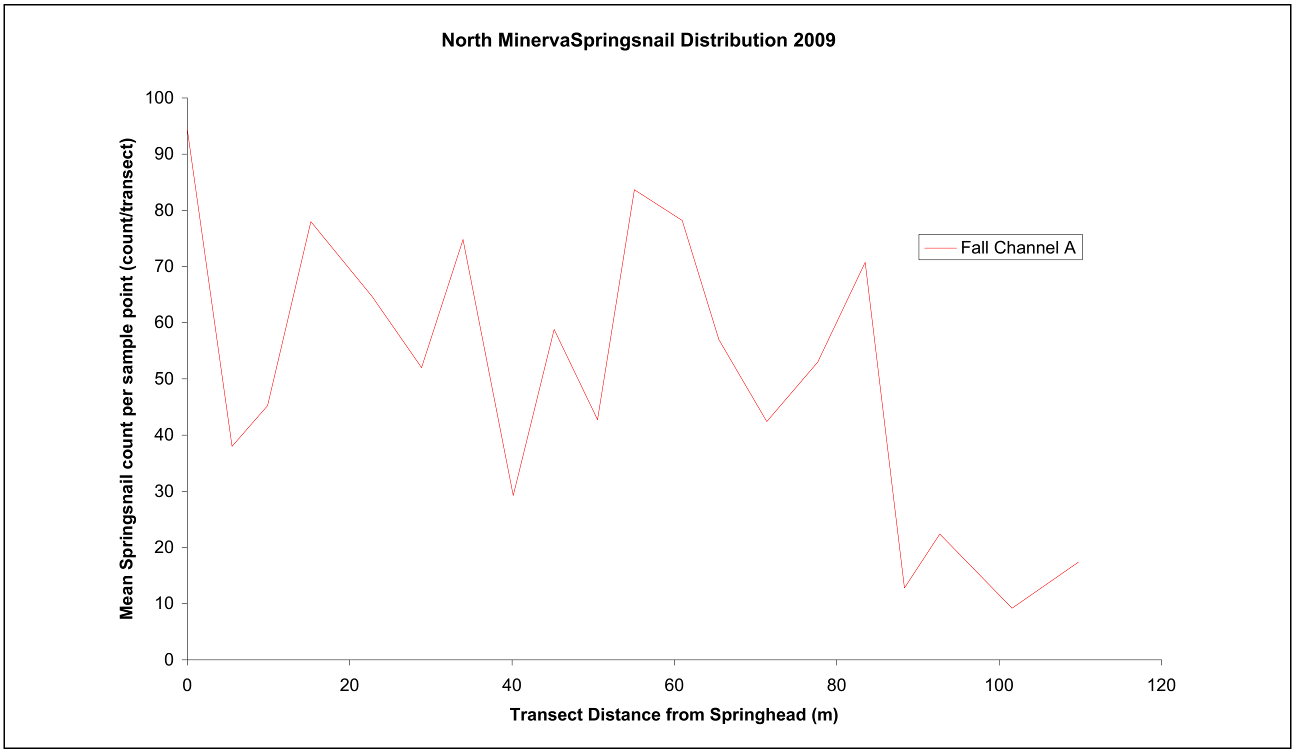


Figure D-3
North Minerva Springsnail Distribution, 2009

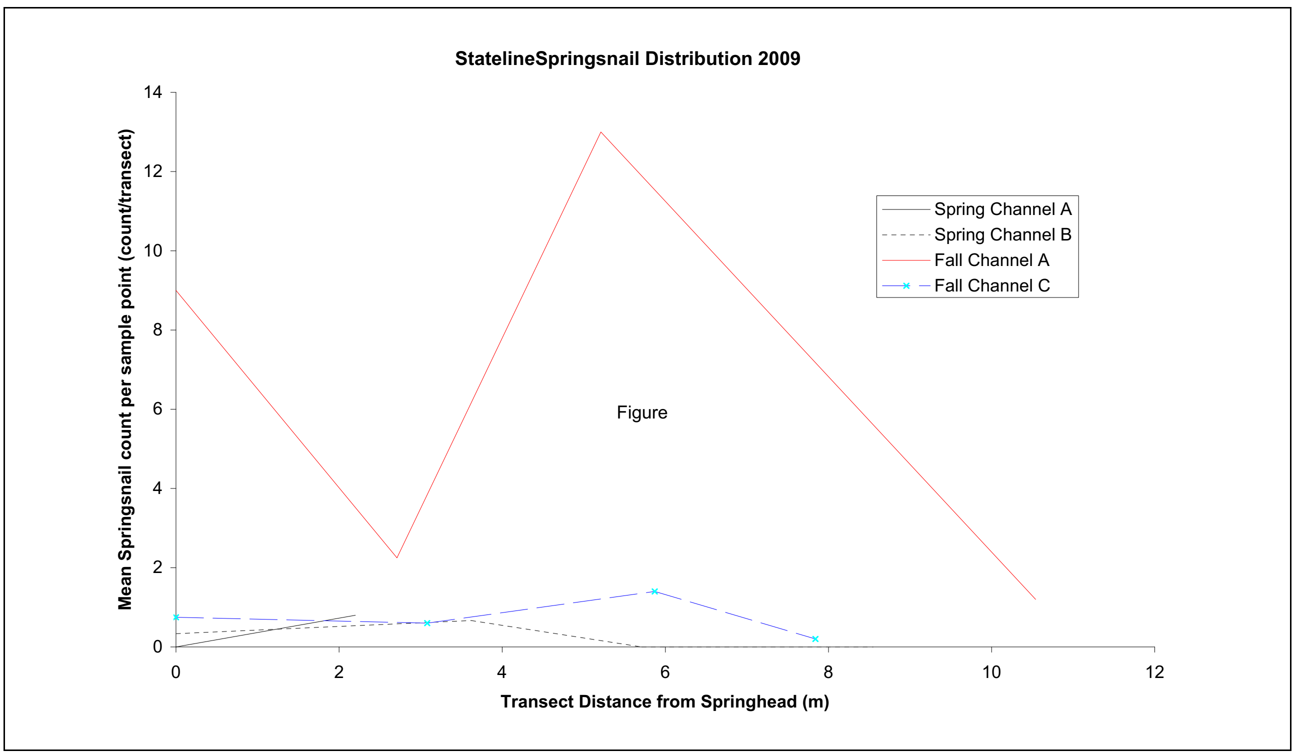


Figure D-4
Stateline Springsnail Distribution, 2009

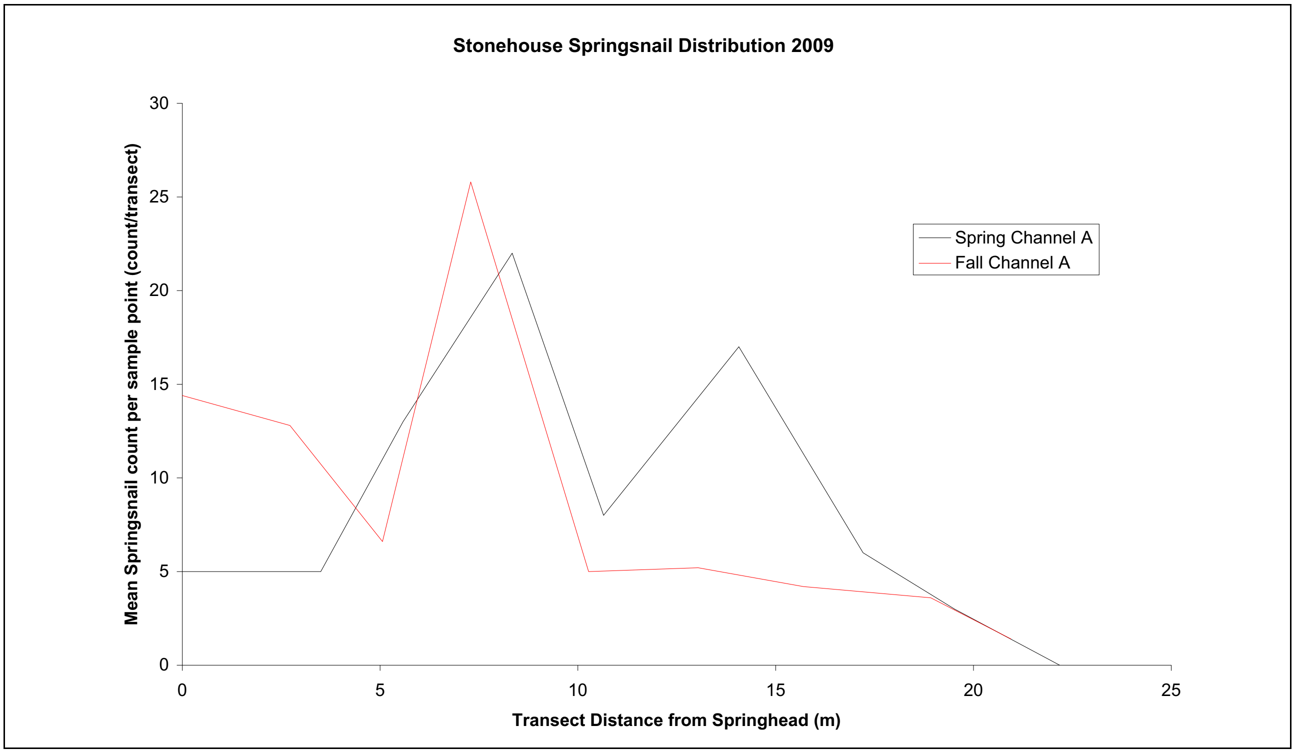


Figure D-5
Stonehouse Springsnail Distribution, 2009

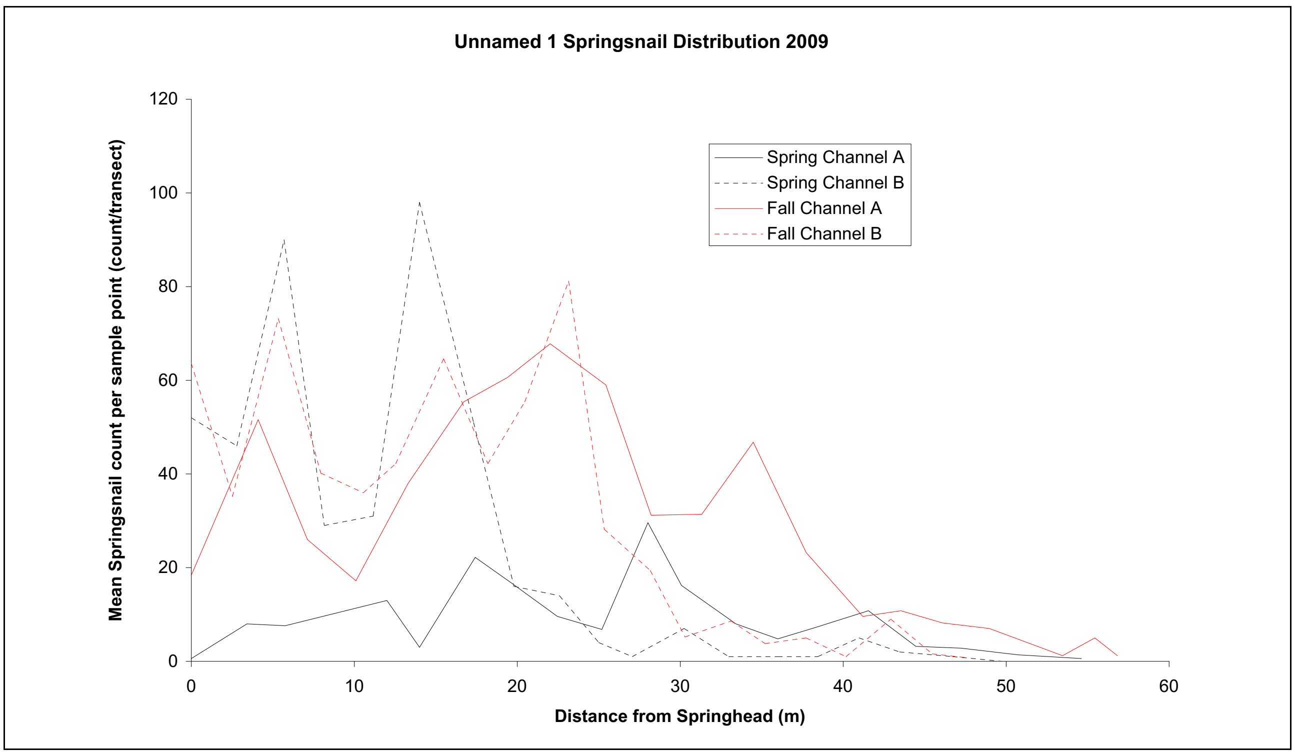


Figure D-6
Unnamed 1 Springsnail Distribution, 2009

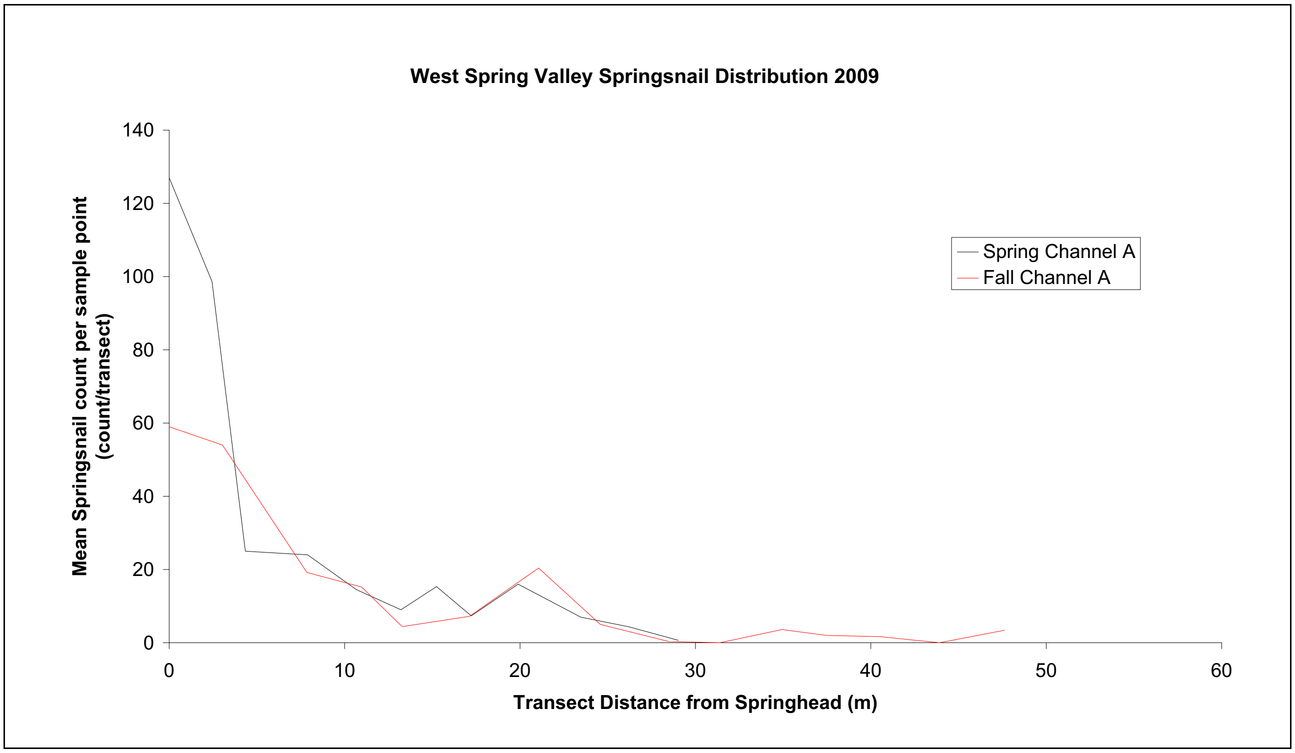


Figure D-7
West Spring Valley Springsnail Distribution, 2009

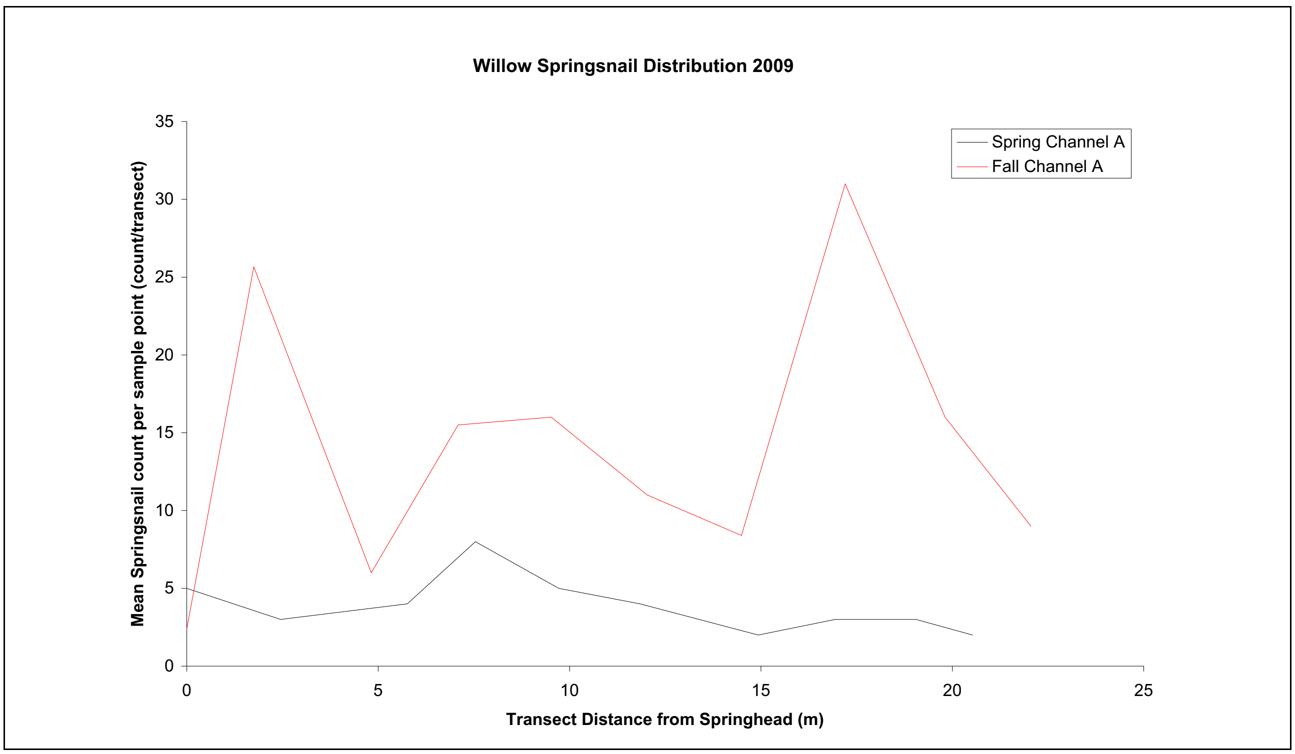


Figure D-8
Willow Springsnail Distribution, 2009

Appendix E

Macroinvertebrate Metric Results
(as provided by Rithron Laboratories)

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp001
Sta. Name: BS: Sample 551
Client ID: Spring 2009
STORET ID:
Coll. Date:

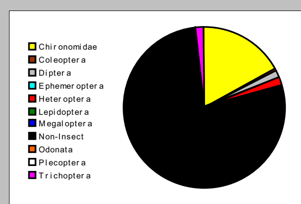
Abundance Measures

Sample Count: 310
Sample Abundance: 715.38   43.33% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	7	240	77.42%
Odonata			
Ephemeroptera			
Plecoptera			
Heteroptera	1	6	1.94%
Megaloptera			
Trichoptera	3	5	1.61%
Lepidoptera			
Coleoptera	1	1	0.32%
Diptera	2	5	1.61%
Chironomidae	8	53	17.10%

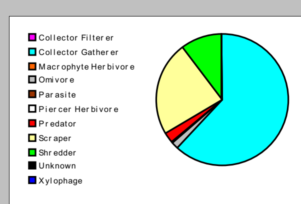


Dominant Taxa

Category	A	PRA
Hyalella	154	49.68%
Pyrgulopsis	62	20.00%
Limnophyes	19	6.13%
Cricotopus	18	5.81%
Pacifastacus leniusculus	11	3.55%
Acricotopus	7	2.26%
Physa	6	1.94%
Ambrysus	6	1.94%
Ostracoda	5	1.61%
Metriocnemus	5	1.61%
Helicopsyche	3	0.97%
Ephydridae	3	0.97%
Tipula	2	0.65%
Parametriocnemus	2	0.65%
Ablabesmyia	1	0.32%

Functional Composition

Category	R	A	PRA
Predator	4	9	2.90%
Parasite			
Collector Gatherer	7	191	61.61%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore	1	1	0.32%
Xylophage			
Scraper	5	73	23.55%
Shredder	4	31	10.00%
Omivore	1	5	1.61%
Unknown			

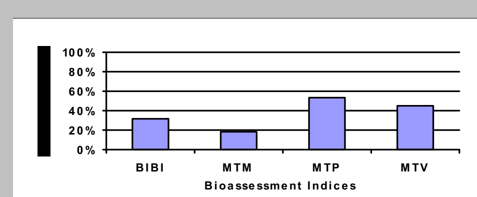


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	22	3	2		1
Non-Insect Percent	77.42%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	3	1		2	
EPT Richness	3		1		0
EPT Percent	1.61%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	49.68%		1		0
Dominant Taxa (2) Percent	69.68%				
Dominant Taxa (3) Percent	75.81%	1			
Dominant Taxa (10) Percent	94.52%				
Diversity					
Shannon H (loge)	1.770				
Shannon H (log2)	2.554		2		
Margalef D	3.876				
Simpson D	0.296				
Evenness	0.091				
Function					
Predator Richness	4		2		
Predator Percent	2.90%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	61.61%		2		2
Scraper+Shredder Percent	33.55%		3		1
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	2				
Burrower Percent	2.26%				
Swimmer Richness	1				
Swimmer Percent	0.32%				
Clinger Richness	5	1			
Clinger Percent	9.03%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	0.32%				
Air Breather Richness	2				
Air Breather Percent	0.97%				
Voltinism					
Univoltine Richness	8				
Semivoltine Richness	2	1			
Multivoltine Percent	19.03%		3		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	0.97%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.601				
Pollution Sensitive Richness	1	1		1	
Pollution Tolerant Percent	10.00%	5		2	
Hilsenhoff Biotic Index	7.528		0		0
Intolerant Percent	0.32%				
Supertolerant Percent	62.26%				
CTQa	92.400				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	16	32.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	16	53.33%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	8	44.44%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	4	19.05%	Severe



Sunday, November 22, 2009

Figure E-1
Spring 2009 Macroinvertebrate Metric Results for Big Springs

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2004
Sta. Name: BS: Sample 552-554
Client ID: Fall 2009
STORET ID:
Coll. Date:

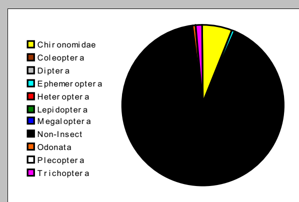
Abundance Measures

Sample Count:	306		
Sample Abundance:	2,295.00	13.33%	of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	8	280	91.50%
Odonata	1	2	0.65%
Ephemeroptera	1	1	0.33%
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	3	4	1.31%
Lepidoptera			
Coleoptera			
Diptera			
Chironomidae	5	19	6.21%

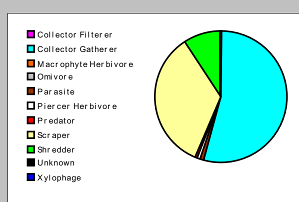


Dominant Taxa

Category	A	PRA
Hyalella	135	44.12%
Hydrobiidae	104	33.99%
Amphipoda	23	7.52%
Cricotopus (Cricotopus)	13	4.25%
Gammarus	10	3.27%
Pacifastacus leniusculus	2	0.65%
Oxyethira	2	0.65%
Ostracoda	2	0.65%
Nematoda	2	0.65%
Cricotopus	2	0.65%
Ferrissia	1	0.33%
Eukiefferiella Claripennis Gr.	1	0.33%
Coenagrionidae	1	0.33%
Cheumatopsyche	1	0.33%
Argia	1	0.33%

Functional Composition

Category	R	A	PRA
Predator	1	2	0.65%
Parasite	1	2	0.65%
Collector Gatherer	5	163	53.27%
Collector Filterer	2	2	0.65%
Macrophyte Herbivore			
Piercer Herbivore	1	2	0.65%
Xylophage			
Scraper	3	106	34.64%
Shredder	4	28	9.15%
Omivore	1	1	0.33%
Unknown			

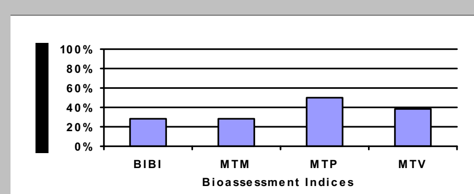


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	18	1	2		0
Non-Insect Percent	91.50%				
E Richness	1	1		0	
P Richness	0	1		0	
T Richness	3	1		2	
EPT Richness	4		1		0
EPT Percent	1.63%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.250				
Dominance					
Dominant Taxon Percent	44.12%		2		1
Dominant Taxa (2) Percent	78.10%				
Dominant Taxa (3) Percent	85.62%	1			
Dominant Taxa (10) Percent	96.41%				
Diversity					
Shannon H (loge)	1.324				
Shannon H (log2)	1.909		1		
Margalef D	3.017				
Simpson D	0.372				
Evenness	0.110				
Function					
Predator Richness	1		0		
Predator Percent	0.65%	1			
Filterer Richness	2				
Filterer Percent	0.65%			3	
Collector Percent	53.92%		3		3
Scraper+Shredder Percent	43.79%		3		2
Scraper/Filterer	53.000				
Scraper/Scraper+Filterer	0.981				
Habit					
Burrower Richness	1				
Burrower Percent	0.33%				
Swimmer Richness	1				
Swimmer Percent	0.33%				
Clinger Richness	4	1			
Clinger Percent	5.88%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	9				
Semivoltine Richness	1	1			
Multivoltine Percent	8.17%		3		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	0.33%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.949				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	6.21%	5		2	
Hilsenhoff Biotic Index	7.389		0		0
Intolerant Percent	0.33%				
Supertolerant Percent	79.74%				
CTQa	103.500				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	14	28.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	15	50.00%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	7	38.89%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	6	28.57%	Moderate



Thursday, December 10, 2009

Figure E-2
Fall 2009 Macroinvertebrate Metric Results for Big Springs

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2003
Sta. Name: CC: Sample 601-613
Client ID: Fall 2009
STORET ID:
Coll. Date:

