Ecological Integrity Assessment of Sisson Meadow Using Benthic Macroinvertebrate Indicators and Percent EPT by Taxa

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And
Siskiyou Land Trust

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Introduction

Wet meadows are a keystone habitat in the broad riparian and wetland ecosystems. These unique habitats provide a vast array of ecosystem service, including, flood control, runoff filtration biodiversity, carbon, and nutrient storage (Long, 2014). Agriculture, livestock, urbanization, environmental and climate changes have directly and indirectly threatened the fragile wet meadow habitats. In recent decades various state and federal regulation has been set to in place to help protect, restore and monitor our critical wetlands.

Benthic macroinvertebrates are organisms, found globally, that inhabit the substrate of waterways for either all or a portion of their life cycle. Many of these organisms include aquatic insects and insect larva, also included are crustaceans and worms. Several key features of macroinvertebrates have made them an indispensable, widely used tool for ecologists. Characteristically benthic inverts spend the majority of their lives in the same area, with some being long-lived, making them a reliable source of information about environmental conditions within their locale (Mandaville, 2002). Macroinvertebrates are an essential step in the trophic level between producers and high consumers of the aquatic ecosystem. Such that, by evaluating their populations a reflection of the larger ecosystems fitness can be seen.

Background

Mount Shasta Bioregional Ecology Center (MSBEC), in collaboration with Siskiyou Land Trust (SLT), selected Sisson Meadow (SM) as the pilot location for introducing a newly developed monitoring program. The purpose of the program is to provide up-to-date and continual information regarding the health, function, and success of restored ecosystems and protected land in SLT's care. The unique wet meadow habitat of SM provides an ideal environment to utilize a combination of methodologies for upland and wetland assessment.

In 2003 SLT acquired the eight acres of land currently known as Sisson Meadow. Historically, the property had been drained and altered to be utilized for agriculture. In 2006 restoration commenced with restoring drain channels to their natural state of meandering perennial streams, creating a pond for waterfowl and wildlife habit, and encouraging native plant growth by removal of non-native and invasive vegetation. For community enhancement, elevated walkways and sitting areas were placed throughout the meadow. Several years of subsequent annual evaluation shows a successful restoration of wet meadow habitat.

Site Description

Located in Mount Shasta California, SM lays several blocks east of Mount Shasta city's downtown area. Residential areas border the west, east, and southern boundary line while the northern boundary meets a school zone and the public library. SM features 5.8 acres of wet-meadow and approximately one acre of Riparian wetland (NSR, 2006). Upwelling groundwater which feeds the meadow flows along an east to west gradient.

The soil profile (see attached soil map) of SM is predominately Diyou Loam, peat substrate (DLPS). A small percentage of the south-east boundary is characterized as Pont-Neer Complex (PNC) with 2- 15 percent slopes and the tip of the northeast boundary corner is Deetz Gravelly Loamy Sand (DGLS) with 0-5 percent slopes (NSR, 2006). Diyou Loam, peat substrate, making up approximately 85% of SM, is classified as wet-meadow and hydric soil by the USDA Soil Conservation Service. This soil features moderately to slow permeability and poor drainage in the top 40 inches. Both PNC and DGLS are deep well draining with rapid

permeability and, not classified as hydric soil (NRCS, 2017). The shift from wet-meadow to Riparian wetland correlate with the soil changes from DLPS to PNC and DGLS.

Occupying the northeast corner is a pond created for waterfowl and migratory birds. Willow, birch, and cattails dominate the bank vegetation. The pond, fed by groundwater upwelling and a small natural stream inlet. Overflow from the pond drains into a restored perennial stream, knowns as the Agriculture Channel (AC), flowing east to south along the eastern boundary of SM. The stream features a substrate of cobble, boulders, and silt. The stream banks displayed areas of slumps and undercuts, with substantial growth of facultative herbaceous and woody vegetation. The property behind the far boundary of the AC is residential. A narrow, deep cut off channels lays on the west side of the perennial stream. A second channel runs parallel with the west boundary of SM. The majority of the north, north-east and central area of SM is marshy, dominated by facultative and obligate graminoid. We observed ground saturation level of the marsh areas had become significantly less between late