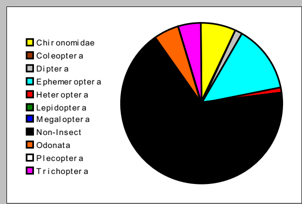
Abundance Measures

Sample Count: 309
Sample Abundance: 2,648.57 11.67% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	8	208	67.31%
Odonata	2	15	4.85%
Ephemeroptera	3	42	13.59%
Plecoptera			
Heteroptera	1	3	0.97%
Megaloptera			
Trichoptera	5	15	4.85%
Lepidoptera			
Coleoptera			
Diptera	3	4	1.29%
Chironomidae	6	22	7.12%

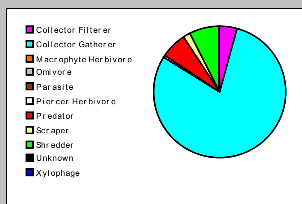


Dominant Taxa

Category	A	PRA
Amphipoda	140	45.31%
Ostracoda	40	12.94%
Baetidae	18	5.83%
Tricorythodes	15	4.85%
Gammarus	15	4.85%
Argia	13	4.21%
Hydropsyche	9	2.91%
Thienemanniella	7	2.27%
Plauditus	5	1.62%
Orthocladius	5	1.62%
Hyalella	5	1.62%
Baetis	4	1.29%
Ferrissia	3	0.97%
Cricotopus (Cricotopus)	3	0.97%
Hydroptilidae	2	0.65%

Functional Composition

Category	R	A	PRA
Predator	5	20	6.47%
Parasite			
Collector Gatherer	10	244	78.96%
Collector Filterer	4	14	4.53%
Macrophyte Herbivore			
Piercer Herbivore	1	2	0.65%
Xylophage			
Scraper	3	5	1.62%
Shredder	4	23	7.44%
Omivore	1	1	0.32%
Unknown			

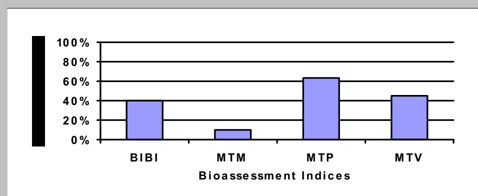


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	28	3	3		2
Non-Insect Percent	67.31%				
E Richness	3	1		1	
P Richness	0	1		0	
T Richness	5	3		3	
EPT Richness	8		2		0
EPT Percent	18.45%		1		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.643				
Hydropsychidae/Trichoptera	0.667				
Dominance					
Dominant Taxon Percent	45.31%		1		0
Dominant Taxa (2) Percent	58.25%				
Dominant Taxa (3) Percent	64.08%	3			
Dominant Taxa (10) Percent	86.41%				
Diversity					
Shannon H (loge)	2.592				
Shannon H (log2)	3.739		3		
Margalef D	5.472				
Simpson D	0.120				
Evenness	0.064				
Function					
Predator Richness	5		2		
Predator Percent	6.47%	1			
Filterer Richness	4				
Filterer Percent	4.53%			3	
Collector Percent	83.50%		1		0
Scraper+Shredder Percent	9.06%		1		0
Scraper/Filterer	0.357				
Scraper/Scraper+Filterer	0.263				
Habit					
Burrower Richness	2				
Burrower Percent	0.65%				
Swimmer Richness	3				
Swimmer Percent	2.27%				
Clinger Richness	9	1			
Clinger Percent	11.00%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	0.32%				
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	15				
Semivoltine Richness	1	1			
Multivoltine Percent	30.10%		3		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	5.83%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.325				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	16.83%	5		1	
Hilsenhoff Biotic Index	5.019		2		0
Intolerant Percent	0.65%				
Supertolerant Percent	15.53%				
CTQa	96.048				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	20	40.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	19	63.33%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	8	44.44%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	2	9.52%	Severe



Thursday, December 10, 2009

Figure E-3
Fall 2009 Macroinvertebrate Metric Results for Big Springs/Lake Creek

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp002
Sta. Name: KR: Sample 51-55
Client ID: Spring 2009
STORET ID:
Coll. Date:

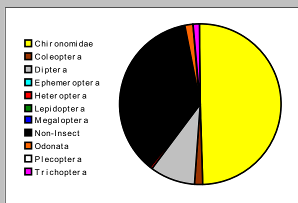
Abundance Measures

Sample Count:	300		
Sample Abundance:	371.90	80.67%	of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	10	110	36.67%
Odonata	1	4	1.33%
Ephemeroptera			
Plecoptera			
Heteroptera	1	2	0.67%
Megaloptera			
Trichoptera	2	4	1.33%
Lepidoptera			
Coleoptera	3	5	1.67%
Diptera	5	27	9.00%
Chironomidae	19	148	49.33%

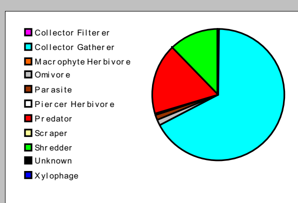


Dominant Taxa

Category	A	PRA
Micropsectra	38	12.67%
Amphipoda	32	10.67%
Hyalella	22	7.33%
Polypedilum	17	5.67%
Ostracoda	17	5.67%
Acricotopus	13	4.33%
Hydrozetes	12	4.00%
Corynoneura	12	4.00%
Chaetocladius	11	3.67%
Cricotopus	10	3.33%
Limnophyes	8	2.67%
Copepoda	8	2.67%
Chironomus	8	2.67%
Bezzia / Palpomyia	8	2.67%
Paratendipes	6	2.00%

Functional Composition

Category	R	A	PRA
Predator	14	53	17.67%
Parasite	1	3	1.00%
Collector Gatherer	18	200	66.67%
Collector Filterer	1	2	0.67%
Macrophyte Herbivore			
Piercer Herbivore	1	1	0.33%
Xylophage			
Scraper			
Shredder	5	37	12.33%
Omivore	1	4	1.33%
Unknown			

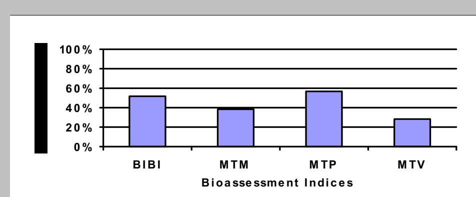


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	41	5	3		3
Non-Insect Percent	36.67%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	2	1		1	
EPT Richness	2		0		0
EPT Percent	1.33%		0		0
Oligochaeta+Hirudinea Percent	2.67%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	12.67%		3		3
Dominant Taxa (2) Percent	23.33%				
Dominant Taxa (3) Percent	30.67%	5			
Dominant Taxa (10) Percent	61.33%				
Diversity					
Shannon H (loge)	3.247				
Shannon H (log2)	4.684		3		
Margalef D	7.208				
Simpson D	0.052				
Evenness	0.039				
Function					
Predator Richness	14		3		
Predator Percent	17.67%	3			
Filterer Richness	1				
Filterer Percent	0.67%			3	
Collector Percent	67.33%		2		2
Scraper+Shredder Percent	12.33%		1		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	7				
Burrower Percent	12.67%				
Swimmer Richness	2				
Swimmer Percent	1.00%				
Clinger Richness	2	1			
Clinger Percent	9.00%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	9				
Hemoglobin Bearer Percent	15.00%				
Air Breather Richness	2				
Air Breather Percent	1.00%				
Voltinism					
Univoltine Richness	9				
Semivoltine Richness	3	3			
Multivoltine Percent	60.00%		1		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	1.33%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.359				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	13.67%	5		1	
Hilsenhoff Biotic Index	6.580		1		0
Intolerant Percent	0.00%				
Supertolerant Percent	38.33%				
CTQa	105.429				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	26	52.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	17	56.67%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	5	27.78%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	8	38.10%	Moderate



Sunday, November 22, 2009

Figure E-4
Spring 2009 Macroinvertebrate Metric Results for Keegan

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2009
Sta. Name: KR: Sample 56-58
Client ID: Fall 2009
STORET ID:
Coll. Date:

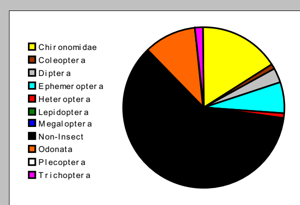
Abundance Measures

Sample Count:	302	
Sample Abundance:	1,132.50	26.67% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	11	183	60.60%
Odonata	3	32	10.60%
Ephemeroptera	1	20	6.62%
Plecoptera			
Heteroptera	2	2	0.66%
Megaloptera			
Trichoptera	1	5	1.66%
Lepidoptera			
Coleoptera	3	3	0.99%
Diptera	3	8	2.65%
Chironomidae	17	49	16.23%

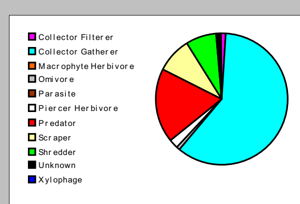


Dominant Taxa

Category	A	PRA
Amphipoda	56	18.54%
Hyalella	41	13.58%
Ostracoda	25	8.28%
Coenagrionidae	24	7.95%
Gammarus	22	7.28%
Callibaetis	20	6.62%
Physidae	11	3.64%
Tanypodinae	10	3.31%
Planorbidae	6	1.99%
Lymnaeidae	6	1.99%
Cladopelma	6	1.99%
Amphiagrion	6	1.99%
Oxyethira	5	1.66%
Copepoda	5	1.66%
Tanypus	4	1.32%

Functional Composition

Category	R	A	PRA
Predator	11	55	18.21%
Parasite			
Collector Gatherer	18	181	59.93%
Collector Filterer	1	3	0.99%
Macrophyte Herbivore			
Piercer Herbivore	3	7	2.32%
Xylophage			
Scraper	4	28	9.27%
Shredder	2	23	7.62%
Omivore	1	2	0.66%
Unknown	1	3	0.99%

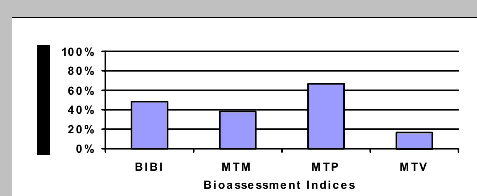


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	41	5	3		3
Non-Insect Percent	60.60%				
E Richness	1	1		0	
P Richness	0	1		0	
T Richness	1	1		0	
EPT Richness	2		0		0
EPT Percent	8.28%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	1.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	18.54%		3		3
Dominant Taxa (2) Percent	32.12%				
Dominant Taxa (3) Percent	40.40%	5			
Dominant Taxa (10) Percent	73.18%				
Diversity					
Shannon H (loge)	2.988				
Shannon H (log2)	4.311		3		
Margalef D	7.508				
Simpson D	0.081				
Evenness	0.048				
Function					
Predator Richness	11		3		
Predator Percent	18.21%	3			
Filterer Richness	1				
Filterer Percent	0.99%			3	
Collector Percent	60.93%		2		2
Scraper+Shredder Percent	16.89%		2		0
Scraper/Filterer	9.333				
Scraper/Scraper+Filterer	0.903				
Habit					
Burrower Richness	4				
Burrower Percent	3.64%				
Swimmer Richness	6				
Swimmer Percent	8.94%				
Clinger Richness	2	1			
Clinger Percent	1.32%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	6				
Hemoglobin Bearer Percent	7.28%				
Air Breather Richness	3				
Air Breather Percent	0.99%				
Voltinism					
Univoltine Richness	15				
Semivoltine Richness	3	3			
Multivoltine Percent	33.77%		3		
Tolerance					
Sediment Tolerant Richness	3				
Sediment Tolerant Percent	5.63%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.468				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	40.40%	3		0	
Hilsenhoff Biotic Index	6.549		1		0
Intolerant Percent	0.00%				
Supertolerant Percent	42.05%				
CTQa	105.120				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	24	48.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	20	66.67%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	3	16.67%	Severe
MTM	Montana DEQ Mountains (Bukantis 1998)	8	38.10%	Moderate



Thursday, December 10, 2009

Figure E-5
Fall 2009 Macroinvertebrate Metric Results for Keegan

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp004
Sta. Name: MSS: Sample 651-654
Client ID: Spring 2009
STORET ID:
Coll. Date:

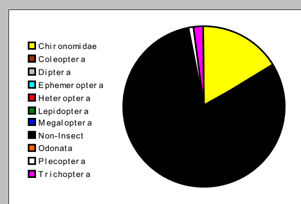
Abundance Measures

Sample Count: 300
Sample Abundance: 765.96 39.17% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	5	239	79.67%
Odonata	1	1	0.33%
Ephemeroptera			
Plecoptera	1	3	1.00%
Heteroptera			
Megaloptera			
Trichoptera	2	6	2.00%
Lepidoptera			
Coleoptera	1	1	0.33%
Diptera			
Chironomidae	6	50	16.67%

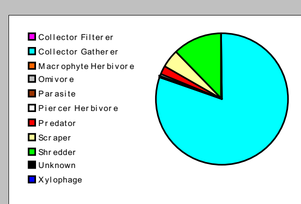


Dominant Taxa

Category	A	PRA
Ostracoda	141	47.00%
Hyalella	46	15.33%
Chaetocladius	43	14.33%
Gammarus	30	10.00%
Pyrgulopsis	10	3.33%
Amphipoda	7	2.33%
Limnephilidae	5	1.67%
Perlodidae	3	1.00%
Hydrobiidae	3	1.00%
Lebertia	2	0.67%
Cricotopus	2	0.67%
Acricotopus	2	0.67%
Hydroptilidae	1	0.33%
Corynoneura	1	0.33%
Coenagrionidae	1	0.33%

Functional Composition

Category	R	A	PRA
Predator	4	7	2.33%
Parasite			
Collector Gatherer	6	241	80.33%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore	1	1	0.33%
Xylophage			
Scraper	1	13	4.33%
Shredder	3	37	12.33%
Omivore	1	1	0.33%
Unknown			

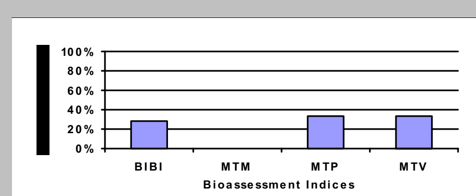


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	16	1	1		0
Non-Insect Percent	79.67%				
E Richness	0	1		0	
P Richness	1	1		1	
T Richness	2	1		1	
EPT Richness	3		1		0
EPT Percent	3.00%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	47.00%		1		0
Dominant Taxa (2) Percent	62.33%				
Dominant Taxa (3) Percent	76.67%	1			
Dominant Taxa (10) Percent	96.67%				
Diversity					
Shannon H (loge)	1.614				
Shannon H (log2)	2.329		1		
Margalef D	2.646				
Simpson D	0.294				
Evenness	0.105				
Function					
Predator Richness	4		2		
Predator Percent	2.33%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	80.33%		1		0
Scraper+Shredder Percent	16.67%		2		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	1				
Burrower Percent	0.33%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	3	1			
Clinger Percent	2.00%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	1				
Air Breather Percent	0.33%				
Voltinism					
Univoltine Richness	5				
Semivoltine Richness	1	1			
Multivoltine Percent	64.67%		1		
Tolerance					
Sediment Tolerant Richness	0				
Sediment Tolerant Percent	0.00%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.469				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	10.67%	5		1	
Hilsenhoff Biotic Index	7.014		0		0
Intolerant Percent	1.00%				
Supertolerant Percent	65.00%				
CTQa	100.615				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	14	28.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	10	33.33%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	6	33.33%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	0	0.00%	Severe



Sunday, November 22, 2009

Figure E-6
Spring 2009 Macroinvertebrate Metric Results for Minerva Middle

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2002
Sta. Name: MSS: Sample 655, 656
Client ID: Fall 2009
STORET ID:
Coll. Date:

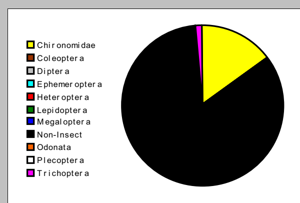
Abundance Measures

Sample Count: 300
Sample Abundance: 8,000.00 3.75% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	10	250	83.33%
Odonata	1	1	0.33%
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	2	4	1.33%
Lepidoptera			
Coleoptera			
Diptera			
Chironomidae	6	45	15.00%

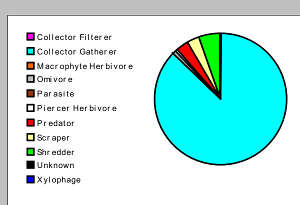


Dominant Taxa

Category	A	PRA
Ostracoda	159	53.00%
Hyalella	28	9.33%
Thienemanniella	25	8.33%
Amphipoda	24	8.00%
Hydrobiidae	9	3.00%
Copepoda	9	3.00%
Gammarus	7	2.33%
Cricotopus (Cricotopus)	7	2.33%
Orthocladius	6	2.00%
Oligochaeta	5	1.67%
Corynoneura	5	1.67%
Lebertia	4	1.33%
Polycelis coronata	2	0.67%
Thienemannimyia Gr.	1	0.33%
Tanypodinae	1	0.33%

Functional Composition

Category	R	A	PRA
Predator	5	9	3.00%
Parasite			
Collector Gatherer	7	261	87.00%
Collector Filterer	1	1	0.33%
Macrophyte Herbivore			
Piercer Herbivore	1	2	0.67%
Xylophage			
Scraper	1	9	3.00%
Shredder	3	16	5.33%
Omivore	1	2	0.67%
Unknown			

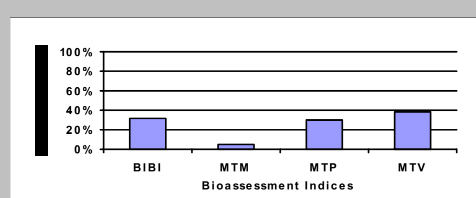


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	19	1	2		1
Non-Insect Percent	83.33%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	2	1		1	
EPT Richness	2		0		0
EPT Percent	1.33%		0		0
Oligochaeta+Hirudinea Percent	2.33%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	53.00%		1		0
Dominant Taxa (2) Percent	62.33%				
Dominant Taxa (3) Percent	70.67%	3			
Dominant Taxa (10) Percent	93.00%				
Diversity					
Shannon H (loge)	1.652				
Shannon H (log2)	2.384		1		
Margalef D	3.209				
Simpson D	0.361				
Evenness	0.083				
Function					
Predator Richness	5		2		
Predator Percent	3.00%	1			
Filterer Richness	1				
Filterer Percent	0.33%			3	
Collector Percent	87.33%		1		0
Scraper+Shredder Percent	8.33%		1		0
Scraper/Filterer	9.000				
Scraper/Scraper+Filterer	0.900				
Habit					
Burrower Richness	0				
Burrower Percent	0.00%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	1	1			
Clinger Percent	2.67%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	8				
Semivoltine Richness	0	1			
Multivoltine Percent	73.67%		1		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	1.67%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.387				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	3.67%	5		3	
Hilsenhoff Biotic Index	7.257		0		0
Intolerant Percent	0.67%				
Supertolerant Percent	72.33%				
CTQa	108.000				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	16	32.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	9	30.00%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	7	38.89%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	1	4.76%	Severe



Thursday, December 10, 2009

Figure E-7
Fall 2009 Macroinvertebrate Metric Results for Minerva Middle

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp003
Sta. Name: MS North: Sample 401
Client ID: Spring 2009
STORET ID:
Coll. Date:

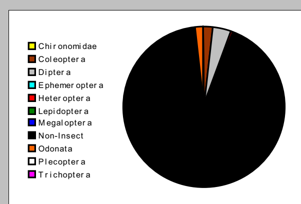
Abundance Measures

Sample Count:	310	
Sample Abundance:	516.67	60.00% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	10	286	92.26%
Odonata	1	5	1.61%
Ephemeroptera			
Plecoptera			
Heteroptera	2	2	0.65%
Megaloptera			
Trichoptera			
Lepidoptera			
Coleoptera	4	6	1.94%
Diptera	1	11	3.55%
Chironomidae			

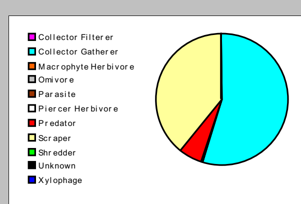


Dominant Taxa

Category	A	PRA
Ostracoda	123	39.68%
Lymnaeidae	79	25.48%
Amphipoda	31	10.00%
Pyrgulopsis	26	8.39%
Gyraulus	17	5.48%
Odontomyia	11	3.55%
Coenagrionidae	5	1.61%
Hyalella	4	1.29%
Thyas	2	0.65%
Liodessus obscurellus	2	0.65%
Hydroporus	2	0.65%
Notonectidae	1	0.32%
Lebertia	1	0.32%
Hydrozetes	1	0.32%
Agabus	1	0.32%

Functional Composition

Category	R	A	PRA
Predator	11	18	5.81%
Parasite			
Collector Gatherer	3	169	54.52%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore	1	1	0.32%
Xylophage			
Scraper	3	122	39.35%
Shredder			
Omivore			
Unknown			

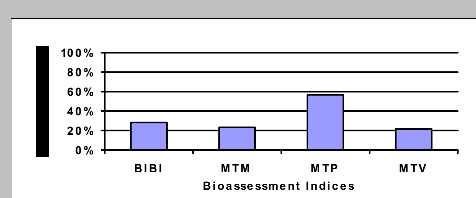


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	18	1	2		0
Non-Insect Percent	92.26%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	0	1		0	
EPT Richness	0		0		0
EPT Percent	0.00%		0		0
Oligochaeta+Hirudinea Percent	0.32%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	39.68%		2		1
Dominant Taxa (2) Percent	65.16%				
Dominant Taxa (3) Percent	75.16%	1			
Dominant Taxa (10) Percent	96.77%				
Diversity					
Shannon H (loge)	1.638				
Shannon H (log2)	2.363		1		
Margalef D	3.019				
Simpson D	0.287				
Evenness	0.104				
Function					
Predator Richness	11		3		
Predator Percent	5.81%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	54.52%		3		3
Scraper+Shredder Percent	39.35%		3		1
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	1				
Burrower Percent	0.32%				
Swimmer Richness	3				
Swimmer Percent	1.29%				
Clinger Richness	0	1			
Clinger Percent	0.00%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	2				
Hemoglobin Bearer Percent	5.81%				
Air Breather Richness	4				
Air Breather Percent	4.84%				
Voltinism					
Univoltine Richness	7				
Semivoltine Richness	3	3			
Multivoltine Percent	40.32%		2		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	30.97%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.065				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	32.58%	3		1	
Hilsenhoff Biotic Index	6.890		1		0
Intolerant Percent	0.00%				
Supertolerant Percent	48.06%				
CTQa	108.000				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	14	28.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	17	56.67%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	4	22.22%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	5	23.81%	Moderate



Sunday, November 22, 2009

Figure E-8
Spring 2009 Macroinvertebrate Metric Results for Minerva North

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2012
Sta. Name: MS North: Sample 402
Client ID: Fall 2009
STORET ID:
Coll. Date:

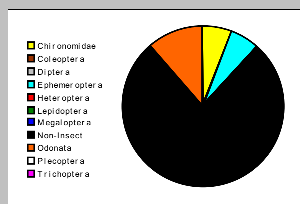
Abundance Measures

Sample Count: 321
Sample Abundance: 5,502.86 5.83% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	8	246	76.64%
Odonata	2	37	11.53%
Ephemeroptera	1	19	5.92%
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera			
Lepidoptera			
Coleoptera			
Diptera			
Chironomidae	5	19	5.92%

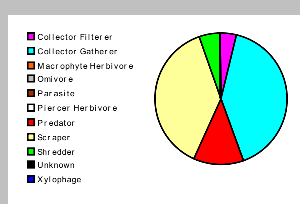


Dominant Taxa

Category	A	PRA
Planorbidae	73	22.74%
Ostracoda	56	17.45%
Coenagrionidae	32	9.97%
Pyrgulopsis	28	8.72%
Hyalella	23	7.17%
Gammarus	17	5.30%
Callibaetis	14	4.36%
Cladocera	13	4.05%
Gyraulus	12	3.74%
Copepoda	12	3.74%
Hydrobiidae	8	2.49%
Corynoneura	7	2.18%
Tvetenia Bavarica Gr.	5	1.56%
Orthocladius	5	1.56%
Baetidae	5	1.56%

Functional Composition

Category	R	A	PRA
Predator	3	38	11.84%
Parasite			
Collector Gatherer	8	130	40.50%
Collector Filterer	1	13	4.05%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	3	123	38.32%
Shredder	1	17	5.30%
Omivore			
Unknown			

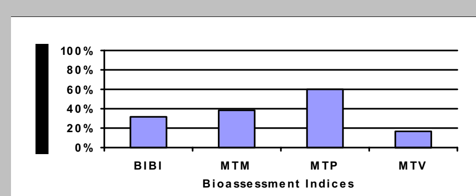


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	16	1	1		0
Non-Insect Percent	76.64%				
E Richness	1	1		0	
P Richness	0	1		0	
T Richness	0	1		0	
EPT Richness	1		0		0
EPT Percent	5.92%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	1.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	22.74%		3		3
Dominant Taxa (2) Percent	40.19%				
Dominant Taxa (3) Percent	50.16%	3			
Dominant Taxa (10) Percent	87.23%				
Diversity					
Shannon H (loge)	2.277				
Shannon H (log2)	3.286		3		
Margalef D	2.831				
Simpson D	0.133				
Evenness	0.087				
Function					
Predator Richness	3		1		
Predator Percent	11.84%	3			
Filterer Richness	1				
Filterer Percent	4.05%			3	
Collector Percent	44.55%		3		3
Scraper+Shredder Percent	43.61%		3		2
Scraper/Filterer	9.462				
Scraper/Scraper+Filterer	0.904				
Habit					
Burrower Richness	0				
Burrower Percent	0.00%				
Swimmer Richness	1				
Swimmer Percent	4.36%				
Clinger Richness	0	1			
Clinger Percent	0.00%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	26.48%				
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	5				
Semivoltine Richness	1	1			
Multivoltine Percent	37.07%		3		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	27.10%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.768				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	47.04%	3		0	
Hilsenhoff Biotic Index	6.945		1		0
Intolerant Percent	0.00%				
Supertolerant Percent	42.99%				
CTQa	100.000				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	16	32.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	18	60.00%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	3	16.67%	Severe
MTM	Montana DEQ Mountains (Bukantis 1998)	8	38.10%	Moderate



Thursday, December 10, 2009

Figure E-9
Fall 2009 Macroinvertebrate Metric Results for Minerva North

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp005
Sta. Name: SM: Sample 151
Client ID: Spring 2009
STORET ID:
Coll. Date:

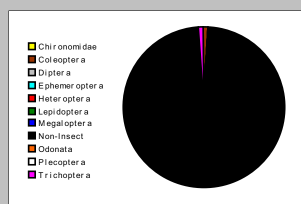
Abundance Measures

Sample Count:	330		
Sample Abundance:	2,475.00	13.33%	of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	3	323	97.88%
Odonata			
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	1	4	1.21%
Lepidoptera			
Coleoptera	1	3	0.91%
Diptera			
Chironomidae			

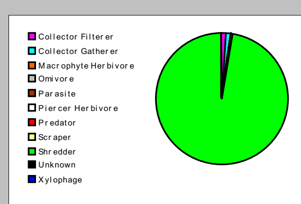


Dominant Taxa

Category	A	PRA
Gammarus	317	96.06%
Limnephilidae	4	1.21%
Cleptelmis addenda	3	0.91%
Sphaeriidae	2	0.61%
Pisidium	2	0.61%
Physa	2	0.61%

Functional Composition

Category	R	A	PRA
Predator			
Parasite			
Collector Gatherer	1	3	0.91%
Collector Filterer	1	4	1.21%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	1	2	0.61%
Shredder	2	321	97.27%
Omivore			
Unknown			

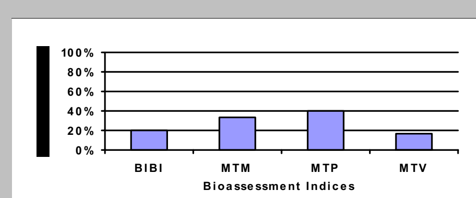


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	5	1	0		0
Non-Insect Percent	97.88%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	1	1		0	
EPT Richness	1		0		0
EPT Percent	1.21%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	96.06%		0		0
Dominant Taxa (2) Percent	97.27%				
Dominant Taxa (3) Percent	98.18%	1			
Dominant Taxa (10) Percent	100.00%				
Diversity					
Shannon H (loge)	0.177				
Shannon H (log2)	0.256		0		
Margalef D	0.691				
Simpson D	0.940				
Evenness	0.019				
Function					
Predator Richness	0		0		
Predator Percent	0.00%	1			
Filterer Richness	1				
Filterer Percent	1.21%			3	
Collector Percent	2.12%		3		3
Scraper+Shredder Percent	97.88%		3		3
Scraper/Filterer	0.500				
Scraper/Scraper+Filterer	0.333				
Habit					
Burrower Richness	0				
Burrower Percent	0.00%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	1	1			
Clinger Percent	0.91%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	4				
Semivoltine Richness	1	1			
Multivoltine Percent	0.00%		3		
Tolerance					
Sediment Tolerant Richness	0				
Sediment Tolerant Percent	0.00%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	1.013				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	96.67%	1		0	
Hilsenhoff Biotic Index	4.042		3		1
Intolerant Percent	0.00%				
Supertolerant Percent	1.21%				
CTQa	106.667				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	10	20.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	12	40.00%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	3	16.67%	Severe
MTM	Montana DEQ Mountains (Bukantis 1998)	7	33.33%	Moderate



Sunday, November 22, 2009

Figure E-10
Spring 2009 Macroinvertebrate Metric Results for South Millick

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2011
Sta. Name: SM: Sample 152, 153
Client ID: Fall 2009
STORET ID:
Coll. Date:

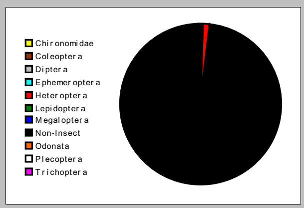
Abundance Measures

Sample Count: 311
Sample Abundance: 2,665.71 11.67% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	4	303	97.43%
Odonata	1	1	0.32%
Ephemeroptera			
Plecoptera			
Heteroptera	1	4	1.29%
Megaloptera			
Trichoptera	1	1	0.32%
Lepidoptera			
Coleoptera	1	1	0.32%
Diptera	1	1	0.32%
Chironomidae			

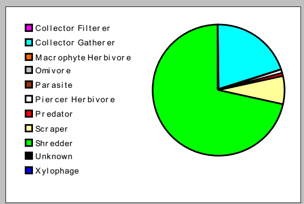


Dominant Taxa

Category	A	PRA
Gammarus	221	71.06%
Amphipoda	48	15.43%
Physidae	22	7.07%
Ostracoda	7	2.25%
Hyalella	5	1.61%
Hesperocorixa	4	1.29%
Lepidostoma	1	0.32%
Ephydridae	1	0.32%
Coenagrionidae	1	0.32%
Cleptelmis addenda	1	0.32%

Functional Composition

Category	R	A	PRA
Predator	1	1	0.32%
Parasite			
Collector Gatherer	4	62	19.94%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore	1	4	1.29%
Xylophage			
Scraper	1	22	7.07%
Shredder	2	222	71.38%
Omivore			
Unknown			

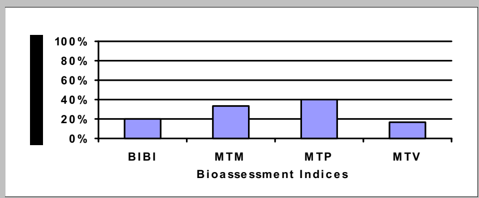


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	9	1	0		0
Non-Insect Percent	97.43%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	1	1		0	
EPT Richness	1		0		0
EPT Percent	0.32%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	71.06%		0		0
Dominant Taxa (2) Percent	86.50%				
Dominant Taxa (3) Percent	93.57%	1			
Dominant Taxa (10) Percent	100.00%				
Diversity					
Shannon H (loge)	0.674				
Shannon H (log2)	0.972		0		
Margalef D	1.436				
Simpson D	0.713				
Evenness	0.066				
Function					
Predator Richness	1		0		
Predator Percent	0.32%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	19.94%		3		3
Scraper+Shredder Percent	78.46%		3		3
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	0				
Burrower Percent	0.00%				
Swimmer Richness	1				
Swimmer Percent	1.29%				
Clinger Richness	1	1			
Clinger Percent	0.32%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	7				
Semivoltine Richness	1	1			
Multivoltine Percent	2.25%		3		
Tolerance					
Sediment Tolerant Richness	0				
Sediment Tolerant Percent	0.00%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	1.224				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	78.46%	1		0	
Hilsenhoff Biotic Index	4.521		3		1
Intolerant Percent	0.32%				
Supertolerant Percent	12.22%				
CTQa	92.333				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	10	20.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	12	40.00%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	3	16.67%	Severe
MTM	Montana DEQ Mountains (Bukantis 1998)	7	33.33%	Moderate



Thursday, December 10, 2009

Figure E-11
Fall 2009 Macroinvertebrate Metric Results for South Millick

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp008
Sta. Name: STL: Sample 501
Client ID: Spring 2009
STORET ID:
Coll. Date:

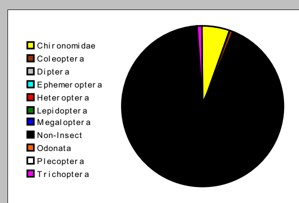
Abundance Measures

Sample Count: 317
Sample Abundance: 10,868.57 2.92% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	5	293	92.43%
Odonata			
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	2	3	0.95%
Lepidoptera			
Coleoptera	2	2	0.63%
Diptera	1	1	0.32%
Chironomidae	1	18	5.68%

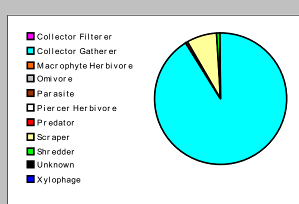


Dominant Taxa

Category	A	PRA
Hyalella	141	44.48%
Ostracoda	129	40.69%
Pyrgulopsis	19	5.99%
Chaetocladius	18	5.68%
Physa	3	0.95%
Hydroptilidae sp. (RAI Taxon # 00	2	0.63%
Sanfilippodytes	1	0.32%
Pacifastacus leniusculus	1	0.32%
Helicopsyche	1	0.32%
Cleptelmis addenda	1	0.32%
Ceratopogonidae	1	0.32%

Functional Composition

Category	R	A	PRA
Predator	2	2	0.63%
Parasite			
Collector Gatherer	4	289	91.17%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	3	23	7.26%
Shredder	2	3	0.95%
Omivore			
Unknown			

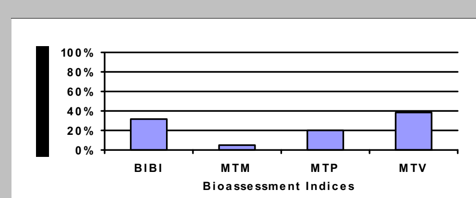


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	11	1	0		0
Non-Insect Percent	92.43%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	2	1		1	
EPT Richness	2		0		0
EPT Percent	0.95%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	44.48%		2		1
Dominant Taxa (2) Percent	85.17%				
Dominant Taxa (3) Percent	91.17%	1			
Dominant Taxa (10) Percent	99.68%				
Diversity					
Shannon H (loge)	1.225				
Shannon H (log2)	1.767		0		
Margalef D	1.736				
Simpson D	0.368				
Evenness	0.137				
Function					
Predator Richness	2		0		
Predator Percent	0.63%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	91.17%		1		0
Scraper+Shredder Percent	8.20%		1		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	0				
Burrower Percent	0.00%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	2	1			
Clinger Percent	0.63%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	0				
Hemoglobin Bearer Percent	0.00%				
Air Breather Richness	1				
Air Breather Percent	0.32%				
Voltinism					
Univoltine Richness	4				
Semivoltine Richness	3	3			
Multivoltine Percent	46.37%		2		
Tolerance					
Sediment Tolerant Richness	0				
Sediment Tolerant Percent	0.00%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.014				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	1.26%	5		3	
Hilsenhoff Biotic Index	7.824		0		0
Intolerant Percent	0.00%				
Supertolerant Percent	86.12%				
CTQa	84.500				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	16	32.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	6	20.00%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	7	38.89%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	1	4.76%	Severe



Sunday, November 22, 2009

Figure E-12
Spring 2009 Macroinvertebrate Metric Results for Stateline

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2007
Sta. Name: STL: Sample 502
Client ID: Fall 2009
STORET ID:
Coll. Date:

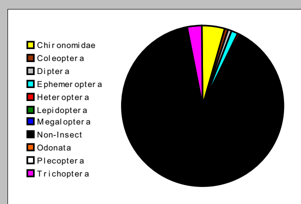
Abundance Measures

Sample Count: 308
Sample Abundance: 1,026.67 30.00% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	10	275	89.29%
Odonata			
Ephemeroptera	2	4	1.30%
Plecoptera			
Heteroptera	1	1	0.32%
Megaloptera			
Trichoptera	3	9	2.92%
Lepidoptera			
Coleoptera	1	2	0.65%
Diptera	2	3	0.97%
Chironomidae	5	14	4.55%

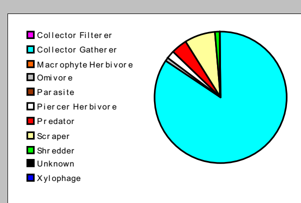


Dominant Taxa

Category	A	PRA
Hyalella	125	40.58%
Ostracoda	121	39.29%
Physidae	9	2.92%
Hydrobiidae	9	2.92%
Thienemanniella	8	2.60%
Pacifastacus leniusculus	4	1.30%
Helicopsyche	4	1.30%
Metriocnemus	3	0.97%
Lebertia	3	0.97%
Callibaetis	3	0.97%
Oxyethira	2	0.65%
Ochrotrichia	2	0.65%
Ceratopogoninae	2	0.65%
Hydroptilidae	1	0.32%
Dytiscidae	1	0.32%

Functional Composition

Category	R	A	PRA
Predator	8	12	3.90%
Parasite			
Collector Gatherer	7	260	84.42%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore	3	6	1.95%
Xylophage			
Scraper	4	23	7.47%
Shredder	1	4	1.30%
Omivore	1	3	0.97%
Unknown			

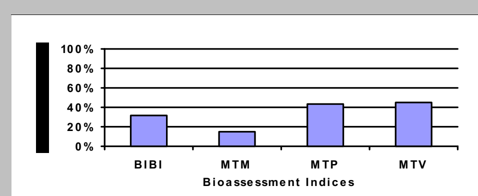


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	24	3	2		2
Non-Insect Percent	89.29%				
E Richness	2	1		1	
P Richness	0	1		0	
T Richness	3	1		2	
EPT Richness	5		1		0
EPT Percent	4.22%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.750				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	40.58%		2		1
Dominant Taxa (2) Percent	79.87%				
Dominant Taxa (3) Percent	82.79%	1			
Dominant Taxa (10) Percent	93.83%				
Diversity					
Shannon H (loge)	1.579				
Shannon H (log2)	2.277		1		
Margalef D	4.021				
Simpson D	0.326				
Evenness	0.097				
Function					
Predator Richness	8		3		
Predator Percent	3.90%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	84.42%		1		0
Scraper+Shredder Percent	8.77%		1		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	2				
Burrower Percent	1.62%				
Swimmer Richness	3				
Swimmer Percent	1.62%				
Clinger Richness	2	1			
Clinger Percent	2.27%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	0.32%				
Air Breather Richness	1				
Air Breather Percent	0.65%				
Voltinism					
Univoltine Richness	9				
Semivoltine Richness	2	1			
Multivoltine Percent	48.05%		2		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	0.65%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.063				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	7.79%	5		2	
Hilsenhoff Biotic Index	7.703		0		0
Intolerant Percent	0.00%				
Supertolerant Percent	88.64%				
CTQa	101.111				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	16	32.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	13	43.33%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	8	44.44%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	3	14.29%	Severe



Thursday, December 10, 2009

Figure E-13
Fall 2009 Macroinvertebrate Metric Results for Stateline

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp007
Sta. Name: ST: Sample 1-5
Client ID: Spring 2009
STORET ID:
Coll. Date:

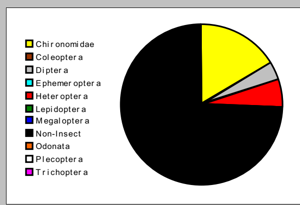
Abundance Measures

Sample Count:	300	
Sample Abundance:	456.85	65.67% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	11	222	74.00%
Odonata	1	1	0.33%
Ephemeroptera			
Plecoptera			
Heteroptera	1	17	5.67%
Megaloptera			
Trichoptera			
Lepidoptera			
Coleoptera	1	1	0.33%
Diptera	5	10	3.33%
Chironomidae	10	49	16.33%

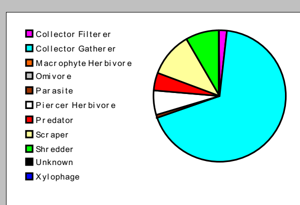


Dominant Taxa

Category	A	PRA
Hyalella	87	29.00%
Ostracoda	58	19.33%
Amphipoda	27	9.00%
Pyrgulopsis	22	7.33%
Cricotopus	20	6.67%
Corixidae	17	5.67%
Paratendipes	10	3.33%
Hydrobiidae	8	2.67%
Gammarus	5	1.67%
Chaetocladius	5	1.67%
Tanypus	4	1.33%
Odontomyia / Hedriodiscus	4	1.33%
Sphaeriidae	3	1.00%
Nematoda	3	1.00%
Erpobdellidae	3	1.00%

Functional Composition

Category	R	A	PRA
Predator	7	14	4.67%
Parasite	1	3	1.00%
Collector Gatherer	12	202	67.33%
Collector Filterer	3	6	2.00%
Macrophyte Herbivore			
Piercer Herbivore	1	17	5.67%
Xylophage			
Scraper	3	33	11.00%
Shredder	2	25	8.33%
Omivore			
Unknown			

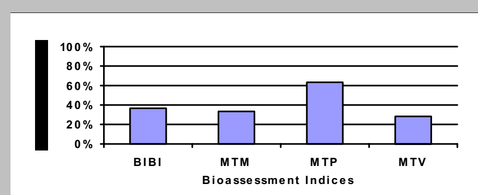


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	29	3	3		3
Non-Insect Percent	74.00%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	0	1		0	
EPT Richness	0		0		0
EPT Percent	0.00%		0		0
Oligochaeta+Hirudinea Percent	1.00%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	29.00%		3		2
Dominant Taxa (2) Percent	48.33%				
Dominant Taxa (3) Percent	57.33%	3			
Dominant Taxa (10) Percent	86.33%				
Diversity					
Shannon H (loge)	2.257				
Shannon H (log2)	3.256		3		
Margalef D	5.028				
Simpson D	0.177				
Evenness	0.075				
Function					
Predator Richness	7		3		
Predator Percent	4.67%	1			
Filterer Richness	3				
Filterer Percent	2.00%			3	
Collector Percent	69.33%		2		2
Scraper+Shredder Percent	19.33%		2		0
Scraper/Filterer	5.500				
Scraper/Scraper+Filterer	0.846				
Habit					
Burrower Richness	7				
Burrower Percent	6.00%				
Swimmer Richness	1				
Swimmer Percent	5.67%				
Clinger Richness	1	1			
Clinger Percent	6.67%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	5				
Hemoglobin Bearer Percent	6.33%				
Air Breather Richness	2				
Air Breather Percent	0.67%				
Voltinism					
Univoltine Richness	9				
Semivoltine Richness	1	1			
Multivoltine Percent	37.67%		3		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	0.67%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	4.040				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	8.67%	5		2	
Hilsenhoff Biotic Index	7.505		0		0
Intolerant Percent	0.00%				
Supertolerant Percent	66.00%				
CTQa	108.000				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	18	36.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	19	63.33%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	5	27.78%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	7	33.33%	Moderate



Sunday, November 22, 2009

Figure E-14
Spring 2009 Macroinvertebrate Metric Results for Stonehouse

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2005
Sta. Name: ST: Sample 6-9
Client ID: Fall 2009
STORET ID:
Coll. Date:

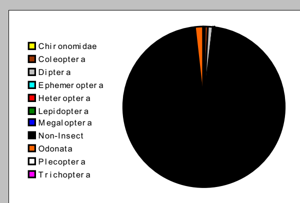
Abundance Measures

Sample Count: 322
Sample Abundance: 4,830.00 6.67% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	11	310	96.27%
Odonata	1	5	1.55%
Ephemeroptera			
Plecoptera			
Heteroptera	1	1	0.31%
Megaloptera			
Trichoptera			
Lepidoptera			
Coleoptera	2	2	0.62%
Diptera	3	3	0.93%
Chironomidae	1	1	0.31%

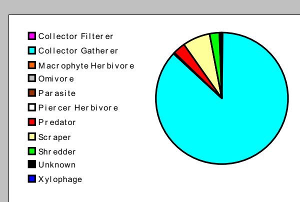


Dominant Taxa

Category	A	PRA
Hyalella	242	75.16%
Ostracoda	34	10.56%
Gammarus	8	2.48%
Physidae	6	1.86%
Stagnicola	5	1.55%
Coenagrionidae	5	1.55%
Gyraulus	4	1.24%
Lymnaeidae	3	0.93%
Hydrobiidae	2	0.62%
Glossiphoniidae	2	0.62%
Fossaria	2	0.62%
Sperchon	1	0.31%
Sigara	1	0.31%
Pericoma / Telmatoscopus	1	0.31%
Liodessus	1	0.31%

Functional Composition

Category	R	A	PRA
Predator	5	10	3.11%
Parasite			
Collector Gatherer	5	279	86.65%
Collector Filterer	1	1	0.31%
Macrophyte Herbivore			
Piercer Herbivore	1	1	0.31%
Xylophage			
Scraper	5	22	6.83%
Shredder	1	8	2.48%
Omivore			
Unknown	1	1	0.31%

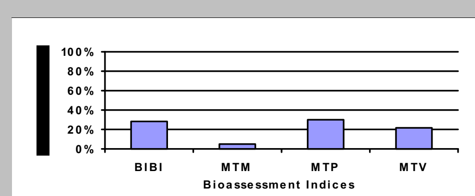


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	19	1	2		1
Non-Insect Percent	96.27%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	0	1		0	
EPT Richness	0		0		0
EPT Percent	0.00%		0		0
Oligochaeta+Hirudinea Percent	0.62%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	75.16%		0		0
Dominant Taxa (2) Percent	85.71%				
Dominant Taxa (3) Percent	88.20%	1			
Dominant Taxa (10) Percent	96.58%				
Diversity					
Shannon H (loge)	1.059				
Shannon H (log2)	1.527		0		
Margalef D	3.122				
Simpson D	0.587				
Evenness	0.065				
Function					
Predator Richness	5		2		
Predator Percent	3.11%	1			
Filterer Richness	1				
Filterer Percent	0.31%			3	
Collector Percent	86.96%		1		0
Scraper+Shredder Percent	9.32%		1		0
Scraper/Filterer	22.000				
Scraper/Scraper+Filterer	0.957				
Habit					
Burrower Richness	2				
Burrower Percent	0.62%				
Swimmer Richness	3				
Swimmer Percent	0.93%				
Clinger Richness	0	1			
Clinger Percent	0.00%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	1.24%				
Air Breather Richness	2				
Air Breather Percent	0.62%				
Voltinism					
Univoltine Richness	12				
Semivoltine Richness	2	1			
Multivoltine Percent	11.18%		3		
Tolerance					
Sediment Tolerant Richness	3				
Sediment Tolerant Percent	4.35%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.957				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	10.25%	5		1	
Hilsenhoff Biotic Index	7.769		0		0
Intolerant Percent	0.00%				
Supertolerant Percent	90.37%				
CTQa	108.000				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	14	28.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	9	30.00%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	4	22.22%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	1	4.76%	Severe



Thursday, December 10, 2009

Figure E-15
Fall 2009 Macroinvertebrate Metric Results for Stonehouse

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp006
Sta. Name: SS: Sample 351-353
Client ID: Spring 2009
STORET ID:
Coll. Date:

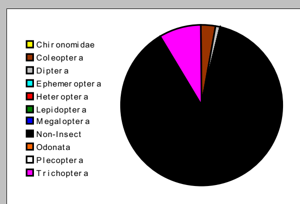
Abundance Measures

Sample Count: 300
Sample Abundance: 1,080.43 27.77% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	6	262	87.33%
Odonata			
Ephemeroptera			
Plecoptera	1	1	0.33%
Heteroptera			
Megaloptera			
Trichoptera	1	25	8.33%
Lepidoptera			
Coleoptera	2	9	3.00%
Diptera	2	3	1.00%
Chironomidae			

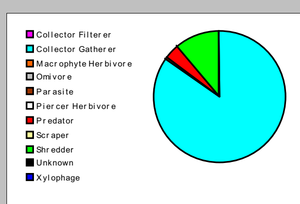


Dominant Taxa

Category	A	PRA
Ostracoda	244	81.33%
Lepidostoma	25	8.33%
Gammarus	8	2.67%
Thyas	7	2.33%
Heterlimnius	5	1.67%
Cleptelmis addenda	4	1.33%
Mallochohelea	2	0.67%
Perlidae	1	0.33%
Nematoda	1	0.33%
Hydrozetes	1	0.33%
Hyalella	1	0.33%
Dicranota	1	0.33%

Functional Composition

Category	R	A	PRA
Predator	5	12	4.00%
Parasite	1	1	0.33%
Collector Gatherer	4	254	84.67%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper			
Shredder	2	33	11.00%
Omivore			
Unknown			

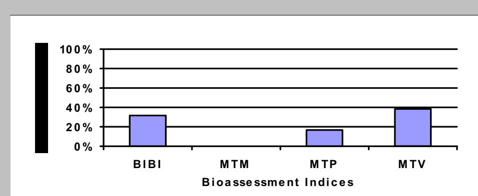


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	12	1	1		0
Non-Insect Percent	87.33%				
E Richness	0	1		0	
P Richness	1	1		1	
T Richness	1	1		0	
EPT Richness	2		0		0
EPT Percent	8.67%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	81.33%		0		0
Dominant Taxa (2) Percent	89.67%				
Dominant Taxa (3) Percent	92.33%	1			
Dominant Taxa (10) Percent	99.33%				
Diversity					
Shannon H (loge)	0.814				
Shannon H (log2)	1.174		0		
Margalef D	1.929				
Simpson D	0.669				
Evenness	0.065				
Function					
Predator Richness	5		2		
Predator Percent	4.00%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	84.67%		1		0
Scraper+Shredder Percent	11.00%		1		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	2				
Burrower Percent	1.00%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	2	1			
Clinger Percent	3.00%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	1				
Air Breather Percent	0.33%				
Voltinism					
Univoltine Richness	4				
Semivoltine Richness	3	3			
Multivoltine Percent	82.33%		0		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	0.33%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	1.415				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	2.67%	5		3	
Hilsenhoff Biotic Index	7.100		0		0
Intolerant Percent	8.67%				
Supertolerant Percent	82.00%				
CTQa	70.000				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	16	32.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	5	16.67%	Severe
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	7	38.89%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	0	0.00%	Severe



Sunday, November 22, 2009

Figure E-16
Spring 2009 Macroinvertebrate Metric Results for Swallow

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2001
Sta. Name: SS: Sample 354, 355
Client ID: Fall 2009
STORET ID:
Coll. Date:

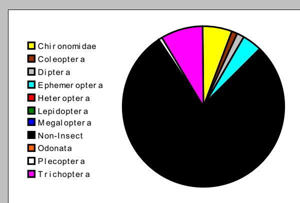
Abundance Measures

Sample Count: 310
Sample Abundance: 9,300.00 3.33% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	7	243	78.39%
Odonata			
Ephemeroptera	2	13	4.19%
Plecoptera	1	1	0.32%
Heteroptera			
Megaloptera			
Trichoptera	1	27	8.71%
Lepidoptera			
Coleoptera	1	4	1.29%
Diptera	3	4	1.29%
Chironomidae	5	18	5.81%

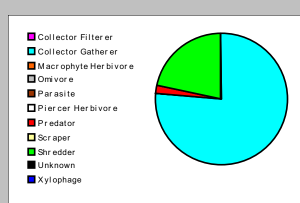


Dominant Taxa

Category	A	PRA
Ostracoda	195	62.90%
Gammarus	40	12.90%
Lepidostoma	27	8.71%
Baetis	12	3.87%
Thienemanniella	11	3.55%
Elmidae	4	1.29%
Torrenticola	2	0.65%
Pisidiidae	2	0.65%
Eukiefferiella Claripennis Gr.	2	0.65%
Eukiefferiella Brehmi Gr.	2	0.65%
Dixa	2	0.65%
Perlidae	1	0.32%
Orthocladiinae	1	0.32%
Nematoda	1	0.32%
Ephemerella inermis	1	0.32%

Functional Composition

Category	R	A	PRA
Predator	4	5	1.61%
Parasite	1	1	0.32%
Collector Gatherer	12	236	76.13%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper			
Shredder	3	68	21.94%
Omivore			
Unknown			

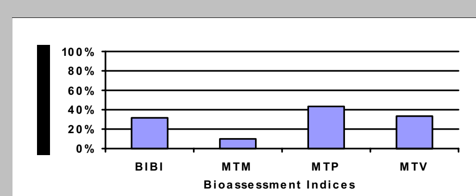


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	20	3	2		1
Non-Insect Percent	78.39%				
E Richness	2	1		1	
P Richness	1	1		1	
T Richness	1	1		0	
EPT Richness	4		1		0
EPT Percent	13.23%		1		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.923				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	62.90%		0		0
Dominant Taxa (2) Percent	75.81%				
Dominant Taxa (3) Percent	84.52%	1			
Dominant Taxa (10) Percent	95.81%				
Diversity					
Shannon H (loge)	1.401				
Shannon H (log2)	2.021		1		
Margalef D	3.316				
Simpson D	0.427				
Evenness	0.083				
Function					
Predator Richness	4		2		
Predator Percent	1.61%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	76.13%		2		1
Scraper+Shredder Percent	21.94%		2		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	2				
Burrower Percent	0.65%				
Swimmer Richness	2				
Swimmer Percent	4.52%				
Clinger Richness	3	1			
Clinger Percent	1.94%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	0				
Hemoglobin Bearer Percent	0.00%				
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	8				
Semivoltine Richness	2	1			
Multivoltine Percent	73.87%		1		
Tolerance					
Sediment Tolerant Richness	0				
Sediment Tolerant Percent	0.00%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	1.908				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	12.90%	5		1	
Hilsenhoff Biotic Index	6.487		1		0
Intolerant Percent	9.68%				
Supertolerant Percent	66.13%				
CTQa	88.867				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	16	32.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	13	43.33%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	6	33.33%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	2	9.52%	Severe



Thursday, December 10, 2009

Figure E-17
Fall 2009 Macroinvertebrate Metric Results for Swallow

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp010
Sta. Name: UN: Sample 451
Client ID: Spring 2009
STORET ID:
Coll. Date:

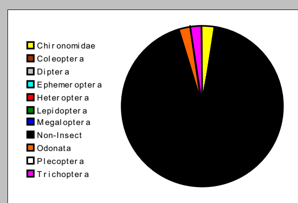
Abundance Measures

Sample Count:	330		
Sample Abundance:	9,900.00	3.33%	of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	7	304	92.12%
Odonata	1	9	2.73%
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	1	7	2.12%
Lepidoptera			
Coleoptera	1	1	0.30%
Diptera	1	1	0.30%
Chironomidae	2	8	2.42%

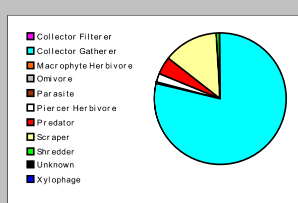


Dominant Taxa

Category	A	PRA
Ostracoda	126	38.18%
Hyalella	125	37.88%
Pyrgulopsis	45	13.64%
Argia	8	2.42%
Chaetocladius	6	1.82%
Ochrotrichia	4	1.21%
Thyas	3	0.91%
Hydroptilidae	3	0.91%
Gammarus	3	0.91%
Metriocnemus	2	0.61%
Mideopsis	1	0.30%
Enochrus	1	0.30%
Caloparyphus	1	0.30%
Argia immunda	1	0.30%
Acari	1	0.30%

Functional Composition

Category	R	A	PRA
Predator	4	14	4.24%
Parasite			
Collector Gatherer	5	259	78.48%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore	1	7	2.12%
Xylophage			
Scraper	1	45	13.64%
Shredder	1	3	0.91%
Omivore	1	2	0.61%
Unknown			

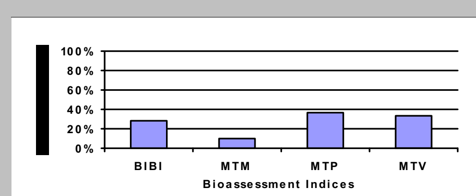


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	13	1	1		0
Non-Insect Percent	92.12%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	1	1		0	
EPT Richness	1		0		0
EPT Percent	2.12%		0		0
Oligochaeta+Hirudinea Percent					
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	38.18%		2		1
Dominant Taxa (2) Percent	76.06%				
Dominant Taxa (3) Percent	89.70%	1			
Dominant Taxa (10) Percent	98.48%				
Diversity					
Shannon H (loge)	1.350				
Shannon H (log2)	1.947		1		
Margalef D	2.081				
Simpson D	0.328				
Evenness	0.129				
Function					
Predator Richness	4		2		
Predator Percent	4.24%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	78.48%		2		1
Scraper+Shredder Percent	14.55%		1		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	2				
Burrower Percent	0.91%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	1	1			
Clinger Percent	4.55%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness					
Hemoglobin Bearer Percent					
Air Breather Richness	2				
Air Breather Percent	0.61%				
Voltinism					
Univoltine Richness	3				
Semivoltine Richness	1	1			
Multivoltine Percent	43.33%		2		
Tolerance					
Sediment Tolerant Richness	0				
Sediment Tolerant Percent	0.00%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.970				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	4.85%	5		3	
Hilsenhoff Biotic Index	7.746		0		0
Intolerant Percent	0.00%				
Supertolerant Percent	76.06%				
CTQa	108.000				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	14	28.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	11	36.67%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	6	33.33%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	2	9.52%	Severe



Sunday, November 22, 2009

Figure E-18
Spring 2009 Macroinvertebrate Metric Results for Unnamed 1

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2008
Sta. Name: UN: Sample 452-454
Client ID: Fall 2009
STORET ID:
Coll. Date:

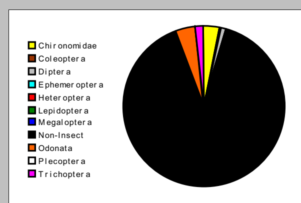
Abundance Measures

Sample Count: 326
Sample Abundance: 78,240.00 0.42% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	10	293	89.88%
Odonata	1	13	3.99%
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	2	5	1.53%
Lepidoptera			
Coleoptera	1	1	0.31%
Diptera	1	3	0.92%
Chironomidae	4	11	3.37%

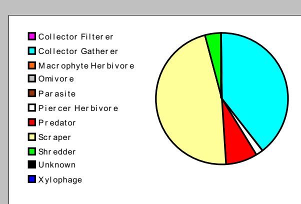


Dominant Taxa

Category	A	PRA
Pyrgulopsis	144	44.17%
Hyalella	43	13.19%
Ostracoda	39	11.96%
Amphipoda	36	11.04%
Gammarus	14	4.29%
Argia	13	3.99%
Hydrobiidae	7	2.15%
Pseudochironomus	5	1.53%
Orthocladiinae	4	1.23%
Ochrotrichia	4	1.23%
Helobdella stagnalis	4	1.23%
Ceratopogoninae	3	0.92%
Physidae	2	0.61%
Acari	2	0.61%
Pseudosmittia	1	0.31%

Functional Composition

Category	R	A	PRA
Predator	7	25	7.67%
Parasite			
Collector Gatherer	6	129	39.57%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore	2	5	1.53%
Xylophage			
Scraper	3	153	46.93%
Shredder	1	14	4.29%
Omivore			
Unknown			

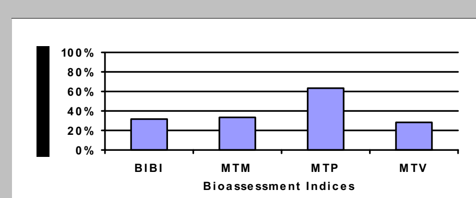


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	19	1	2		1
Non-Insect Percent	89.88%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	2	1		1	
EPT Richness	2		0		0
EPT Percent	1.53%		0		0
Oligochaeta+Hirudinea Percent	1.23%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	44.17%		2		1
Dominant Taxa (2) Percent	57.36%				
Dominant Taxa (3) Percent	69.33%	3			
Dominant Taxa (10) Percent	94.79%				
Diversity					
Shannon H (loge)	1.747				
Shannon H (log2)	2.521		2		
Margalef D	3.177				
Simpson D	0.292				
Evenness	0.092				
Function					
Predator Richness	7		3		
Predator Percent	7.67%	1			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	39.57%		3		3
Scraper+Shredder Percent	51.23%		3		2
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	2				
Burrower Percent	2.45%				
Swimmer Richness	1				
Swimmer Percent	0.31%				
Clinger Richness	2	1			
Clinger Percent	5.21%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	1.53%				
Air Breather Richness	1				
Air Breather Percent	0.31%				
Voltinism					
Univoltine Richness	8				
Semivoltine Richness	1	1			
Multivoltine Percent	17.79%		3		
Tolerance					
Sediment Tolerant Richness	0				
Sediment Tolerant Percent	0.00%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.850				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	11.66%	5		1	
Hilsenhoff Biotic Index	6.514		1		0
Intolerant Percent	0.00%				
Supertolerant Percent	29.45%				
CTQa	105.750				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	16	32.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	19	63.33%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	5	27.78%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	7	33.33%	Moderate



Thursday, December 10, 2009

Figure E-19
Fall 2009 Macroinvertebrate Metric Results for Unnamed 1

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp009
Sta. Name: U5: Sample 101-105
Client ID: Spring 2009
STORET ID:
Coll. Date:

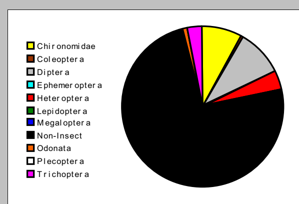
Abundance Measures

Sample Count:	300		
Sample Abundance:	398.23	75.33%	of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	8	223	74.33%
Odonata	1	3	1.00%
Ephemeroptera			
Plecoptera			
Heteroptera	2	11	3.67%
Megaloptera			
Trichoptera	1	9	3.00%
Lepidoptera			
Coleoptera	1	1	0.33%
Diptera	2	29	9.67%
Chironomidae	10	24	8.00%

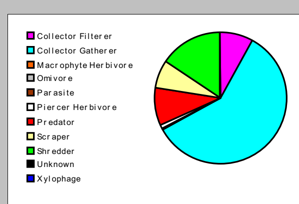


Dominant Taxa

Category	A	PRA
Hyalella	57	19.00%
Ostracoda	44	14.67%
Amphipoda	39	13.00%
Gammarus	33	11.00%
Pisidium	25	8.33%
Bezzia / Palpomyia	21	7.00%
Gyraulus parvus	12	4.00%
Limnephilus	9	3.00%
Notonecta	8	2.67%
Physa	7	2.33%
Chaetocladius	5	1.67%
Polypedilum	4	1.33%
Ceratopogoninae	4	1.33%
Erpobdellidae	3	1.00%
Ceratopogonidae	3	1.00%

Functional Composition

Category	R	A	PRA
Predator	7	28	9.33%
Parasite	1	1	0.33%
Collector Gatherer	9	175	58.33%
Collector Filterer	1	25	8.33%
Macrophyte Herbivore			
Piercer Herbivore	1	3	1.00%
Xylophage			
Scraper	2	21	7.00%
Shredder	4	47	15.67%
Omivore			
Unknown			

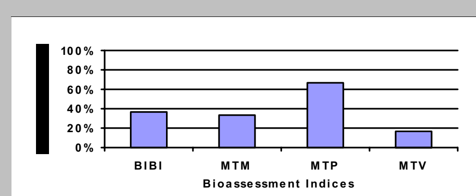


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	25	3	3		2
Non-Insect Percent	74.33%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	1	1		0	
EPT Richness	1		0		0
EPT Percent	3.00%		0		0
Oligochaeta+Hirudinea Percent	1.00%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	19.00%		3		3
Dominant Taxa (2) Percent	33.67%				
Dominant Taxa (3) Percent	46.67%	5			
Dominant Taxa (10) Percent	85.00%				
Diversity					
Shannon H (loge)	2.464				
Shannon H (log2)	3.555		3		
Margalef D	4.344				
Simpson D	0.120				
Evenness	0.071				
Function					
Predator Richness	7		3		
Predator Percent	9.33%	1			
Filterer Richness	1				
Filterer Percent	8.33%			2	
Collector Percent	66.67%		2		2
Scraper+Shredder Percent	22.67%		2		0
Scraper/Filterer	0.840				
Scraper/Scraper+Filterer	0.457				
Habit					
Burrower Richness	4				
Burrower Percent	10.33%				
Swimmer Richness	3				
Swimmer Percent	4.00%				
Clinger Richness	1	1			
Clinger Percent	1.33%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	8				
Hemoglobin Bearer Percent	12.00%				
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	11				
Semivoltine Richness	1	1			
Multivoltine Percent	23.00%		3		
Tolerance					
Sediment Tolerant Richness	0				
Sediment Tolerant Percent	0.67%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.635				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	21.00%	3		1	
Hilsenhoff Biotic Index	6.253		1		0
Intolerant Percent	0.00%				
Supertolerant Percent	44.67%				
CTQa	108.000				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	18	36.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	20	66.67%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	3	16.67%	Severe
MTM	Montana DEQ Mountains (Bukantis 1998)	7	33.33%	Moderate



Sunday, November 22, 2009

Figure E-20
Spring 2009 Macroinvertebrate Metric Results for Unnamed 5

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2010
Sta. Name: U5: Sample 106, 107
Client ID: Fall 2009
STORET ID:
Coll. Date:

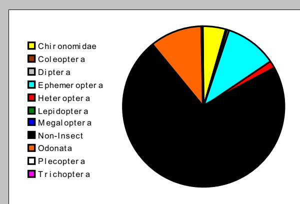
Abundance Measures

Sample Count: 300
Sample Abundance: 9,000.00 3.33% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	7	215	71.67%
Odonata	3	32	10.67%
Ephemeroptera	1	31	10.33%
Plecoptera			
Heteroptera	1	5	1.67%
Megaloptera			
Trichoptera	1	1	0.33%
Lepidoptera			
Coleoptera	1	1	0.33%
Diptera	1	1	0.33%
Chironomidae	6	14	4.67%

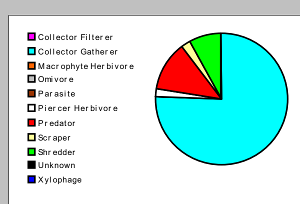


Dominant Taxa

Category	A	PRA
Ostracoda	135	45.00%
Baetidae	31	10.33%
Coenagrionidae	30	10.00%
Gammarus	23	7.67%
Amphipoda	23	7.67%
Hyalella	15	5.00%
Pisidiidae	11	3.67%
Psectrocladius	4	1.33%
Physidae	4	1.33%
Corixidae	4	1.33%
Acricotopus	3	1.00%
Thienemannimyia Gr.	2	0.67%
Gyraulus	2	0.67%
Limnophyes	1	0.33%
Libellulidae	1	0.33%

Functional Composition

Category	R	A	PRA
Predator	7	38	12.67%
Parasite			
Collector Gatherer	9	226	75.33%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore	2	6	2.00%
Xylophage			
Scraper	2	7	2.33%
Shredder	1	23	7.67%
Omivore			
Unknown			

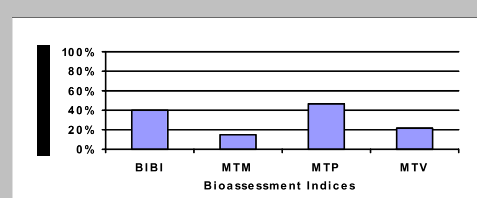


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	21	3	2		1
Non-Insect Percent	71.67%				
E Richness	1	1		0	
P Richness	0	1		0	
T Richness	1	1		0	
EPT Richness	2		0		0
EPT Percent	10.67%		1		0
Oligochaeta+Hirudinea Percent	0.33%				
Baetidae/Ephemeroptera	1.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	45.00%		1		1
Dominant Taxa (2) Percent	55.33%				
Dominant Taxa (3) Percent	65.33%	3			
Dominant Taxa (10) Percent	93.33%				
Diversity					
Shannon H (loge)	1.795				
Shannon H (log2)	2.589		2		
Margalef D	3.572				
Simpson D	0.286				
Evenness	0.087				
Function					
Predator Richness	7		3		
Predator Percent	12.67%	3			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	75.33%		2		1
Scraper+Shredder Percent	10.00%		1		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	2				
Burrower Percent	0.67%				
Swimmer Richness	2				
Swimmer Percent	2.00%				
Clinger Richness	1	1			
Clinger Percent	0.33%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	2				
Hemoglobin Bearer Percent	1.33%				
Air Breather Richness	1				
Air Breather Percent	0.33%				
Voltinism					
Univoltine Richness	9				
Semivoltine Richness	3	3			
Multivoltine Percent	60.33%		1		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	1.00%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.649				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	22.67%	3		1	
Hilsenhoff Biotic Index	6.850		1		0
Intolerant Percent	0.00%				
Supertolerant Percent	61.00%				
CTQa	103.200				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	20	40.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	14	46.67%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	4	22.22%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	3	14.29%	Severe



Thursday, December 10, 2009

Figure E-21
Fall 2009 Macroinvertebrate Metric Results for Unnamed 5

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp012
Sta. Name: WV: Sample 301-304
Client ID: Spring 2009
STORET ID:
Coll. Date:

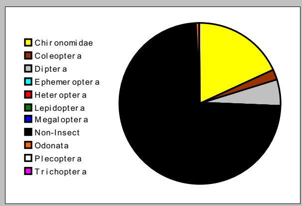
Abundance Measures

Sample Count:	300		
Sample Abundance:	473.68	63.33%	of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	10	221	73.67%
Odonata	1	2	0.67%
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera			
Lepidoptera			
Coleoptera	5	6	2.00%
Diptera	6	16	5.33%
Chironomidae	10	55	18.33%

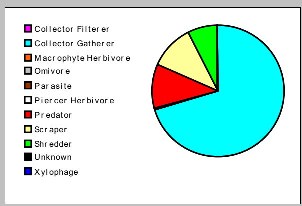


Dominant Taxa

Category	A	PRA
Ostracoda	69	23.00%
Hyalella	69	23.00%
Pyrgulopsis	32	10.67%
Amphipoda	21	7.00%
Gammarus	19	6.33%
Chaetocladius	19	6.33%
Micropsectra	12	4.00%
Acricotopus	9	3.00%
Probezzia	5	1.67%
Chironomus	5	1.67%
Larsia	4	1.33%
Culicoides	4	1.33%
Erpobdellidae	3	1.00%
Nematoda	2	0.67%
Arrenurus	2	0.67%

Functional Composition

Category	R	A	PRA
Predator	14	33	11.00%
Parasite	1	2	0.67%
Collector Gatherer	11	210	70.00%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	2	33	11.00%
Shredder	4	22	7.33%
Omivore			
Unknown			

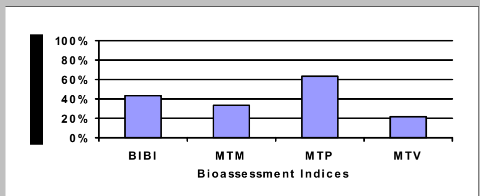


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	32	3	3		3
Non-Insect Percent	73.67%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	0	1		0	
EPT Richness	0		0		0
EPT Percent	0.00%		0		0
Oligochaeta+Hirudinea Percent	1.67%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	23.00%		3		3
Dominant Taxa (2) Percent	46.00%				
Dominant Taxa (3) Percent	56.67%	3			
Dominant Taxa (10) Percent	86.67%				
Diversity					
Shannon H (loge)	2.365				
Shannon H (log2)	3.413		3		
Margalef D	5.519				
Simpson D	0.151				
Evenness	0.071				
Function					
Predator Richness	14		3		
Predator Percent	11.00%	3			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	70.00%		2		1
Scraper+Shredder Percent	18.33%		2		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	5				
Burrower Percent	6.00%				
Swimmer Richness	3				
Swimmer Percent	1.00%				
Clinger Richness	2	1			
Clinger Percent	0.67%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	3				
Hemoglobin Bearer Percent	2.33%				
Air Breather Richness	4				
Air Breather Percent	1.67%				
Voltinism					
Univoltine Richness	8				
Semivoltine Richness	4	3			
Multivoltine Percent	44.67%		2		
Tolerance					
Sediment Tolerant Richness	1				
Sediment Tolerant Percent	0.33%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	2.813				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	10.67%	5		1	
Hilsenhoff Biotic Index	6.970		1		0
Intolerant Percent	0.00%				
Supertolerant Percent	54.33%				
CTQa	102.952				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	22	44.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	19	63.33%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	4	22.22%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	7	33.33%	Moderate



Sunday, November 22, 2009

Figure E-22
Spring 2009 Macroinvertebrate Metric Results for West Spring Valley Complex

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2006
Sta. Name: WV: Sample 305-308
Client ID: Fall 2009
STORET ID:
Coll. Date:

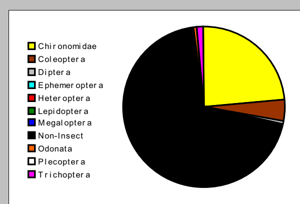
Abundance Measures

Sample Count: 317
Sample Abundance: 15,216.00 2.08% of sample used

Coll. Procedure:
Sample Notes: X=jm 1.5, ssm .5
X=ms 11.5, ah .5

Taxonomic Composition

Category	R	A	PRA
Non-Insect	11	220	69.40%
Odonata	1	2	0.63%
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	1	4	1.26%
Lepidoptera			
Coleoptera	3	13	4.10%
Diptera	3	3	0.95%
Chironomidae	12	75	23.66%

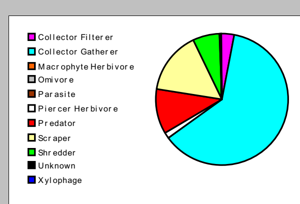


Dominant Taxa

Category	A	PRA
Amphipoda	49	15.46%
Hydrobiidae	38	11.99%
Hyalella	37	11.67%
Copepoda	37	11.67%
Orthocladius	26	8.20%
Gammarus	17	5.36%
Oligochaeta	14	4.42%
Tanypodinae	12	3.79%
Liodessus	11	3.47%
Ostracoda	9	2.84%
Physidae	8	2.52%
Apedilum	8	2.52%
Nilotanypus	7	2.21%
Cladocera	6	1.89%
Tanytarsini	4	1.26%

Functional Composition

Category	R	A	PRA
Predator	7	36	11.36%
Parasite			
Collector Gatherer	14	194	61.20%
Collector Filterer	2	11	3.47%
Macrophyte Herbivore			
Piercer Herbivore	2	5	1.58%
Xylophage			
Scraper	3	49	15.46%
Shredder	2	20	6.31%
Omivore			
Unknown	1	2	0.63%

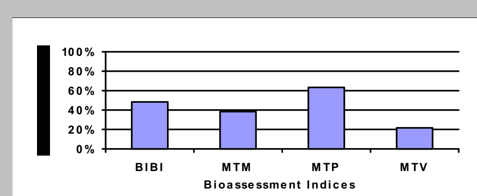


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	31	3	3		3
Non-Insect Percent	69.40%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	1	1		0	
EPT Richness	1		0		0
EPT Percent	1.26%		0		0
Oligochaeta+Hirudinea Percent	4.73%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	15.46%		3		3
Dominant Taxa (2) Percent	27.44%				
Dominant Taxa (3) Percent	39.12%	5			
Dominant Taxa (10) Percent	78.86%				
Diversity					
Shannon H (loge)	2.703				
Shannon H (log2)	3.900		3		
Margalef D	5.445				
Simpson D	0.091				
Evenness	0.059				
Function					
Predator Richness	7		3		
Predator Percent	11.36%	3			
Filterer Richness	2				
Filterer Percent	3.47%			3	
Collector Percent	64.67%		2		2
Scraper+Shredder Percent	21.77%		2		0
Scraper/Filterer	4.455				
Scraper/Scraper+Filterer	0.817				
Habit					
Burrower Richness	3				
Burrower Percent	0.95%				
Swimmer Richness	3				
Swimmer Percent	4.10%				
Clinger Richness	2	1			
Clinger Percent	1.89%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	4				
Hemoglobin Bearer Percent	4.10%				
Air Breather Richness	2				
Air Breather Percent	3.79%				
Voltinism					
Univoltine Richness	11				
Semivoltine Richness	3	3			
Multivoltine Percent	41.01%		2		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	5.36%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.132				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	11.67%	5		1	
Hilsenhoff Biotic Index	6.655		1		0
Intolerant Percent	0.00%				
Supertolerant Percent	49.53%				
CTQa	105.545				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	24	48.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	19	63.33%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	4	22.22%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	8	38.10%	Moderate



Thursday, December 10, 2009

Figure E-23
Fall 2009 Macroinvertebrate Metric Results for West Spring Valley Complex

Metrics Report

Project ID: SNWA09comp
RAI No.: SNWA09comp011
Sta. Name: WS: Sample 251-255
Client ID: Spring 2009
STORET ID:
Coll. Date:

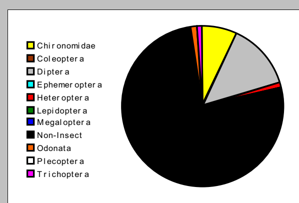
Abundance Measures

Sample Count: 300
Sample Abundance: 323.74 92.67% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	11	229	76.33%
Odonata	2	4	1.33%
Ephemeroptera			
Plecoptera			
Heteroptera	1	2	0.67%
Megaloptera			
Trichoptera	2	3	1.00%
Lepidoptera			
Coleoptera	1	1	0.33%
Diptera	5	40	13.33%
Chironomidae	10	21	7.00%

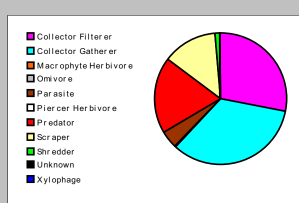


Dominant Taxa

Category	A	PRA
Hyalella	61	20.33%
Sphaeriidae	56	18.67%
Pyrgulopsis	35	11.67%
Ceratopogoninae	31	10.33%
Pisidium	28	9.33%
Ostracoda	17	5.67%
Nematoda	12	4.00%
Fossaria	7	2.33%
Arrenurus	6	2.00%
Oligochaeta	4	1.33%
Chironomus	4	1.33%
Micropsectra	3	1.00%
Coenagrionidae	3	1.00%
Chaetocladius	3	1.00%
Bezzia / Palpomyia	2	0.67%

Functional Composition

Category	R	A	PRA
Predator	13	57	19.00%
Parasite	1	12	4.00%
Collector Gatherer	11	100	33.33%
Collector Filterer	2	85	28.33%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	2	42	14.00%
Shredder	2	3	1.00%
Omivore	1	1	0.33%
Unknown			

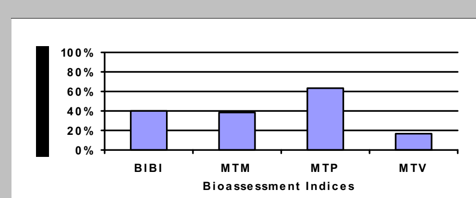


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	32	3	3		3
Non-Insect Percent	76.33%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	2	1		1	
EPT Richness	2		0		0
EPT Percent	1.00%		0		0
Oligochaeta+Hirudinea Percent	1.67%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	20.33%		3		3
Dominant Taxa (2) Percent	39.00%				
Dominant Taxa (3) Percent	50.67%	3			
Dominant Taxa (10) Percent	85.67%				
Diversity					
Shannon H (loge)	2.471				
Shannon H (log2)	3.565		3		
Margalef D	5.803				
Simpson D	0.141				
Evenness	0.067				
Function					
Predator Richness	13		3		
Predator Percent	19.00%	3			
Filterer Richness	2				
Filterer Percent	28.33%			0	
Collector Percent	61.67%		2		2
Scraper+Shredder Percent	15.00%		2		0
Scraper/Filterer	0.494				
Scraper/Scraper+Filterer	0.331				
Habit					
Burrower Richness	5				
Burrower Percent	14.00%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	1	1			
Clinger Percent	0.33%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	4				
Hemoglobin Bearer Percent	2.67%				
Air Breather Richness	3				
Air Breather Percent	1.33%				
Voltinism					
Univoltine Richness	13				
Semivoltine Richness	1	1			
Multivoltine Percent	19.00%		3		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	3.67%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.285				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	8.00%	5		2	
Hilsenhoff Biotic Index	7.043		0		0
Intolerant Percent	0.33%				
Supertolerant Percent	49.33%				
CTQa	106.200				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	20	40.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	19	63.33%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	3	16.67%	Severe
MTM	Montana DEQ Mountains (Bukantis 1998)	8	38.10%	Moderate



Sunday, November 22, 2009

Figure E-24
Spring 2009 Macroinvertebrate Metric Results for Willow

Metrics Report

Project ID: SNWA09CW2
RAI No.: SNWA09CW2013
Sta. Name: WS: Sample 256
Client ID: Fall 2009
STORET ID:
Coll. Date:

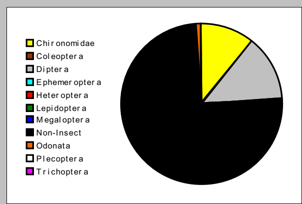
Abundance Measures

Sample Count: 300
Sample Abundance: 1,800.00 16.67% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	10	224	74.67%
Odonata	1	3	1.00%
Ephemeroptera	1	1	0.33%
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera			
Lepidoptera			
Coleoptera			
Diptera	1	39	13.00%
Chironomidae	7	33	11.00%

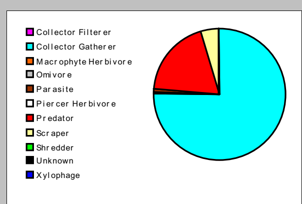


Dominant Taxa

Category	A	PRA
Hyalella	82	27.33%
Ostracoda	75	25.00%
Pisidiidae	40	13.33%
Ceratopogoninae	39	13.00%
Micropsectra	13	4.33%
Pyrgulopsis	11	3.67%
Oligochaeta	9	3.00%
Parachironomus	6	2.00%
Tanypodinae	4	1.33%
Apsectrotanypus	3	1.00%
Thienemannimyia Gr.	2	0.67%
Paratendipes	2	0.67%
Nematoda	2	0.67%
Coenagrionidae	2	0.67%
Apedilum	2	0.67%

Functional Composition

Category	R	A	PRA
Predator	7	59	19.67%
Parasite	1	2	0.67%
Collector Gatherer	9	225	75.00%
Collector Filterer			
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	2	13	4.33%
Shredder			
Omivore	1	1	0.33%
Unknown			

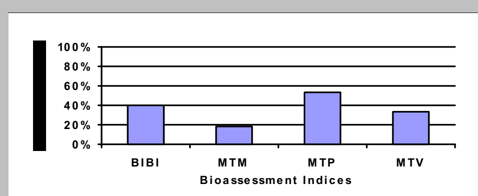


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	20	3	2		1
Non-Insect Percent	74.67%				
E Richness	1	1		0	
P Richness	0	1		0	
T Richness	0	1		0	
EPT Richness	1		0		0
EPT Percent	0.33%		0		0
Oligochaeta+Hirudinea Percent	3.33%				
Baetidae/Ephemeroptera	1.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	27.33%		3		2
Dominant Taxa (2) Percent	52.33%				
Dominant Taxa (3) Percent	65.67%	3			
Dominant Taxa (10) Percent	94.00%				
Diversity					
Shannon H (loge)	2.004				
Shannon H (log2)	2.891		2		
Margalef D	3.349				
Simpson D	0.185				
Evenness	0.094				
Function					
Predator Richness	7		3		
Predator Percent	19.67%	3			
Filterer Richness	0				
Filterer Percent	0.00%			3	
Collector Percent	75.00%		2		1
Scraper+Shredder Percent	4.33%		1		0
Scraper/Filterer	0.000				
Scraper/Scraper+Filterer	0.000				
Habit					
Burrower Richness	3				
Burrower Percent	14.67%				
Swimmer Richness	1				
Swimmer Percent	0.33%				
Clinger Richness	0	1			
Clinger Percent	0.00%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	4				
Hemoglobin Bearer Percent	4.33%				
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	7				
Semivoltine Richness	0	1			
Multivoltine Percent	37.33%		3		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	3.67%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.126				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	4.33%	5		3	
Hilsenhoff Biotic Index	7.559		0		0
Intolerant Percent	0.33%				
Supertolerant Percent	73.00%				
CTQa	104.727				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	20	40.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	16	53.33%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	6	33.33%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	4	19.05%	Severe



Thursday, December 10, 2009

Figure E-25
Fall 2009 Macroinvertebrate Metric Results for Willow

This Page Left Intentionally Blank

Appendix F

Vegetation Data
(Species Lists, Micro-Community Dominant Species, and Percent Cover Overall and by Line Transects on VFRM Juniper Belt Transects)

Table F-1
Scientific Names, Common Names, and Synonyms of Plant Taxa Encountered on the Vegetation Transects in 2009 and Which Transect Types the Taxa are Present
(Page 1 of 6)

Scientific Name	Common Name	Synonym	Transect Type			
			AQ	WM	PS	SC
Achillea millefolium	Yarrow		X	X		X
Achnatherum hymenoides	Indian Ricegrass	*Oryzopsis hymenoides*			X	X
Agoseris glauca			X	X		
Agrostis gigantea	Creeping Bent		X	X		X
Alisma plantago-aquatica	European Waterplantain		X			
Angelica sp.	Angelica		X			
Aqulegia formosa	California Columbine		X	X		X
Arctium minus	Common Burdock		X			
Argentina anserina	Silverweed Cinquefoil	*Potentilla anserina*	X	X		X
Artemisia tridentata	Big Sagebrush		X	X	X	X
Asclepias speciosa	Showy Milkweed		X	X		
Aster sp.	Aster		X	X		
Astragalus convallarius	Timber Milkvetch					X
Astragalus sp.	Milkvetch			X		X
Atriplex canescens	Fourwing Saltbrush				X	
Atriplex confertifolia	Shadscale				X	
Atriplex micrantha			X	X		X
Atriplex serenana	Bractscale		X			X
Atriplex truncata	Wedgescale		X		X	
Atriplex sp.	Saltbush			X		
Bassia americana	Greenmolly	*Kochia americana*			X	
Bassia scoparia	Kochia	*Kochia scoparia*	X	X	X	X
Berula erecta	Water Parsnip		X	X		
Bidens cernua	Nooding Beggarsticks		X	X		
Bromus inermis	Smooth Brome		X	X		
Bromus tectorum	Cheatgrass		X	X		X
Cardaria draba	Pepperweed Whitetop		X	X		
Carduus nutans	Musk Thistle			X		
Carex aurea	Golden Sedge		X	X		
Carex douglasii	Douglas Sedge			X		
Carex nebrascensis	Nebraska Sedge		X	X		X
Carex praegracilis	Fieldclustered Sedge		X	X		X
Carex rostrata	Beaked Sedge		X	X		
Carex simulata	Analogne Sedge		X	X		X

Table F-1
Scientific Names, Common Names, and Synonyms of Plant Taxa Encountered on the Vegetation Transects in 2009 and Which Transect Types the Taxa are Present
(Page 2 of 6)

Scientific Name	Common Name	Synonym	Transect Type			
			AQ	WM	PS	SC
Carex sp.	Sedge		X	X		X
Castilleja minor	Indian Paintbrush		X	X		
Catabrosa aquatica	Brookgrass		X	X		
Caulanthus sp.	Wild Cabbage					X
Centaurium exaltatum	Nevada Centaury		X		X	
Chara sp.	Stonewort, Chara		X	X		
Chenopodium berlandieri	Pitseed Lambsquarters		X	X		
Chenopodium incanum	Mariola	*Parthenium incanum*	X		X	
Chenopodium leptophyllum	Narrowleaf Labsquarters				X	
Chenopodium sp.	Lambsquarters		X	X	X	X
Chrysothamnus viscidiflorus	Green Rabbitbrush				X	X
Cirsium arvense	Canada Thistle		X	X		
Cirsium scariosum	Elk Thistle		X	X		X
Cirsium vulgare	Bull Thistle		X	X		X
Clematis ligusticifolia	Western Virginsbower		X			
Cleomella plocasperma	Greasewood Cleomella				X	
Comandra umbellata	Bastard Toadflax					X
Conium maculatum	Poison Hemlock			X		
Convolvulus arvensis	Bindweed		X	X		
Conyza canadensis	Canada Horseweed					X
Cordylanthus ramosus	Birds Beak					X
Crepis runcinata	Hawksbeard		X	X		X
Dactylis glomerata	Orchardgrass			X		
Deschampsia caespitosa	Tufted Hairgrass		X	X		
Descurainia sophia	Flexweed Tansymustard		X	X	X	X
Distichlis spicata	Saltgrass		X	X	X	X
Dodecatheon pulchellum	Shootingstar			X		X
Downingia laeta	Downingia			X		
Elaeagnus angustifolia	Russian Olive		X			
Eleocharis palustris	Creeping Spikerush		X	X		
Eleocharis quinqueflora	Fewflowered Spikerush	*Eleocharis pauciflora*		X		
Eleocharis rostellata	Beaked Spikerush		X	X		
Eleocharis sp.	Spikerush		X	X		
Elymus elymoides	Squirreltail	*Sitanion hystrix*			X	X
Elymus trachycaulus	Slender Wheatgrass	*Agropyron trachycaulum*	X	X		

Table F-1
Scientific Names, Common Names, and Synonyms of Plant Taxa Encountered on the Vegetation Transects in 2009 and Which Transect Types the Taxa are Present
(Page 3 of 6)

Scientific Name	Common Name	Synonym	Transect Type			
			AQ	WM	PS	SC
Ephedra viridis	Green Mormon Tea				X	
Epilobium ciliatum	Purpleleaf Willowherb		X	X		
Epilobium sp.	Willowherb, Fireweed		X	X		
Equisetum arvense	Field Horsetail		X	X		X
Ericameria nauseosa	Rubber Rabbitbrush	*Chrysothamnus nauseosus*	X	X	X	X
Erigeron lonchophyllus	Spearleaf Fleabane		X	X		
Eriogonum cernuum	Nodding Wildbuckwheat					X
Festuca sororia	Ravine Fescue			X		
Galium trifidum	Small Bedstraw		X	X		
Gentianella amarella	Annual Gentian		X			X
Glaux maritima	Sea Milkwort		X	X		X
Grayia spinosa	Spiny Hopsage				X	
Grindelia squarrosa	Curlycup Gumweed		X			
Gutierrezia sarothrae	Snakeweed				X	
Halogeton glomeratus	Halogeton		X		X	
Helianthus nuttallii	Nuttall Sunflower		X	X		
Hesperochiron pumilus	Evening Centaur			X		
Hippuris vulgaris	Common Marestail		X	X		
Hordeum brachyantherum	Meadow Barley		X	X		
Hordeum jubatum	Foxtail Barley		X	X		X
Hymenopappus filifolius	Hymenopappus					X
Hymenoxys lemmonii	Lemmon Actinia		X	X		X
Ipomopsis aggregata	Scarlet Gila					X
Iris missouriensis	Rocky Mountain Iris		X	X		X
Iva axillaris	Sumpweed		X	X	X	X
Ivesia kingii	Alkali Ivesia		X	X		X
Juncus arcticus	Baltic Rush	*Juncus balticus*	X	X		X
Juncus bufonius	Toad Rush			X		
Juncus longistylis	Longstyle Rush			X		
Juncus nevadensis	Nevada Rush		X	X		
Juncus saximontanus	Rocky Mountain Rush		X			
Juncus torreyi	Torrey Rush		X			
Juncus sp.	Rush		X	X		
Juniperus scopulorum	Rocky Mountain Juniper		X	X		X

Table F-1
Scientific Names, Common Names, and Synonyms of Plant Taxa Encountered on the Vegetation Transects in 2009 and Which Transect Types the Taxa are Present
(Page 4 of 6)

Scientific Name	Common Name	Synonym	Transect Type			
			AQ	WM	PS	SC
Krascheninnikovia lanata	Winterfat	*Eurotia lanata*			X	
Lactuca serriola	Prickly Lettuce	*Lactuca scariola*	X	X		X
Lemna minor	Common Duckweed		X	X		
Lemna minuta	Least Duckweed	*Lemna minima*	X	X		
Lemna trisulca	Star Duckweed		X	X		
Lemna sp.	Duckweed		X	X		
Leymus cinereus	Basin Wildrye	*Elymus cinereus*				X
Leymus triticoides	Creeping Wildrye	*Elymus triticoides*	X	X		X
Limosella aquatica	Water Mudwort			X		
Linanthus pungens	Flaxflower		X			
Machaeranthera carnosa	Alkali Aster				X	
Maianthemum racemosum	Scurvy Berry		X			X
Medicago polymorpha	California Burclover		X	X		X
Melilotus officinalis	Sweetclover		X	X		X
Mentha arvensis	Field Mint			X		
Mentha spicata	Spear Mint		X	X		
Mimulus guttatus	Common Monkeyflower		X	X		
Muhlenbergia asperifolia	Alkali Muhly		X	X		X
Muhlenbergia richardsonis	Mat Muhly		X	X		X
Musineon divaricatum						X
Myriophyllum verticillatum	Parrotfeather		X	X		
Nasturtium officinale	Watercress		X	X		
Nitrophila occidentalis	Alkali Pink			X		X
Pascopyrum smithii	Western Wheatgrass	*Agropyron smithii*		X		
Phalaris arundinacea	Reed Canarygrass			X		
Phleum pratense	Timothy		X	X		
Phlox pulvinata	Tufted Flox					X
Phragmites australis	Common Reed		X	X		
Picrothamnus desertorum	Budsage	*Artemisia spinescens*			X	
Plagiobothrys scouleri	Popcorn Flower			X		
Plantago major	Common Plantain		X	X		
Poa pratensis	Kentucky Bluegrass		X	X		X
Poa secunda	Sandberg Bluegrass		X	X	X	X
Poa sp.	Bluegrass		X	X		
Polygonum aviculare	Prostrate Knotweed		X	X		X

Table F-1
Scientific Names, Common Names, and Synonyms of Plant Taxa Encountered on the Vegetation Transects in 2009 and Which Transect Types the Taxa are Present
(Page 5 of 6)

Scientific Name	Common Name	Synonym	Transect Type			
			AQ	WM	PS	SC
Polygonum sp.	Knotweed			X		
Polypogon monspeliensis	Rabbitsfoot Grass		X	X		
Populus angustifolia	Narrowleaf Popular		X			
Potamogeton sp.	Pondweed		X	X		
Potentilla gracilis	Northwest Cinquefoil		X	X		
Potentilla hippiana	Horse Cinquefoil		X	X		
Potentilla pensylvanica	Pennsylvania Cinquefoil		X	X		
Puccinellia distans	Weeping Alkaligrass		X	X		
Puccinellia lemmonii	Lemmon Alkaligrass		X	X		X
Pyrrocoma lanceolata	Lanceleaf Goldenweed	*Haplopappus lanceolatus*	X	X		X
Raillardella argentea	Silky Raillardella					X
Ranunculus aquatilis	Water Crowfoot		X			
Ranunculus cymbalaria	Shore Buttercup		X	X		
Ranunculus sceleratus	Blister Buttercup		X	X		
Rhus trilobata	Skunkbush		X			
Ribes sp.	Currant		X			
Rorippa sinuata	Spreading Watercress		X			
Rosa woodsii	Woods Rose		X	X		X
Rumex crispus	Curly Dock		X	X		
Sagittaria cuneata	Duckpotato Arrowhead		X	X		
Salix sp.	Willow		X			
Salsola tragus	Russian Thistle		X			
Sambucus nigra	European Elder		X			
Sarcobatus vermiculatus	Greasewood			X	X	X
Schedonorus pratensis	Meadow Fescue	*Festuca elatior*	X	X		X
Schoenoplectus acutus	Tule Bulrush	*Scirpus acutus*	X	X		
Schoenoplectus americanus	American Bulrush	*Scirpus americanus*	X	X		
Schoenoplectus pungens	Common Threesquare	*Scirpus pungens*	X	X		
Sida neomexicana	New Mexico Sida		X	X		
Sisyrinchium halophilum	Alkali Blueeyedgrass		X	X		X
Sium suave	Hemlock Waterparsnip		X	X		
Solidago nana	Baby Goldenrod			X		X
Solidago sp.	Goldenrod		X	X		
Sparganium eurycarpum	Giant Burreed		X	X		
Spartina gracilis	Alkali Cordgrass		X	X		X

Table F-1
Scientific Names, Common Names, and Synonyms of Plant Taxa Encountered on the Vegetation Transects in 2009 and Which Transect Types the Taxa are Present
(Page 6 of 6)

Scientific Name	Common Name	Synonym	Transect Type			
			AQ	WM	PS	SC
Sphaeralcea coccinea	Orange Globemallow				X	
Sphenopholis obtusata	Prairie Wedgescale		X	X		
Sporobolus airoides	Alkali Sacaton		X	X	X	X
Stellaria longipes	Longstalk Starwort			X		
Stuckenia filiformis	Slender-leaved Pondweed	*Potamogeton filiformis*	X	X		
Suaeda calceoliformis	Horned Seablite				X	
Suaeda moquinii	Bush Seepweed				X	
Symphyotrichum eatonii	Eaton Aster	*Aster eatonii*	X	X		X
Symphyotrichum spathulatum	Western Aster	*Aster occidentalis*	X			X
Taraxacum officinale	Dandelion		X	X		X
Tetradymia spinosa	Spiny Horsebrush				X	
Thermopsis rhombifolia	Golden Thermopsis		X	X		
Thinopyrum ponticum	Tall Wheatgrass	*Agropyron elongatum*		X		
Trifolium fragiferum	Strawberry Clover		X	X		
Trifolium hybridum	Alsike Clover		X	X		
Trifolium pratense	Red Clover		X	X		
Trifolium repens	White Clover		X	X	X	
Trifolium sp.	Clover		X	X		
Triglochin concinna	Arrowgrass			X		
Triglochin maritima	Seaside Arrowgrass		X	X	X	
Triglochin palustris	Marsh Arrowgrass			X		
Triglochin sp.	Arrowgrass			X		
Typha latifolia	Common Cattail		X	X		
Typha sp.	Cattail		X			
Urtica dioica	Stinging Nettle		X			
Utricularia macrorhiza	Bladderwort		X	X		
Verbascum thapsus	Mullein		X			
Verbena bracteata	Rose Verbena			X		
Veronica anagallis-aquatica	Water Speedwell		X	X		
Viola nephrophylla	Northern Bog		X	X		
Xanthium strumarium	Cocklebur		X	X		
Zannichellia palustris	Horned Poolmat		X	X		
Zigadenus elegans	Mountain Deathcamus			X		

AQ = aquatic, WM = wetland/meadow, PS = phreatophytic shrubland, SC = VFRM Juniper

Table F-2
Plant Species that were Micro-Community Dominants along the Vegetation Transects in 2009 Classified by Typical Habitat Type
(Page 1 of 3)

Special Habitat Type	Code	Species	Common Name
D = surface commonly dry	ARTR	*Artemisia Tridentata*	Big Sagebrush
	ATCA	*Atriplex Canescens*	Fourwing Saltbush
	BASC	*Bassia Scoparia*	Kochia
	BRTE	*Bromus Tectorum*	Cheatgrass
	CHBE	*Chenopodium Berlandieri*	Pitseed Lambsquarters
	CHEN	*Chenopodium Sp.*	Lambsquarters
	CHVI	*Chrysothamnus Viscidiflorus*	Green Rabbitbrush
	ERNA	*Ericameria Nauseosa*	Rubber Rabbitbrush
	GRSP	*Grayia Spinosa*	Spiny Hopsage
	GUSA	*Gutierrezia Sarothrae*	Snakeweed
	HYLE	*Hymenoxys Lemmonii*	Lemmon Actinia
	JUSC	*Juniperus Scopulorum*	Rocky Mountain Juniper
	PASM	*Pascopyrum Smithii*	Western Wheatgrass
	PIDE	*Picrothmnus Desertorum*	Budsage
	POSE	*Poa Secunda*	Sandberg Bluegrass
	PYLA	*Pyrrocoma Lanceolata*	Lanceleaf Goldenweed
	RHTR	*Rhus Trilobata*	Skunkbush
	SATR	*Salsola Tragus*	Russian Thistle
M = surface soil often saturated	ACMI	*Achillea Millefolium*	Yarrow
	ARMI	*Arctium Minus*	Common Burdock
	ARAN	*Argentina Anserina*	Silverweed Cinquefoil
	ASSP	*Asclepias Speciosa*	Showy Milkweed
	ATCO	*Atriplex Confertifolia*	Shadscale
	BAAM	*Bassia Americana*	Greenmolly
	CARX	*Carex Sp.*	Sedge
	CHIN	*Chenopodium Incanum*	Mariola
	CIAR	*Cirsium Arvense*	Canada Thistle
	CLLI	*Clematis Ligusticifolia*	Western Virginsbower
	DAGL	*Dactylis Glomerata*	Orchardgrass
	DECE	*Deschampsia Caespitosa*	Tufted Hairgrass
	DISP	*Distichlis Spicata*	Saltgrass
	ERLO	*Erigeron Lonchophyllus*	Spearleaf Fleabane
	HOBR	*Hordeum Brachyantherum*	Meadow Barley
	HOJU	*Hordeum Jubatum*	Foxtail Barley
	IVKI	*Ivesia Kingii*	Alkali Ivesia
	JUBU	*Juncus Bufonius*	Toad Rush

Table F-2
Plant Species that were Micro-Community Dominants along the Vegetation Transects in 2009 Classified by Typical Habitat Type
(Page 2 of 3)

Special Habitat Type	Code	Species	Common Name
M = surface soil often saturated	MEPO	*Medicago Polymorpha*	California Burclover
	MEOF	*Melilotus Officinalis*	Sweetclover
	MEAR	*Mentha Arvensis*	Field Mint
	MURI	*Muhlenbergia Richardsonis*	Mat Muhly
	PHAU	*Phragmites Australis*	Common Reed
	PLMA	*Plantago Major*	Common Plantain
	POAV	*Polygonum Aviculare*	Prostrate Knotweed
	POAN	*Populus Angustifolia*	Narrowleaf Poplar
	POGR	*Potentilla Gracilis*	Northwest Cinquefoil
	PUDI	*Puccinellia Distans*	Weeping Alkaligrass
	PULE	*Puccinellia Lemmonii*	Lemmon Alkaligrass
	ROWO	*Rosa Woodsii*	Woods Rose
	SAVE	*Sarcobatus Vermiculatus*	Greasewood
	SPAI	*Sporobolus Airoides*	Alkali Sacaton
	TAOF	*Taraxacum Officinale*	Dandelion
	THRH	*Thermopsis Rhombifolia*	Golden Thermopsis
	TRRE	*Trifolium Repens*	White Clover
	TRIF	*Trifolium Sp.*	Clover
S = intermittently flooded, soil generally saturated	AGGI	*Agrostis Gigantea*	Creeping Bent
	AQFO	*Aqulegia Formosa*	California Columbine
	BICE	*Bidens Cernua*	Nooding Beggarsticks
	CANE	*Carex Nebrascensis*	Nebraska Sedge
	CAPR	*Carex Praegracilis*	Fieldclustered Sedge
	CISC	*Cirsium Scariosum*	Elk Thistle
	CRRU	*Crepis Runcinata*	Hawksbeard
	ELTR	*Elymus Trachycaulus*	Slender Wheatgrass
	IRMI	*Iris Missouriensis*	Rocky Mountain
	IVAX	*Iva Axillaris*	Sumpweed
	JUAR	*Juncus Arcticus*	Baltic Rush
	LETR	*Leymus Triticoides*	Creeping Wildrye
	MUAS	*Muhlenbergia Asperifolia*	Alkali Muhly
	NIOC	*Nitrophila Occidentalis*	Alkali Pink
	SALX	*Salix Sp.*	Willow
	SCPR	*Schedonorus Pratensis*	Meadow Fescue
	SPGR	*Spartina Gracilis*	Alkali Cordgrass

Table F-2
Plant Species that were Micro-Community Dominants along the Vegetation Transects in 2009 Classified by Typical Habitat Type
(Page 3 of 3)

Special Habitat Type	Code	Species	Common Name
S = intermittently flooded, soil generally saturated	SUCA	*Suaeda Calceoliformis*	Horned Seablite
	SUMO	*Suaeda Moquinii*	Bush Seepweed
W = standing water most of the time	CARO	*Carex Rostrata*	Beaked Sedge
	CASI	*Carex Simulata*	Analogne Sedge
	ELPA	*Eleocharis Palustris*	Creeping Spikerush
	ELQU	*Eleocharis Quinqueflora*	
	ELRO	*Eleocharis Rostellata*	Beaked Spikerush
	ELEO	*Eleocharis Sp.*	Spikerush
	EQAR	*Equisetum Arvense*	Field Horsetail
	GLMA	*Glaux Maritima*	Sea Milkwort
	HIVU	*Hippuris Vulgaris*	Common Marestail
	JUNE	*Juncus Nevadensis*	Nevada Rush
	MIGU	*Mimulus Guttatus*	Common Monkeyflower
	RASC	*Ranunculus Sceleratus*	Blister Buttercup
	SPOB	*Sphenopholis Obtusata*	Prairie Wedgescale
	SYEA	*Symphyotrichum Eatonii*	Eaton Aster
A = perennial standing water	ALGA	*Algae*	
	ALPL	*Alisma Plantago-aquatica*	European Waterplantain
	BEER	*Berula Erecta*	Water Parsnip
	CAAQ	*Catabrosa Aquatica*	Brookgrass
	CHAR	*Chara Sp.*	Stonewort, Chara
	LEMI	*Lemna Minor*	Common Duckweed
	MOSS	*Moss*	
	NAOF	*Nasturtium Officinale*	Watercress
	POTA	*Potamogeton Sp.*	Pondweed
	ROSI	*Rorippa Sinuata*	Spreading Watercress
	SCAC	*Schoenoplectus Acutus*	Tule Bulrush
	SCAM	*Schoenoplectus Americanus*	American Bulrush
	SPEU	*Sparganium Eurycarpum*	Giant Burreed
	STFI	*Stuckenia Filiformis*	Slender-leaved Pondweed
	TYLA	*Typha Latifolia*	Common Cattail
	TYPH	*Typha Sp.*	Cattail
	UTMA	*Utricularia Macrorhiza*	Bladderwort
	VEAN	*Veronica Anagallis-aquatica*	Water Speedwell
	ZAPA	*Zannichellia Paulstris*	Horned Poolmat

Table F-3
Mean Percent Cover, Overall and by Line Transect,
at Middle Spring Valley VFRM Juniper Belt Transect 098 in 2009

Species	Overall	098A	098C	098E
Carex praegracilis	1.92	1.10	4.35	0.30
Carex sp.	1.87	0.85	2.60	2.15
Crepis runcinata	0.75	0.00	1.60	0.65
Distichlis spicata	6.28	0.70	0.10	18.05
Dodecatheon pulchellum	3.03	2.55	2.45	4.10
Equisetum arvense	0.17	0.00	0.00	0.50
Hymenoxys lemmonii	0.47	0.00	0.00	1.40
Iris missouriensis	0.75	0.30	1.85	0.10
Ivesia kingii	1.75	0.05	3.85	1.35
Juncus arcticus	2.08	0.55	5.10	0.60
Juniperus scopulorum	65.30	78.20	49.45	68.25
Leymus triticoides	4.88	3.80	4.40	6.45
Maianthemum racemosum	2.67	6.90	1.10	0.00
Muhlenbergia richardsonis	0.52	1.25	0.30	0.00
Nitrophila occidentalis	0.45	0.00	0.00	1.35
Puccinellia lemmonii	8.32	5.55	9.20	10.20
Pyrrocoma lanceolata	5.98	3.95	6.65	7.35
Sisyrinchium halophilum	0.02	0.05	0.00	0.00
Spartina gracilis	1.03	0.05	1.70	1.35
Triglochin maritima	0.13	0.00	0.00	0.40
Total	**108.37**	**105.85**	**94.70**	**124.55**
Total Overstory Species	**65.30**	**78.20**	**49.45**	**68.25**
Total Understory Species	**43.07**	**27.65**	**45.25**	**56.30**
Number of Species	**20**	**15**	**15**	**17**

Table F-4
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 099 in 2009

Species	Overall	099A	099C	099E
Artemisia tridentata	0.10	0.00	0.30	0.00
Atriplex serenana	0.05	0.15	0.00	0.00
Cordylanthus ramosus	0.05	0.15	0.00	0.00
Distichlis spicata	1.55	2.25	1.65	0.75
Elymus elymoides	0.08	0.00	0.00	0.25
Equisetum arvense	0.13	0.40	0.00	0.00
Ericameria nauseosa	7.98	9.90	5.40	8.65
Hymenoxys lemmonii	0.02	0.05	0.00	0.00
Juniperus scopulorum	38.88	57.90	53.00	5.75
Leymus triticoides	0.18	0.20	0.25	0.10
Sarcobatus vermiculatus	0.13	0.40	0.00	0.00
Sporobolus airoides	1.58	1.30	2.45	1.00
Total	**50.73**	**72.70**	**63.05**	**16.50**
Total Overstory Species	**38.88**	**57.90**	**53.00**	**5.75**
Total Understory Species	**11.85**	**14.80**	**10.05**	**10.75**
Number of Species	**12**	**10**	**6**	**6**

Table F-5
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 100 in 2009

Species	Overall	100A	100C	100E
Dodecatheon pulchellum	0.03	0.00	0.10	0.00
Equisetum arvense	0.13	0.05	0.00	0.35
Ericameria nauseosa	4.45	1.65	5.25	6.45
Hymenoxys lemmonii	1.22	2.45	1.20	0.00
Juniperus scopulorum	43.23	49.80	48.40	31.50
Leymus triticoides	1.78	2.60	0.30	2.45
Phlox pulvinata	0.10	0.00	0.00	0.30
Poa secunda	0.07	0.20	0.00	0.00
Puccinellia lemmonii	1.73	0.00	4.95	0.25
Pyrrocoma lanceolata	0.33	0.00	0.00	1.00
Sporobolus airoides	0.33	0.80	0.00	0.20
Total	**53.40**	**57.55**	**60.20**	**42.50**
Total Overstory Species	**43.23**	**49.80**	**48.40**	**31.50**
Total Understory Species	**10.17**	**7.75**	**11.80**	**11.00**
Number of Species	**11**	**7**	**6**	**8**

Table F-6
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 101 in 2009

Species	Overall	101A	101C	101E
Astragalus sp.	0.03	0.00	0.10	0.00
Atriplex truncata	0.42	0.40	0.50	0.35
Equisetum arvense	0.02	0.00	0.05	0.00
Ericameria nauseosa	2.95	2.45	1.75	4.65
Hymenoxys lemmonii	0.22	0.40	0.15	0.10
Ivesia kingii	0.10	0.30	0.00	0.00
Juncus arcticus	0.03	0.10	0.00	0.00
Juniperus scopulorum	37.85	54.25	38.80	20.50
Leymus triticoides	0.23	0.35	0.05	0.30
Poa secunda	1.00	1.25	1.00	0.75
Puccinellia lemmonii	0.07	0.00	0.20	0.00
Pyrrocoma lanceolata	0.05	0.10	0.00	0.05
Spartina gracilis	0.88	0.00	2.65	0.00
Sporobolus airoides	1.58	0.25	0.70	3.80
Total	**45.43**	**59.85**	**45.95**	**30.50**
Total Overstory Species	**37.85**	**54.25**	**38.80**	**20.50**
Total Understory Species	**7.58**	**5.60**	**7.15**	**10.00**
Number of Species	**14**	**10**	**11**	**8**

Table F-7
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 102 in 2009

Species	Overall	102A	102C	102E
Atriplex truncata	0.02	0.05	0.00	0.00
Cirsium scariosum	2.02	1.30	2.15	2.60
Comandra umbellata	0.15	0.00	0.45	0.00
Equisetum arvense	0.07	0.00	0.00	0.20
Ericameria nauseosa	4.97	4.00	5.55	5.35
Hymenoxys lemmonii	1.43	0.45	1.20	2.65
Juncus arcticus	0.10	0.30	0.00	0.00
Juniperus scopulorum	49.70	56.00	49.50	43.60
Leymus triticoides	1.98	1.95	1.50	2.50
Poa secunda	0.97	2.90	0.00	0.00
Puccinellia lemmonii	3.52	0.00	8.20	2.35
Pyrrocoma lanceolata	0.47	0.30	0.35	0.75
Sporobolus airoides	4.13	4.45	1.15	6.80
Total	**69.53**	**71.70**	**70.05**	**66.80**
Total Overstory Species	**49.70**	**56.00**	**49.50**	**43.60**
Total Understory Species	**19.83**	**15.70**	**20.55**	**23.20**
Number of Species	**13**	**10**	**9**	**9**

Table F-8
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 103 in 2009

Species	Overall	103A	103C	103E
Astragalus sp.	0.12	0.35	0.00	0.00
Atriplex truncata	0.03	0.00	0.10	0.00
Cirsium scariosum	0.27	0.00	0.60	0.20
Distichlis spicata	0.10	0.00	0.00	0.30
Equisetum arvense	0.17	0.00	0.25	0.25
Ericameria nauseosa	1.25	0.20	2.30	1.25
Hordeum jubatum	0.18	0.35	0.00	0.20
Hymenoxys lemmonii	0.07	0.00	0.00	0.20
Ivesia kingii	0.02	0.00	0.05	0.00
Juncus arcticus	0.17	0.10	0.15	0.25
Juniperus scopulorum	48.67	52.75	39.25	54.00
Leymus triticoides	0.88	0.20	1.05	1.40
Phlox pulvinata	0.07	0.20	0.00	0.00
Poa secunda	0.60	1.80	0.00	0.00
Puccinellia lemmonii	2.68	0.00	5.70	2.35
Pyrrocoma lanceolata	0.05	0.00	0.10	0.05
Sarcobatus vermiculatus	0.63	0.65	0.00	1.25
Sporobolus airoides	10.97	4.40	14.75	13.75
Total	**66.93**	**61.00**	**64.30**	**75.45**
Total Overstory Species	**48.67**	**52.75**	**39.25**	**54.00**
Total Understory Species	**18.26**	**8.25**	**25.05**	**21.45**
Number of Species	**18**	**10**	**11**	**13**

Table F-9
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 104 in 2009

Species	Overall	104A	104C	104E
Argentina anserina	1.78	0.45	4.90	0.00
Astragalus sp.	0.70	1.50	0.15	0.45
Carex nebrascensis	0.02	0.00	0.05	0.00
Carex praegracilis	0.37	0.10	1.00	0.00
Cirsium scariosum	0.23	0.15	0.25	0.30
Crepis runcinata	0.18	0.40	0.00	0.15
Distichlis spicata	0.70	1.30	0.80	0.00
Dodecatheon pulchellum	0.17	0.00	0.50	0.00
Equisetum arvense	2.20	1.15	2.60	2.85
Ericameria nauseosa	0.72	0.15	1.00	1.00
Gentianella amarella	0.62	0.65	1.20	0.00
Glaux maritima	0.02	0.00	0.05	0.00
Hymneoxys lemmonii	0.05	0.15	0.00	0.00
Juncus arcticus	0.18	0.05	0.30	0.20
Juniperus scopulorum	31.82	40.10	34.55	20.80
Leymus triticoides	0.73	1.15	0.15	0.00
Muhlenbergia asperifolia	0.65	0.00	1.95	0.00
Poa secunda	1.18	3.55	0.00	0.00
Puccinellia lemmonii	5.03	1.65	6.80	6.65
Pyrrocoma lanceolata	0.83	0.75	0.95	0.80
Rosa woodsii	1.15	0.20	1.25	3.00
Sisyrinchium halophilum	1.43	0.90	1.15	2.25
Spartina gracilis	6.22	1.35	1.50	15.80
Symphyotrichum eatonii	0.62	0.10	1.75	0.00
Total	**57.60**	**55.80**	**62.85**	**54.25**
Total Overstory Species	**31.82**	**40.10**	**34.55**	**20.80**
Total Understory Species	**25.78**	**15.70**	**28.30**	**33.45**
Number of Species	**24**	**20**	**21**	**12**

Table F-10
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 105 in 2009

Species	Overall	105A	105C	105E
Crepis runcinata	0.08	0.00	0.00	0.25
Equisetum arvense	0.05	0.00	0.15	0.00
Ericameria nauseosa	4.80	5.95	4.90	3.55
Hymenopappus filifolius	0.07	0.00	0.00	0.20
Hymenoxys lemmonii	0.50	0.30	0.35	0.85
Iris missouriensis	0.25	0.00	0.75	0.00
Ivesia kingii	0.03	0.00	0.10	0.00
Juncus arcticus	0.05	0.00	0.15	0.00
Juniperus scopulorum	43.57	51.20	31.25	48.25
Leymus triticoides	0.08	0.25	0.00	0.00
Musineon divaricatum	0.03	0.00	0.10	0.00
Poa secunda	0.15	0.45	0.00	0.00
Puccinellia lemmonii	1.27	0.00	1.80	2.00
Pyrrocoma lanceolata	0.45	0.10	1.05	0.20
Sisyrinchium halophilum	0.03	0.00	0.10	0.00
Sporobolus airoides	2.82	1.95	0.00	6.50
Total	**54.23**	**60.20**	**40.70**	**61.80**
Total Overstory Species	**43.57**	**51.20**	**31.25**	**48.25**
Total Understory Species	**10.66**	**9.00**	**9.45**	**13.55**
Number of Species	**16**	**7**	**11**	**8**

Table F-11
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 106 in 2009

Species	Overall	106A	106C	106E
Cirsium scariosum	0.37	0.50	0.00	0.60
Distichlis spicata	0.18	0.10	0.35	0.10
Ericameria nauseosa	9.27	10.95	9.40	7.45
Hordeum jubatum	0.02	0.05	0.00	0.00
Hymenoxys lemmonii	0.05	0.15	0.00	0.00
Juncus arcticus	0.05	0.10	0.00	0.05
Juniperus scopulorum	28.25	35.25	14.25	35.25
Leymus triticoides	0.48	0.30	0.45	0.70
Puccinellia lemmonii	1.75	0.65	4.60	0.00
Sarcobatus vermiculatus	1.63	2.65	2.25	0.00
Sporobolus airoides	4.50	6.90	2.15	4.45
Total	**46.55**	**57.60**	**33.45**	**48.60**
Total Overstory Species	**28.25**	**35.25**	**14.25**	**35.25**
Total Understory Species	**18.30**	**22.35**	**19.20**	**13.35**
Numberof Species	**11**	**11**	**7**	**7**

Table F-12
Mean Percent Cover, Overall and by Line Transect,
at Middle Spring Valley VFRM Juniper Belt Transect 107 in 2009

Species	Overall	107A	107C	107E
Atriplex micrantha	0.10	0.05	0.25	0.00
Atriplex truncata	1.45	1.25	0.10	3.00
Bassia scoparia	5.63	3.20	2.90	10.80
Bromus tectorum	0.28	0.00	0.70	0.15
Descurainia sophia	0.15	0.45	0.00	0.00
Distichlis spicata	0.37	0.30	0.00	0.80
Equisetum arvense	0.27	0.10	0.35	0.35
Hymenoxys lemmonii	0.12	0.35	0.00	0.00
Juncus arcticus	0.53	0.05	1.35	0.20
Juniperus scopulorum	54.38	67.40	46.25	49.50
Leymus triticoides	31.32	19.20	31.95	42.80
Poa pratensis	0.85	0.00	0.00	2.55
Poa secunda	1.27	1.85	1.95	0.00
Puccinellia lemmonii	0.87	0.00	0.90	1.70
Spartina gracilis	0.87	0.00	2.45	0.15
Symphyotrichum eatonii	0.07	0.00	0.10	0.10
Total	**98.53**	**94.20**	**89.25**	**112.10**
Total Overstory Species	**54.38**	**67.40**	**46.25**	**49.50**
Total Understory Species	**44.15**	**26.80**	**43.00**	**62.60**
Number of Species	**16**	**11**	**12**	**12**

Table F-13
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 108 in 2009

Species	Overall	108A	108C	108E
Atriplex truncata	0.20	0.05	0.05	0.50
Bassia scoparia	2.33	2.75	1.10	3.15
Cirsium scariosum	0.63	1.50	0.40	0.00
Cleomella plocasperma	0.18	0.45	0.10	0.00
Crepis runcinata	0.53	0.00	0.45	1.15
Distichlis spicata	1.47	1.85	1.65	0.90
Dodecatheon pulchellum	1.27	0.90	2.90	0.00
Equisetum arvense	0.53	0.70	0.25	0.65
Hymenoxys lemmonii	0.60	0.25	1.40	0.15
Juncus arcticus	0.10	0.25	0.05	0.00
Juniperus scopulorum	51.53	53.20	62.65	38.75
Lactuca serriola	0.05	0.00	0.00	0.15
Leymus triticoides	15.85	24.60	20.70	2.25
Puccinellia lemmonii	3.02	1.60	3.95	3.50
Pyrrocoma lanceolata	0.12	0.25	0.10	0.00
Sarcobatus vermiculatus	1.88	5.65	0.00	0.00
Spartina gracilis	4.68	1.90	10.50	1.65
Sporobolus airoides	10.02	10.30	10.30	9.45
Total	94.99	106.20	116.55	62.25
Total Overstory Species	51.53	53.20	62.65	38.75
Total Understory Species	43.46	53.00	53.90	23.50
Number of Species	18	16	16	12

Table F-14
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 109 in 2009

Species	Overall	109A	109C	109E
Astragalus sp.	0.13	0.00	0.00	0.40
Cirsium scariosum	0.45	0.00	0.00	1.35
Equisetum arvense	0.15	0.25	0.05	0.15
Ericameria nauseosa	0.78	1.30	0.00	1.05
Hymenoxys lemmonii	0.45	0.40	0.25	0.70
Ivesia kingii	0.05	0.15	0.00	0.00
Juncus arcticus	0.10	0.30	0.00	0.00
Juniperus scopulorum	54.82	68.90	56.15	39.40
Leymus triticoides	0.55	0.15	0.00	1.50
Musineon divaricatum	0.40	0.10	1.10	0.00
Phlox pulvinata	0.05	0.15	0.00	0.00
Poa secunda	0.57	0.00	0.00	1.70
Puccinellia lemmonii	0.62	1.40	0.45	0.00
Pyrrocoma lanceolata	0.07	0.15	0.00	0.05
Spartina gracilis	0.07	0.10	0.10	0.00
Sporobolus airoides	6.05	8.50	7.30	2.35
Total	**65.31**	**81.85**	**65.40**	**48.65**
Total Overstory Species	**54.82**	**68.90**	**56.15**	**39.40**
Total Understory Species	**10.49**	**12.95**	**9.25**	**9.25**
Number of Species	**16**	**13**	**7**	**10**

Table F-15
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 110 in 2009

Species	Overall	110A	110C	110E
Carex sp.	0.03	0.00	0.00	0.10
Chenopodium sp.	0.03	0.00	0.00	0.10
Cirsium scariosum	1.63	3.10	0.00	1.80
Crepis runcinata	2.02	3.80	0.00	2.25
Distichlis spicata	10.78	10.15	18.30	3.90
Dodecatheon pulchellum	0.40	0.95	0.15	0.10
Equisetum arvense	0.33	0.55	0.00	0.45
Ericameria nauseosa	2.82	3.15	5.30	0.00
Hymenoxys lemmonii	0.35	0.00	0.55	0.50
Ivesia kingii	0.12	0.20	0.00	0.15
Juncus arcticus	0.02	0.00	0.00	0.05
Juniperus scopulorum	54.38	56.75	47.50	58.90
Leymus triticoides	20.78	26.00	27.85	8.50
Nitrophila occidentalis	4.80	5.25	8.75	0.40
Poa secunda	0.50	0.00	0.00	1.50
Puccinellia lemmonii	5.20	5.65	8.45	1.50
Pyrrocoma lanceolata	0.12	0.20	0.00	0.15
Sarcobatus vermiculatus	4.03	7.25	4.35	0.50
Spartina gracilis	0.28	0.00	0.85	0.00
Total	**108.62**	**123.00**	**122.05**	**80.85**
Total Overstory Species	**54.38**	**56.75**	**47.50**	**58.90**
Total Understory Species	**54.24**	**66.25**	**74.55**	**21.95**
Number of Species	**19**	**13**	**10**	**16**

Table F-16
Mean Percent Cover, Overall and by Line Transect,
at Middle Spring Valley VFRM Juniper Belt Transect 111 in 2009

Species	Overall	111A	111C	111E
Argentina anserina	0.12	0.00	0.00	0.35
Carex simulata	0.03	0.00	0.00	0.10
Centaurium exaltatum	0.10	0.00	0.30	0.00
Cirsium scariosum	3.15	2.55	3.35	3.55
Crepis runcinata	0.98	1.25	1.50	0.20
Dodecatheon pulchellum	2.35	2.60	0.70	3.75
Equisetum arvense	3.03	3.65	0.95	4.50
Hymenoxys lemmonii	0.50	0.45	0.00	1.05
Iva axillaris	0.18	0.00	0.55	0.00
Ivesia kingii	0.20	0.20	0.00	0.40
Juncus arcticus	2.72	4.80	0.75	2.60
Juniperus scopulorum	56.17	67.25	38.75	62.50
Leymus triticoides	8.92	12.55	2.15	12.05
Poa pratensis	0.12	0.35	0.00	0.00
Puccinellia lemmonii	1.23	1.40	0.90	1.40
Pyrrocoma lanceolata	2.68	3.50	2.05	2.50
Solidago nana	0.60	0.25	1.55	0.00
Spartina gracilis	4.12	7.65	3.95	0.75
TOTAL	**87.20**	**108.45**	**57.45**	**95.70**
Total Overstory Species	**56.17**	**67.25**	**38.75**	**62.50**
Total Understory Species	**31.03**	**41.20**	**18.70**	**33.20**
Number of Species	**18**	**13**	**12**	**13**

Table F-17
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 112 in 2009

Species	Overall	112A	112C	112E
Dodecatheon pulchellum	0.07	0.20	0.00	0.00
Equisetum arvense	0.25	0.15	0.55	0.05
Ericameria nauseosa	2.68	0.20	0.70	7.15
Hymenoxys lemmonii	0.28	0.30	0.10	0.45
Ivesia kingii	0.12	0.10	0.10	0.15
Juniperus scopulorum	39.88	52.05	12.15	55.45
Leymus triticoides	0.12	0.05	0.00	0.30
Puccinellia lemmonii	10.22	8.80	9.40	12.45
Pyrrocoma lanceolata	0.32	0.50	0.05	0.40
Sarcobatus vermiculatus	0.07	0.00	0.20	0.00
Spartina gracilis	0.07	0.00	0.00	0.20
Sporobolus airoides	2.90	3.70	0.00	5.00
Total	**56.98**	**66.05**	**23.25**	**81.60**
Total Overstory Species	**39.88**	**52.05**	**12.15**	**55.45**
Total Understory Species	**17.10**	**14.00**	**11.10**	**26.15**
Number of Species	**12**	**10**	**8**	**10**

Table F-18
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 113 in 2009

Species	Overall	113A	113C	113E
Artemisia tridentata	2.68	0.00	0.00	8.05
Carex praegracilis	0.93	1.80	0.00	1.00
Cirsium scariosum	0.23	0.70	0.00	0.00
Comandra umbellata	0.05	0.00	0.00	0.15
Cordylanthus ramosus	0.07	0.20	0.00	0.00
Distichlis spicata	0.67	0.85	0.10	1.05
Equisetum arvense	0.37	0.60	0.25	0.25
Ericameria nauseosa	1.82	0.10	3.60	1.75
Hordeum jubatum	0.08	0.00	0.00	0.25
Hymenoxyis lemmonii	0.02	0.00	0.05	0.00
Juniperus scopulorum	31.75	43.50	23.00	28.75
Leymus triticoides	0.38	0.35	0.45	0.35
Puccinellia lemmonii	1.27	2.25	0.95	0.60
Pyrrocoma lanceolata	0.13	0.40	0.00	0.00
Sporobolus airoides	4.45	6.65	3.65	3.05
Total	**44.90**	**57.40**	**32.05**	**45.25**
Total Overstory Species	**31.75**	**43.50**	**23.00**	**28.75**
Total Understory Species	**13.15**	**13.90**	**9.05**	**16.50**
Number of Species	**15**	**11**	**8**	**11**

Table F-19
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 114 in 2009

Species	Overall	114A	114C	114E
Achnatherum hymenoides	0.12	0.05	0.20	0.10
Juniperus scopulorum	51.63	69.75	50.40	34.75
Leymus cinereus	0.25	0.75	0.00	0.00
Sporobolus airoides	1.12	0.40	0.80	2.15
Total	53.12	70.95	51.40	37.00
Total Overstory Species	51.63	69.75	50.40	34.75
Total Understory Species	1.49	1.20	1.00	2.25
Number of Species	4	4	3	3

Table F-20
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 115 in 2009

Species	Overall	115A	115C	115E
Achillea millefolium	2.32	1.15	1.75	4.05
Agrostis gigantea	0.25	0.00	0.40	0.35
Argentina anserina	0.60	1.25	0.25	0.30
Carex nebrascensis	1.47	1.35	1.60	1.45
Carex praegracilis	9.32	7.95	13.35	6.65
Cirsium scariosum	0.37	0.15	0.75	0.20
Juncus arcticus	2.50	2.40	3.45	1.65
Juniperus scopulorum	54.08	65.15	60.75	36.35
Poa pratensis	12.75	7.65	17.40	13.20
Pyrrocoma lanceolata	0.30	0.25	0.65	0.00
Taraxacum officinale	0.93	0.95	1.65	0.20
Trifolium repens	3.32	1.40	8.10	0.45
Total	**88.21**	**89.65**	**110.10**	**64.85**
Total Overstory Species	**54.08**	**65.15**	**60.75**	**36.35**
Total Understory Species	**34.13**	**24.50**	**49.35**	**28.50**
Number of Species	**12**	**11**	**12**	**11**

Table F-21
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 116 in 2009

Species	Overall	116A	116C	116E
Achnatherum hymenoides	0.02	0.05	0.00	0.00
Artemisia tridentata	5.93	5.25	5.50	7.05
Chrysothamnus viscidiflorus	0.32	0.00	0.00	0.95
Ericameria nauseosa	0.08	0.00	0.00	0.25
Eriogonum cernuum	0.07	0.20	0.00	0.00
Juniperus scopulorum	40.37	37.85	63.00	20.25
Sarcobatus vermiculatus	0.57	0.00	1.70	0.00
Total	**47.36**	**43.35**	**70.20**	**28.50**
Total Overstory Species	**40.37**	**37.85**	**63.00**	**20.25**
Total Understory Species	**6.99**	**5.50**	**7.20**	**8.25**
Number of Species	**7**	**4**	**3**	**4**

Table F-22
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 117 in 2009

Species	Overall	117A	117C	117E
Artemisia tridentata	0.23	0.70	0.00	0.00
Distichlis spicata	0.30	0.10	0.75	0.05
Ericameria nauseosa	2.63	3.40	1.95	2.55
Hordeum jubatum	0.02	0.00	0.05	0.00
Juniperus scopulorum	52.08	60.00	37.75	58.50
Leymus triticoides	0.03	0.10	0.00	0.00
Spartina gracilis	0.13	0.00	0.35	0.05
Sporobolus airoides	0.12	0.00	0.00	0.35
Total	**55.54**	**64.30**	**40.85**	**61.50**
Total Overstory Species	**52.08**	**60.00**	**37.75**	**58.50**
Total Understory Species	**3.46**	**4.30**	**3.10**	**3.00**
Number of Species	**8**	**5**	**5**	**5**

Table F-23
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 118 in 2009

Species	Overall	118A	118C	118E
Artemisia tridentata	7.23	6.45	8.25	7.00
Distichlis spicata	0.69	0.35	0.60	1.11
Hordeum jubatum	0.10	0.00	0.30	0.00
Juniperus scopulorum	34.63	46.65	32.50	24.74
Sarcobatus vermiculatus	3.59	2.40	0.95	7.42
Sporobolus airoides	2.19	0.20	3.90	2.47
Total	**48.43**	**56.05**	**46.50**	**42.74**
Total Overstory Species	**34.63**	**46.65**	**32.50**	**24.74**
Total Understory Species	**13.80**	**9.40**	**14.00**	**18.00**
Number of Species	**6**	**5**	**6**	**5**

Table F-24
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 119 in 2009

Species	Overall	119A	119C	119E
Artemisia tridentata	0.92	2.25	0.50	0.00
Ericameria nauseosa	0.97	1.25	1.65	0.00
Juncus arcticus	0.07	0.00	0.20	0.00
Juniperus scopulorum	30.52	42.25	22.00	27.30
Sporobolus airoides	0.20	0.25	0.25	0.10
Total	**32.68**	**46.00**	**24.60**	**27.40**
Total Overstory Species	**30.52**	**42.25**	**22.00**	**27.30**
Total Understory Species	**2.16**	**3.75**	**2.60**	**0.10**
Number of Species	**5**	**4**	**5**	**2**

Table F-25
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 120 in 2009

Species	Overall	120A	120C	120E
Artemisia tridentata	2.82	5.60	0.15	2.70
Carex praegracilis	0.10	0.15	0.00	0.15
Distichlis spicata	0.20	0.15	0.20	0.25
Ericameria nauseosa	5.20	1.20	2.15	12.25
Hordeum jubatum	0.03	0.00	0.00	0.10
Juniperus scopulorum	25.85	35.25	27.00	15.30
Puccinellia lemmonii	0.35	0.65	0.00	0.40
Sarcobatus vermiculatus	0.70	2.10	0.00	0.00
Spartina gracilis	0.08	0.00	0.25	0.00
Sporobolus airoides	1.98	1.40	0.40	4.15
Total	**37.31**	**46.50**	**30.15**	**35.30**
Total Overstory Species	**25.85**	**35.25**	**27.00**	**15.30**
Total Understory Species	**11.46**	**11.25**	**3.15**	**20.00**
Number of Species	**10**	**8**	**5**	**7**

Table F-26
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 121 in 2009

Species	Overall	121A	121C	121E
Carex sp.	0.02	0.05	0.00	0.00
Juniperus scopulorum	45.00	58.25	25.00	51.75
Poa secunda	0.15	0.35	0.00	0.10
Sarcobatus vermiculatus	0.23	0.00	0.00	0.70
Spartina gracilis	0.25	0.00	0.60	0.15
Sporobolus airoides	2.28	0.90	5.75	0.20
Total	**47.93**	**59.55**	**31.35**	**52.90**
Total Overstory Species	**45.00**	**58.25**	**25.00**	**51.75**
Total Understory Species	**2.93**	**1.30**	**6.35**	**1.15**
Number of Species	**6**	**4**	**3**	**5**

Table F-27
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 122 in 2009

Species	Overall	122A	122C	122E
Carex praegracilis	0.03	0.00	0.00	0.10
Carex sp.	0.08	0.10	0.15	0.00
Juncus arcticus	0.05	0.00	0.00	0.15
Juniperus scopulorum	56.58	61.75	27.75	80.25
Leymus triticoides	0.20	0.30	0.30	0.00
Muhlenbergia richardsonis	0.12	0.00	0.00	0.35
Poa pratensis	0.03	0.00	0.00	0.10
Poa secunda	0.03	0.00	0.10	0.00
Puccinellia lemmonii	0.10	0.00	0.00	0.30
Sporobolus airoides	1.82	1.85	2.40	1.20
Total	**59.04**	**64.00**	**30.70**	**82.45**
Total Overstory Species	**56.58**	**61.75**	**27.75**	**80.25**
Total Understory Species	**2.46**	**2.25**	**2.95**	**2.20**
Number of Species	**10**	**4**	**5**	**7**

Table F-28
Mean Percent Cover, Overall and by Line Transect,
at Middle Spring Valley VFRM Juniper Belt Transect 123 in 2009

Species	Overall	123A	123C	123E
Artemisia tridentata	2.05	0.00	0.00	6.15
Equisetum arvense	0.07	0.00	0.00	0.20
Juncus arcticus	0.58	0.60	0.55	0.60
Juniperus scopulorum	52.58	65.25	50.00	42.50
Leymus triticoides	1.22	0.50	0.55	2.60
Puccinellia lemmonii	0.07	0.00	0.00	0.20
Sporobolus airoides	6.62	1.85	9.50	8.50
Total	**63.19**	**68.20**	**60.60**	**60.75**
Total Overstory Species	**52.58**	**65.25**	**50.00**	**42.50**
Total Understory Species	**10.61**	**2.95**	**10.60**	**18.25**
Number of Species	**7**	**4**	**4**	**7**

Table F-29
Mean Percent Cover, Overall and by Line Transect,
at Middle Spring Valley VFRM Juniper Belt Transect 124 in 2009

Species	Overall	124A	124C	124E
Carex praegracilis	0.25	0.10	0.65	0.00
Equisetum arvense	0.17	0.20	0.05	0.25
Iris missouriensis	0.05	0.00	0.15	0.00
Juncus arcticus	0.07	0.00	0.15	0.05
Juniperus scopulorum	77.17	87.25	73.25	71.00
Leymus triticoides	0.67	0.30	1.20	0.50
Muhlenbergia richardsonis	0.82	0.65	1.45	0.35
Sporobolus airoides	1.27	1.05	1.85	0.90
Total	**80.47**	**89.55**	**78.75**	**73.05**
Total Overstory Species	**77.17**	**87.25**	**73.25**	**71.00**
Total Understory Species	**3.30**	**2.30**	**5.50**	**2.05**
Number of Species	**8**	**6**	**8**	**6**

Table F-30
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 125 in 2009

Species	Overall	125A	125C	125E
Artemisia tridentata	0.07	0.00	0.20	0.00
Bassia scoparia	1.77	1.50	2.95	0.85
Chenopodium sp.	0.12	0.00	0.35	0.00
Cirsium scariosum	0.05	0.00	0.15	0.00
Cleomella plocasperma	0.22	0.35	0.20	0.10
Distichlis spicata	6.75	3.45	6.20	10.60
Equisetum arvense	0.08	0.00	0.25	0.00
Ericameria nauseosa	7.40	4.00	7.20	11.00
Juniperus scopulorum	58.50	72.00	58.50	45.00
Leymus triticoides	1.53	0.85	2.85	0.90
Sarcobatus vermiculatus	1.02	0.00	0.00	3.05
Sporobolus airoides	5.42	2.05	8.40	5.80
Total	82.93	84.20	87.25	77.30
Total Overstory Species	58.50	72.00	58.50	45.00
Total Understory Species	24.43	12.20	28.75	32.30
Number of Species	12	7	11	8

Table F-31
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 126 in 2009

Species	Overall	126A	126C	126E
Achillea millefolium	0.20	0.30	0.30	0.00
Agrostis gigantea	7.03	7.60	7.45	6.05
Aquilegia formosa	0.02	0.05	0.00	0.00
Atriplex micrantha	0.48	1.10	0.35	0.00
Carex nebrascensis	0.37	0.00	1.10	0.00
Carex praegracilis	9.88	12.95	9.80	6.90
Chenopodium sp.	0.07	0.00	0.20	0.00
Cirsium scariosum	3.70	4.85	0.00	6.25
Cirsium vulgare	1.08	0.00	3.25	0.00
Conyza canadensis	0.05	0.00	0.15	0.00
Equisetum arvense	0.15	0.20	0.00	0.25
Juncus arcticus	0.15	0.00	0.45	0.00
Juniperus scopulorum	86.67	96.50	73.50	90.00
Medicago polymorpha	0.03	0.00	0.00	0.10
Melilotus officinalis	0.18	0.00	0.55	0.00
Poa pratensis	5.37	11.80	4.30	0.00
Poa secunda	0.03	0.00	0.00	0.10
Polygonum aviculare	0.07	0.20	0.00	0.00
Rosa woodsii	6.47	0.25	0.00	19.15
Schedonorus pratensis	2.00	0.90	4.60	0.50
Symphyotrichum spathulatum	0.02	0.00	0.05	0.00
Taraxacum officinale	2.75	1.25	5.00	2.00
Trifolium repens	0.03	0.10	0.00	0.00
Total	**126.80**	**138.05**	**111.05**	**131.30**
Total Overstory Species	**86.67**	**96.50**	**73.50**	**90.00**
Total Understory Species	**40.13**	**41.55**	**37.55**	**41.30**
Number of Species	**23**	**14**	**15**	**10**

Table F-32
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 127 in 2009

Species	Overall	127A	127C	127E
Achillea millefolium	0.20	0.30	0.30	0.00
Agrostis gigantea	7.03	7.60	7.45	6.05
Aquilegia formosa	0.02	0.05	0.00	0.00
Atriplex micrantha	0.48	1.10	0.35	0.00
Carex nebrascensis	0.37	0.00	1.10	0.00
Carex praegracilis	9.88	12.95	9.80	6.90
Chenopodium sp.	0.07	0.00	0.20	0.00
Cirsium scariosum	3.70	4.85	0.00	6.25
Cirsium vulgare	1.08	0.00	3.25	0.00
Conyza canadensis	0.05	0.00	0.15	0.00
Equisetum arvense	0.15	0.20	0.00	0.25
Juncus arcticus	0.15	0.00	0.45	0.00
Juniperus scopulorum	86.67	96.50	73.50	90.00
Medicago polymorpha	0.03	0.00	0.00	0.10
Melilotus officinalis	0.18	0.00	0.55	0.00
Poa pratensis	5.37	11.80	4.30	0.00
Poa secunda	0.03	0.00	0.00	0.10
Polygonum aviculare	0.07	0.20	0.00	0.00
Rosa woodsii	6.47	0.25	0.00	19.15
Schedonorus pratensis	2.00	0.90	4.60	0.50
Symphyotrichum spathulatum	0.02	0.00	0.05	0.00
Taraxacum officinale	2.75	1.25	5.00	2.00
Trifolium repens	0.03	0.10	0.00	0.00
Total	**126.80**	**138.05**	**111.05**	**131.30**
Total Overstory Species	**86.67**	**96.50**	**73.50**	**90.00**
Total Understory Species	**40.13**	**41.55**	**37.55**	**41.30**
Number of Species	**23**	**14**	**15**	**10**

Table F-33
Mean Percent Cover, Overall and by Line Transect,
at Middle Spring Valley VFRM Juniper Belt Transect 128 in 2009

Species	Overall	128A	128C	128E
Achillea millefolium	0.02	0.05	0.00	0.00
Atriplex truncata	0.02	0.05	0.00	0.00
Caulanthus sp.	0.07	0.20	0.00	0.00
Equisetum arvense	0.15	0.25	0.15	0.05
Hymenoxys lemmonii	0.17	0.10	0.10	0.30
Ipomopsis aggregata	0.02	0.00	0.05	0.00
Juncus arcticus	0.40	0.40	0.20	0.60
Juniperus scopulorum	53.90	62.45	39.25	60.00
Leymus triticoides	0.75	0.90	0.80	0.55
Musineon divaricatum	0.05	0.10	0.05	0.00
Poa secunda	1.25	0.45	3.30	0.00
Puccinellia lemmonii	2.87	3.60	0.00	5.00
Pyrrocoma lanceolata	0.40	0.20	0.45	0.55
Raillardella argentea	0.07	0.00	0.00	0.20
Spartina gracilis	1.43	0.80	0.05	3.45
Sporobolus airoides	1.48	0.35	0.05	4.05
Symphyotrichum eatonii	0.03	0.10	0.00	0.00
Taraxacum officinale	0.12	0.35	0.00	0.00
Total	**63.20**	**70.35**	**44.45**	**74.75**
Total Overstory Species	**53.90**	**62.45**	**39.25**	**60.00**
Total Understory Species	**9.30**	**7.90**	**5.20**	**14.75**
Number of Species	**18**	**16**	**11**	**10**

Table F-34
Mean Percent Cover, Overall and by Line Transect, at Middle Spring Valley VFRM Juniper Belt Transect 129 in 2009

Species	Overall	129A	129C	129E
Artemisia tridentata	0.07	0.20	0.00	0.00
Carex praegracilis	0.42	0.00	1.10	0.15
Distichlis spicata	0.17	0.10	0.30	0.10
Ericameria nauseosa	0.03	0.10	0.00	0.00
Hymenoxys lemmonii	0.02	0.05	0.00	0.00
Ivesia kingii	0.03	0.00	0.10	0.00
Juncus arcticus	0.35	0.45	0.10	0.50
Juniperus scopulorum	20.50	38.50	10.25	12.75
Leymus triticoides	0.13	0.10	0.30	0.00
Pyrrocoma lanceolata	0.02	0.00	0.05	0.00
Sporobolus airoides	1.38	1.30	0.90	1.95
Total	**23.12**	**40.80**	**13.10**	**15.45**
Total Overstory Species	**20.50**	**38.50**	**10.25**	**12.75**
Total Understory Species	**2.62**	**2.30**	**2.85**	**2.70**
Number of Species	**11**	**8**	**8**	**5**

Table F-35
Site, Transect Number (SNWA Permanent Transect Number) and Length (meters), Date of Sampling of Transect, and UTM Coordinates for the Aquatic Transects, 2009
(Page 1 of 2)

Site	Number	Length (m)	Date
Stonehouse Complex	039	26	22-Jul
	040	28	22-Jul
	041	21	22-Jul
	042	30	22-Jul
	043	9	7-Jul
Willow Spring	049	26	4-Jul
	050	10	4-Jul
	051	9	4-Jul
	052	20	6-Jul
	053	19	6-Jul
Keegan Ranch Complex	021	100	3-Jul
	027	20	4-Jul
	080	47	6-Jul
	093	43	30-Jun
	150	56	5-Aug
West Spring Valley	086	26	7-Aug
	088	38	7-Aug
	094	5	7-Aug
	095	5	7-Aug
	096	5	7-Aug
South Millick Spring	016	29	28-Jul
	017	30	28-Jul
	018	23	28-Jul
	019	11	28-Jul
	020	18	28-Jul
Unnamed 5 Spring	054	42	28-Jul
	055	45	28-Jul
	056	64	28-Jul
	057	50	28-Jul
	058	28	28-Jul
Four Wheel Drive	059	14	21-Jul
	060	14	21-Jul
	061	10	21-Jul
	062	17	21-Jul
	063	16	21-Jul

Table F-35
Site, Transect Number (SNWA Permanent Transect Number) and Length (meters), Date of Sampling of Transect, and UTM Coordinates for the Aquatic Transects, 2009
(Page 2 of 2)

Site	Number	Length (m)	Date
Willard Spring	064	18	20-Jul
	065	36	20-Jul
	066	38	20-Jul
	067	54	20-Jul
	068	26	20-Jul
Minerva Spring Complex	001	20	27-Jul
	004	60	27-Jul
	006	4	27-Jul
	007	30	24-Jul
	010	20	24-Jul
Swallow Spring	044	39	3-Aug
	045	44	16-Jul
	046	22	15-Jul
	047	40	16-Jul
	048	44	16-Jul
North Little Spring	174	28	5-Aug
	175	17	5-Aug
	176	26	5-Aug
	177	20	5-Aug
	178	33	5-Aug
Big Springs	169	24	5-Aug
	170	25	5-Aug
	171	28	5-Aug
	172	15	5-Aug
	173	25	5-Aug
Unnamed 1 Spring	164	12	4-Aug
	165	44	4-Aug
	166	40	3-Aug
	167	26	3-Aug
	168	30	3-Aug
Stateline Springs	131	14	30-Jul
	132	22	30-Jul
	133	24	30-Jul
	134	13	30-Jul
	135	16	30-Jul

Table F-36
Site, Transect Number (SNWA Permanent Transect Number) and Length (meters), Date of Sampling of Transect, and UTM Coordinates of Wetland/Meadow Transects, 2009
(Page 1 of 2)

Site	Number	Length	Date
Stonehouse Complex	029	102	23-Jul
	030	93	23-Jul
	031	100	23-Jul
	032	95	22-Jul
	033	100	22-Jul
	034	77	22-Jul
	035	100	7-Jul
	036	100	7-Jul
	037	62	7-Jul
	038	78	7-Jul
Keegan Ranch Complex	021[1]	100	3-Jul
	022	120	3-Jul
	023	64	3-Jul
	024	99	3-Jul
	025	100	1-Jul
	026	130	6-Jul
	027[2]	100	4-Jul
	028	79	4-Jul
West Spring Valley Complex	085	27	9-Aug
	086[3]	26	7-Aug
	087	54	7-Aug
	088[4]	38	7-Aug
	089	32	7-Aug
	090	22	7-Aug
	091	24	7-Aug
	092	44	7-Aug
Minerva Spring Complex	002	50	27-Jul
	003	30	27-Jul
	004[5]	60	27-Jul
	005	50	27-Jul
	006[6]	28	27-Jul
	008	25	24-Jul
	009	33	24-Jul

Table F-36
Site, Transect Number (SNWA Permanent Transect Number) and Length (meters), Date of Sampling of Transect, and UTM Coordinates of Wetland/Meadow Transects, 2009
(Page 2 of 2)

Site	Number	Length	Date
Shoshone Ponds	074	80	14-Jul
	075	100	15-Jul
	076	100	17-Jul
	077	100	17-Jul
	078	100	14-Jul
	079	50	20-Jul
	081	100	16-Jul
	082	100	16-Jul
	083	100	16-Jul
	084	100	20-Jul
The Seep	069	110	14-Jul
	070	100	15-Jul
	071	100	15-Jul
	072	100	14-Jul
	073	75	19-Jul
Blind Spring	011	43	21-Jul
	012	43	21-Jul
	013	39	21-Jul
	014	47	21-Jul
	015	34	21-Jul
Burbank Meadows	139	100	30-Jul
	140	100	30-Jul
	141	100	30-Jul
	142	100	3-Aug
	143	100	3-Aug
	144	100	3-Aug
	145	100	4-Aug
	146	100	4-Aug
	147	100	4-Aug
	148	100	5-Aug

1 Transect 021 also serves as one of the aquatic transects.
2 Transect 027 contains a 20-m aquatic transect imbedded in it.
3 Transect 086 contains an 8-m aquatic transect imbedded in it.
4 Transect 088 contains a 7-m aquatic transect imbedded in it.
5 Transect 004 contains a 24-m aquatic transect imbedded in it.
6 Transect 006 contains a 4-m aquatic transect imbedded in it.

Table F-37
Site, Transect Number (SNWA Permanent Transect Number) and Length (meters), Date of Sampling of Transect, and UTM Coordinates of Shrubland Transects, 2009

Site	Number	Length	Date
North Spring Valley	153	100	4-Aug
	154	100	4-Aug
	157	100	4-Aug
	158	100	4-Aug
	185	100	5-Aug
Middle Spring Valley	151	100	4-Aug
	152	100	4-Aug
	155	100	4-Aug
	156	100	4-Aug
Middle Spring Valley	184	100	5-Aug
South Spring Valley	130	100	30-Jul
	136	100	30-Jul
	137	100	30-Jul
	138	100	30-Jul
	149	100	5-Aug
Hamlin Valley	159	100	4-Aug
	160	100	4-Aug
	161	100	4-Aug
	162	100	4-Aug
	163	100	4-Aug
Snake Valley	179	100	5-Aug
	180	100	5-Aug
	181	100	5-Aug
	182	100	5-Aug
	183	100	5-Aug

Table F-38
Site, Transect Number (SNWA Permanent Transect Number), Date of Sampling, and UTM Coordinates of Woodland Transects, 2009

Site	Number	Length	Date
Middle Spring Valley	098	20	3-Aug
	099	20	3-Aug
	100	20	30-Jul
	101	20	30-Jul
	102	20	30-Jul
	103	20	31-Jul
	104	20	31-Jul
	105	20	31-Jul
	106	20	3-Aug
	107	20	3-Aug
	108	20	3-Aug
	109	20	30-Jul
	110	20	30-Jul
	111	20	30-Jul
	112	20	31-Jul
	113	20	31-Jul
South Spring Valley	114	20	31-Jul
	115	20	30-Jul
	116	20	30-Jul
	117	20	31-Jul
	118	20	31-Jul
	119	20	30-Jul
	120	20	30-Jul
	121	20	31-Jul
	122	20	31-Jul
	123	20	31-Jul
	124	20	30-Jul
	125	20	31-Jul
	126	20	30-Jul
	127	20	30-Jul
	128	20	30-Jul
	129	20	30-Jul

Appendix G

Fixed Station Photography

G.1.0 INTRODUCTION

Photographs presented in this appendix were selected to provide a representative selection of aquatic monitoring sites and monitored ecosystem types; demonstrate line and belt vegetation transects and the crossing of ecotones by vegetation transects; describe habitat delineation during physical habitat mapping; visualize different levels of site disturbance; and demonstrate the ability of fixed-station photographs to qualitatively show change across seasons and years. The station numbers and compass bearings of fixed station photographs at each spring and pond site are presented in Table G-1.

Table G-1
Photo Station Numbers and Compass Bearing of Fixed Station Photographs at Each Spring and Pond Site
(Page 1 of 3)

Site	Photo Station Number	Compass Bearing
Big Springs	024	265
Big Springs	024	317
Big Springs	025	097
Big Springs	026	049
Big Springs	026	350
Four Wheel Drive Spring	049	075
Four Wheel Drive Spring	049	112
Four Wheel Drive Spring	050	240
Keegan Spring Complex North	010	162
Keegan Spring Complex North	010	130
Keegan Spring Complex North	010	089
Keegan Spring Complex North	010	043
Keegan Spring Complex North	010	005
Keegan Spring Complex North	010	335
Keegan Spring Complex North	011	190
Keegan Spring Complex North	011	155
Keegan Spring Complex North	011	125
Keegan Spring Complex North	012	092
Keegan Spring Complex North	012	126
Keegan Spring Complex North	012	156
Keegan Spring Complex North	012	196
Keegan Spring Complex North	013	110
Keegan Spring Complex North	013	144
Keegan Spring Complex North	013	177
Keegan Spring Complex North	014	031

Table G-1
Photo Station Numbers and Compass Bearing of Fixed Station Photographs at Each Spring and Pond Site
(Page 2 of 3)

Site	Photo Station Number	Compass Bearing
Keegan Spring Complex North	014	070
Keegan Spring Complex North	014	110
Minerva Spring Complex Middle	030	250
Minerva Spring Complex Middle	031	294
Minerva Spring Complex Middle	031	341
Minerva Spring Complex Middle	032	209
Minerva Spring Complex Middle	033	144
Minerva Spring Complex Middle	034	091
Minerva Spring Complex North	035	255
Minerva Spring Complex North	036	145
Minerva Spring Complex North	037	029
Minerva Spring Complex North	037	054
Minerva Spring Complex North	037	102
Minerva Spring Complex North	028	007
Minerva Spring Complex North	029	082
North Little Spring	015	063
North Little Spring	016	212
North Little Spring	016	063
North Little Spring	017	210
Shoshone Ponds	067	195
South Millick Spring	051	242
South Millick Spring	051	270
South Millick Spring	054	115
South Millick Spring	055	140
South Millick Spring	055	302
Stateline Springs	021	282
Stateline Springs	021	242
Stateline Springs	022	213
Stateline Springs	023	309
Stonehouse Complex	004	050
Stonehouse Complex	004	090
Stonehouse Complex	004	127
Stonehouse Complex	004	164
Stonehouse Complex	004	208
Stonehouse Complex	005	073
Stonehouse Complex	005	110
Stonehouse Complex	005	147
Stonehouse Complex	006	153
Stonehouse Complex	007	144

Table G-1
Photo Station Numbers and Compass Bearing of Fixed Station Photographs at Each Spring and Pond Site
(Page 3 of 3)

Site	Photo Station Number	Compass Bearing
Stonehouse Complex	008	114
Stonehouse Complex	008	084
Stonehouse Complex	008	002
Stonehouse Complex	009	063
Swallow Spring	040	123
Swallow Spring	041	079
Swallow Spring	041	152
Swallow Spring	042	016
Swallow Spring	043	060
Swallow Spring	044	068
Swallow Spring	044	167
Swallow Spring	045	090
Swallow Spring	046	083
Unnamed 1 Spring North of Big	018	149
Unnamed 1 Spring North of Big	019	249
Unnamed 1 Spring North of Big	020	287
Unnamed 5 Spring	001	232
Unnamed 5 Spring	002	356
Unnamed 5 Spring	002	068
Unnamed 5 Spring	003	174
Unnamed 5 Spring	003	140
West Spring Valley Complex 1	058	038
West Spring Valley Complex 1	059	131
West Spring Valley Complex 1	059	230
West Spring Valley Complex 1	060	220
West Spring Valley Complex 1	060	050
West Spring Valley Complex 1	061	214
West Spring Valley Complex 1	061	062
West Spring Valley Complex 1	062	032
West Spring Valley Complex 1	063	244
West Spring Valley Complex 1	064	075
West Spring Valley Complex 1	065	060
West Spring Valley Complex 1	066	293
Willard Spring	047	159
Willard Spring	047	080
Willard Spring	048	112
Willow-NV Spring	056	049
Willow-NV Spring	056	010
Willow-NV Spring	057	186

Note: Photographs show low emergent vegetation cover at the Swallow Spring channel (physical habitat map category: <30% emergent vegetation) compared to high emergent vegetation cover at the Big Springs channel (physical habitat map category: >90% emergent vegetation).

Figure G-1
Swallow Spring (top) and Big Springs (bottom), Fall 2009

Note: Photographs show a line-point vegetation transect crossing an aquatic/wetland ecotone at Minerva, and a belt transect within the southern valley-floor Rocky Mountain juniper population. Belt transects encompass three line-point transects along which vegetation cover and composition data are collected, as well as a rectangular area where tree count and size (growth) data are collected.

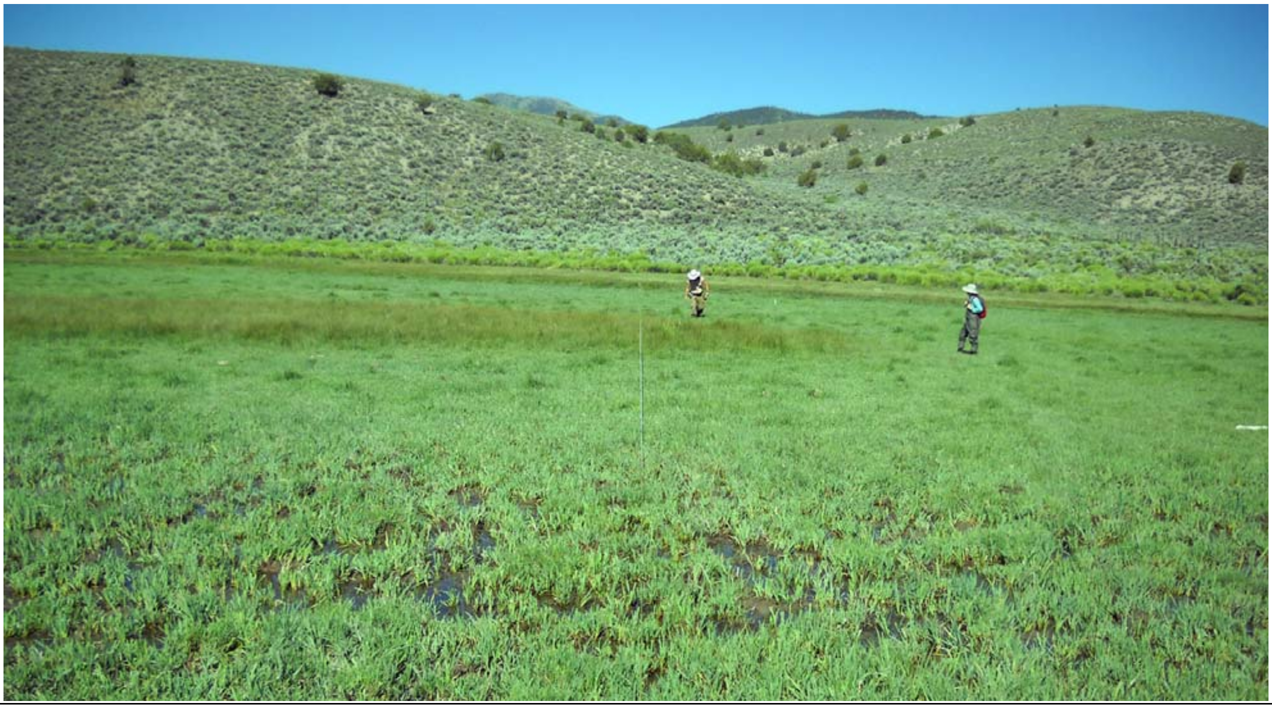
Figure G-2
Minerva Spring Complex Middle (top) and
VFRM Juniper South (bottom), Summer 2009

Note: Photographs show the increase in emergent vegetation cover from spring to fall.

Figure G-3
West Spring Valley Complex Pool and Channel during Spring (top) and Fall (bottom), 2009

Note: Photographs show the increase in emergent vegetation cover from spring to fall.

Figure G-4
Unnamed 5 Spring Pool and Channel
during Spring (top) and Fall (bottom), 2009



Note: Vegetation transect crossing an aquatic/wetland ecotone. Photograph shows unclear aquatic boundaries that have prompted physical habitat mapping protocol modification for this portion of Stonehouse Complex

Figure G-5
Stonehouse Complex, Summer 2009

Note: Photograph shows a vegetation transect in the woody riparian zone near the springhead.

Figure G-6
Swallow Spring, Summer 2009

Note: Greasewood transects are stratified across five IBMA zones on the valley floor: Spring Valley North, Spring Valley Middle, Spring Valley South, Hamlin Valley North, and Snake Valley South.

Figure G-7
Greasewood (Phreatophytic Shrubland)
Vegetation Transect (Spring Valley North), Summer 2009

Note: Wetland/meadow vegetation transect. Photograph shows cattle disturbance.

Figure G-8
The Seep, Summer 2009

Figure G-9
Four Wheel Drive Spring, Fall 2009 (top) and Keegan Spring Complex, Fall 2009

Figure G-10
North Little Spring, Fall 2009 (top) and
Shoshone Ponds (Stock Pond), Fall 2009 (bottom)

Figure G-11
South Millick Spring, Fall 2009 (top) and
Stateline Springs Flowing into Lake Creek, Fall 2009 (bottom)

Figure G-12
Unnamed 1 Spring North of Big, Fall 2009 (top) and Willard Spring, which was dry in Fall 2009 (bottom)

Figure G-13
Willow Spring, Fall 2009

Appendix H

Nevada Department of Wildlife Native Fish and Amphibians Field Trip Report

NEVADA DEPARTMENT OF WILDLIFE
NATIVE FISH AND AMPHIBIANS
FIELD TRIP REPORT

DATE(S): 23 and 30 July, 2009
LOCATION(S): Shoshone Ponds, White Pine County, NV
PURPOSE(S): To estimate the population sizes of Pahrump poolfish and relict dace
PERSONNEL: Brian Hobbs, Chris Crookshanks, LoriKim Alexander, Jeffrey Goldstein, Phil Cunningham, Kelly Douglas, Henry Weckesser, Lindsey Clark, Lee Simons Simons, Ryan Drew, Keven Netcher and Chris Cruckshanks.
PREPARED BY: Jeffrey Goldstein, Brian Hobbs

INTRODUCTION
In 1972 Ely District of the BLM constructed three small warm water ponds in eastern Nevada with the intent of providing habitat for endangered species. On 13 August 1976, 50 Pahrump poolfish (*Empetrichthys latos latos*) were transplanted into one of the ponds. The Relict dace (*Relictus solitarius*) was introduced to one of the four ponds in December 1977. Currently there are Pahrump poolfish in the three northern most ponds and there are Relict dace in the most southern pond of the refuge. Population estimates are conducted annually at this refuge.

METHODS
On 23 July, four standard Gee Minnow 0.64 centimeters (cm) mesh traps and one exotic 0.32 cm mesh traps, without bait, were set around the perimeter of each of the three lower Shoshone Ponds in White Pine County at 08:00 hours. Nineteen standard traps and one exotic trap were set, without bait, around the perimeter of the stock pond at 09:00 hours. The traps were allowed to fish three hours before they were pulled. All of the fish in the exotic traps were measured and each fish greater than 30 millimeters (mm) was marked with an oblique clip on the caudal fin before being released.

On 30 July, five standard traps, without bait, were and set, along the perimeter of each of the three lower ponds at 08:00 hours. Twenty-four standard traps, without bait, were set in the stock pond at 08:15 hours. Traps were allowed to fish for about 3.5 hours before they were pulled. Each fish caught was examined for marks, tallied and released. Water chemistry data was taken at two locations at the stock pond and at one location at the three fenced in ponds with a YSI 600XL Probe.

A population estimate was calculated using Peterson's estimator: MC/R. Where M=number of individuals marked, C=number of individuals captured and R=number of individuals recaptured. Approximate 95% confidence intervals were determined using a table appropriate to the Poisson distribution, after the method described in Ricker (1975).

RESULTS

The majority of the Pahrump poolfish captured were caught in the stock pond (Table 1). The population estimate for the Relict dace is questionable because of the low recapture rate during the second session (Table 1 and Figure 1, 2 and 3).

Table 1. Mark-recapture data for Shoshone Ponds, White Pine County, NV, 2009.

Location	Species	M	C	R	CPUE M	CPUE C	Estimate
North Pond	*E. l. latos*	155	74	60	10.73	4.55	149<**191**<246
Middle Pond	*E. l. latos*	172	131	87	11.6	8.06	210<**260**<319
South Pond	*R. solitarus*	127	56	13	8.47	3.45	319<**547**<1031
Stock Pond	*E. l. latos*	1150	800	249	19.23	8.89	3263<**3695**<4183

Population estimates for poolfish in the middle and stock ponds have dropped from last year's estimate while the estimate in the north pond increased this year and fish condition in this pond appeared to have improved (Figure 1).

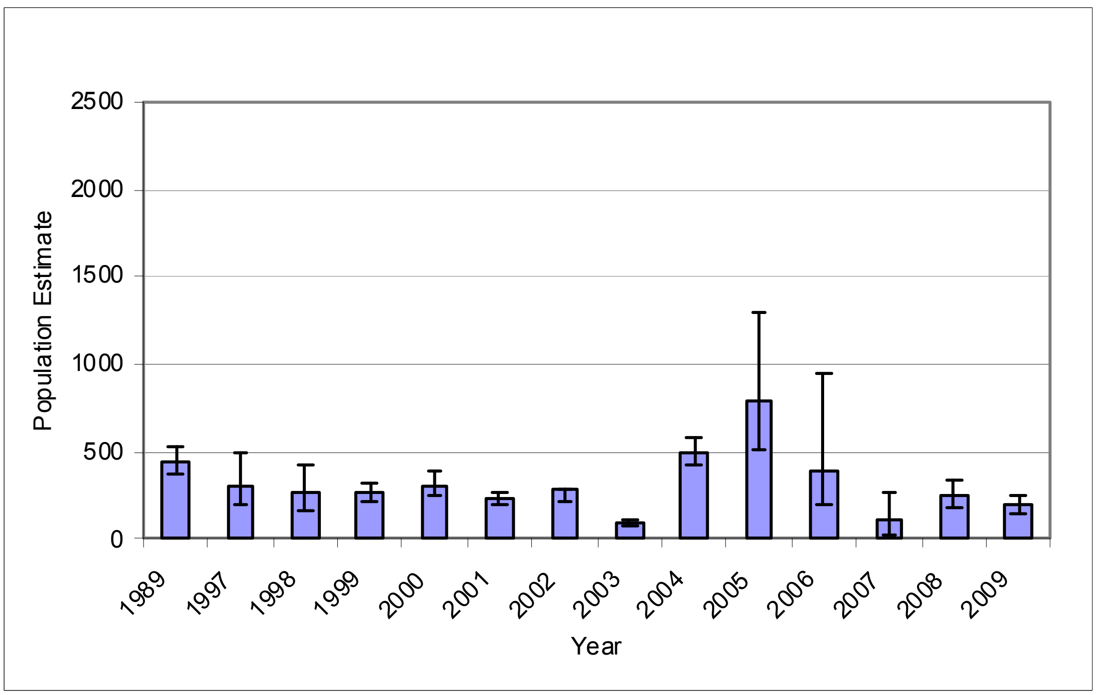


Figure 1. Population Estimates for Pahrump poolfish at Shoshone Ponds north pond 1989-Present.

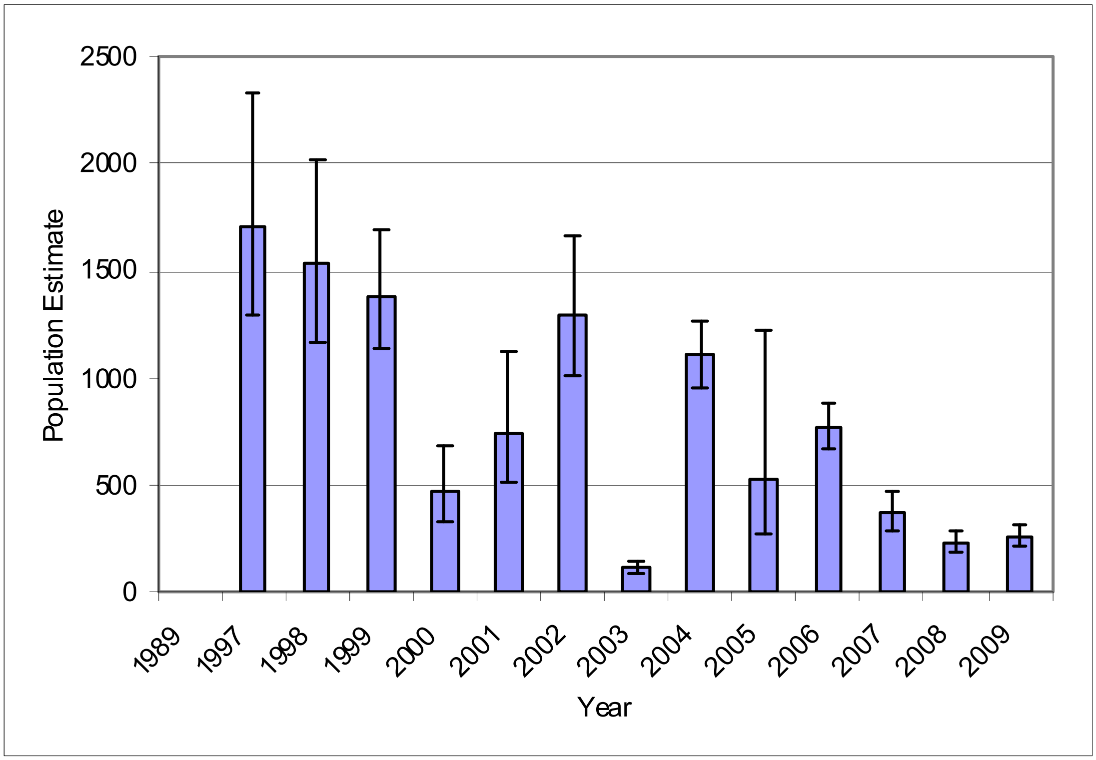


Figure 2. Population Estimates for Pahrump poolfish at Shoshone Ponds middle pond 1989-Present.

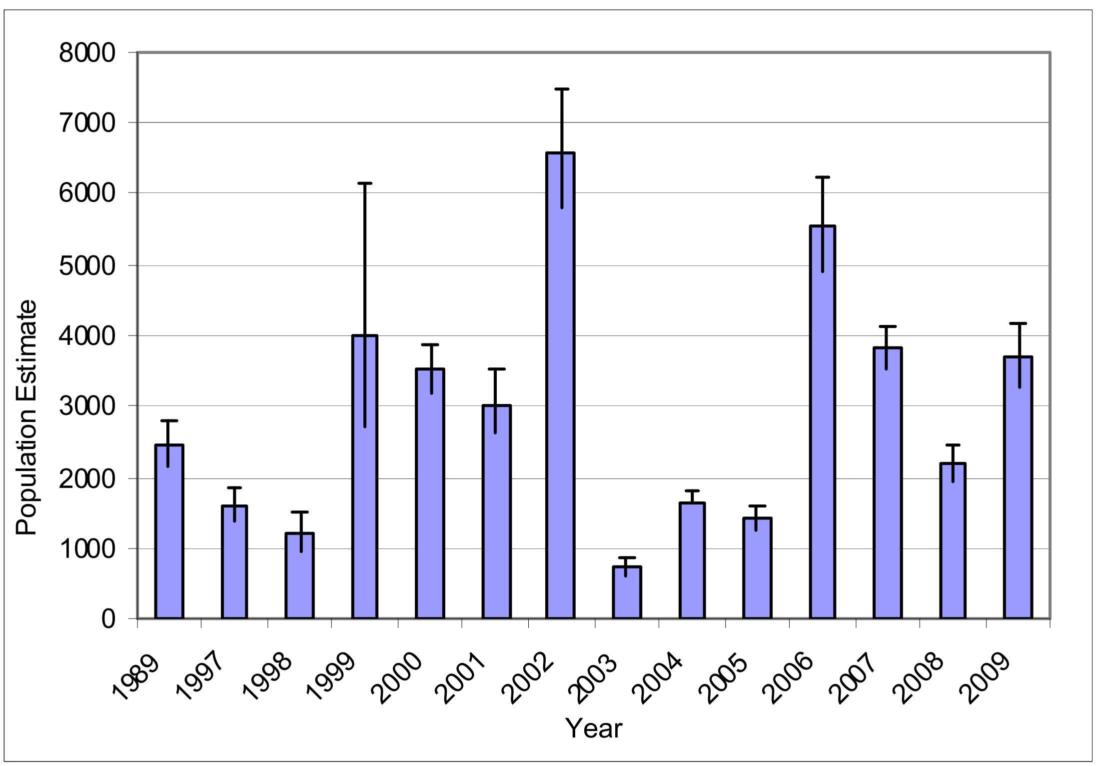


Figure 3. Population Estimates for Pahrump poolfish at Shoshone Ponds stock pond 1989-Present.

The population estimate for Relict dace is slightly higher than last year's estimate but once again was hampered by a low number of recaptures (Figure 4).

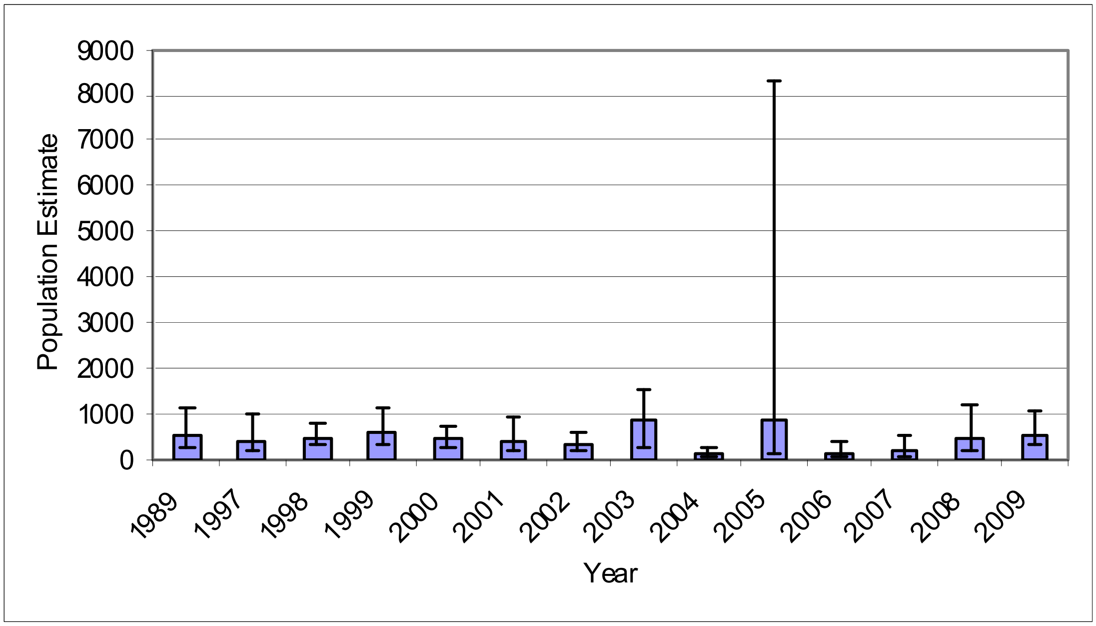


Figure 4. Population Estimates for Relict dace at the South Pond of Shoshone Ponds 1989-Present.

Poolfish populations in the Middle and stock ponds appear healthy with multiple age classes well represented (Figure 6 and 7). The north pond population continues to look unhealthy with only one solid age class (Figure 5).

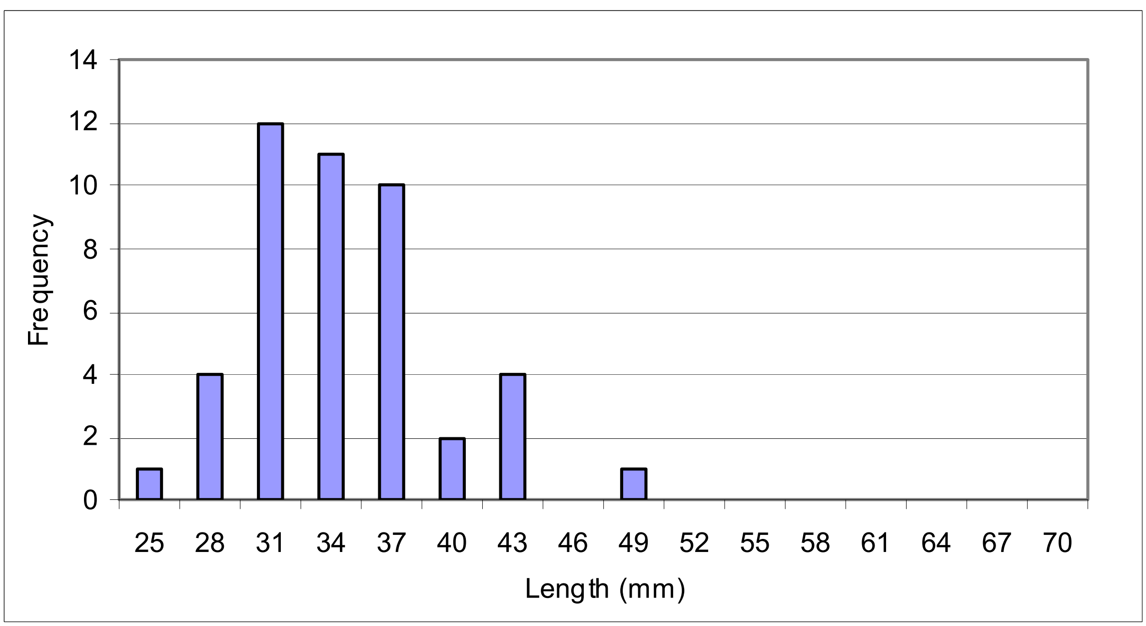


Figure 5. Length of Pahrump poolfish at Shoshone Ponds north pond -2009.

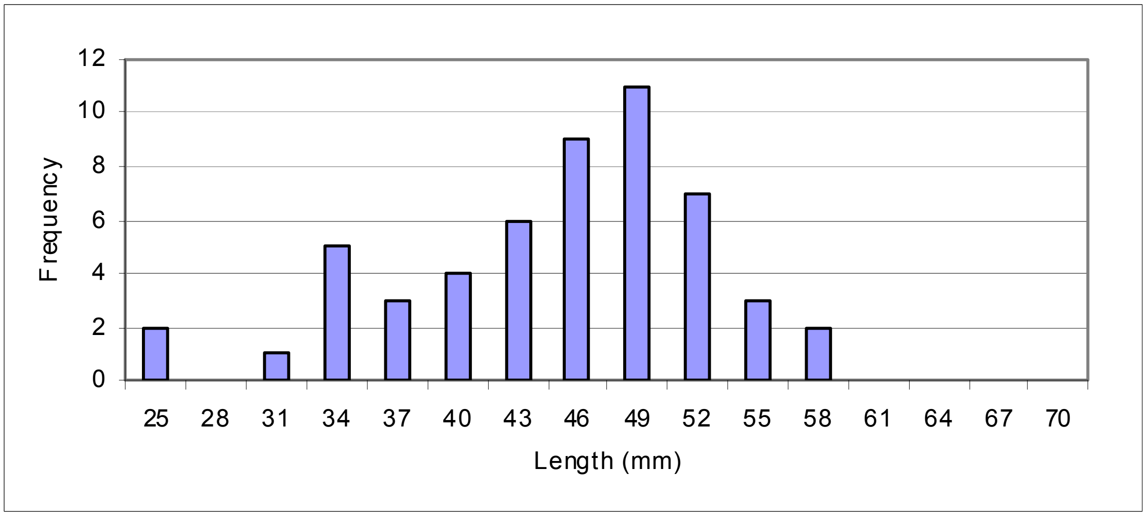


Figure 6. Length of Pahrump poolfish at Shoshone Ponds middle pond -2009.

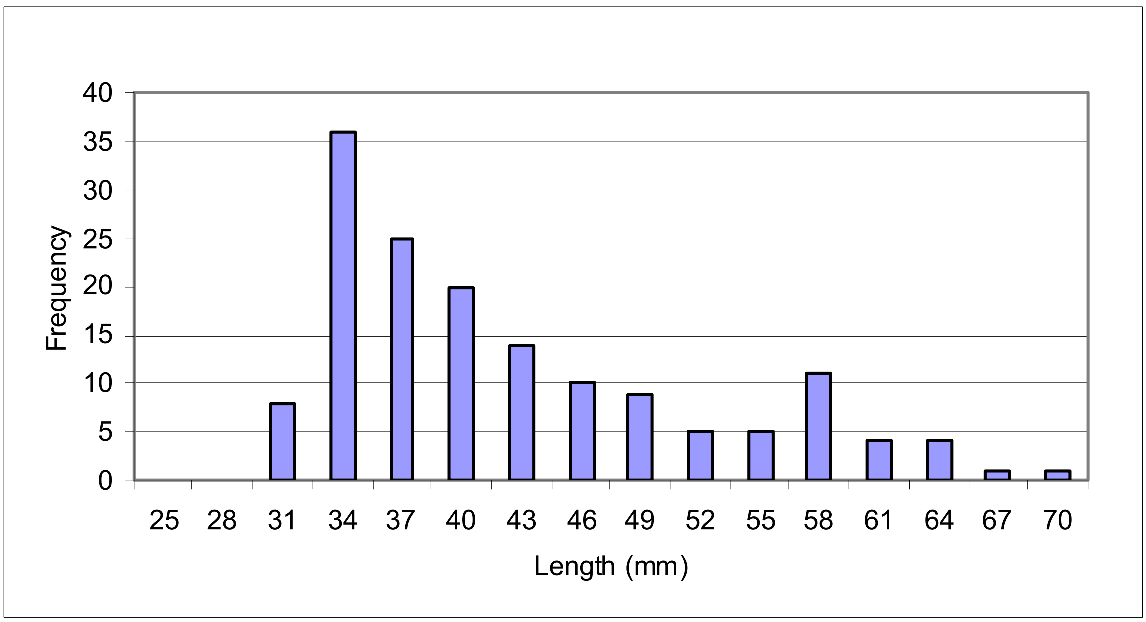


Figure 7. Length of Pahrump poolfish at Shoshone Ponds stock pond -2009.

Table 2: Summary of length data for the Pahrump poolfish, *E. l. latos*, 2009.

Location	Average	Median	Mode	Minimum	Maximum
North Pond	33.7	33	30	25	47
Middle Pond	43.9	46	47	25	58
Stock Pond	41.5	38	33	29	68

Due to low numbers, we did not measure relict dace from the south pond.

Water quality parameters are represented in Table 3.

Table 3: Water Quality parameters 2009.					
Location	DO (mg/L)	DO (% Sat.)	Conductivity/ Specific (µS)	Salinity (ppt)	Temperature (°C)
Stock pond (source)	2.04	22.1	108.6	0.1	20.1
Stock pond (outlet)	2.11	23.9	107.6	0.1	22.7
North pond	1.86	22.8	151.8	0.1	25.5
Middle pond	2.04	24.2	156.3	0.1	23.6
South pond	2.34	27.2	158.7	0.1	23.3

DISCUSSION

Overall, the poolfish population at Shoshone Ponds remains stable despite decreases in the middle and stock pond populations. The relict dace population has been difficult to effectively sample over the past few years and this year was no exception. More time spent trapping would have yielded a more precise estimate, but we did not have the time. For all of the ponds, the habitat was relatively unchanged compared to past site visits.

Plans to enlarge the exclosure and incorporate the flowing well pond immediately north are still ongoing and should be completed within the next few years. This work should create more habitat for the poolfish and further secure the habitat into the future. The relict dace population will likely have to be moved to another location or added to an existing population.

Surveys will continue in summer 2010.

LITERATURE CITED

Ricker WE. 1975. *Computation and Interpretation of Biological Statistics of Fish Populations*. Bulletin of the Fisheries Research Board of Canada. 191: 382 pp.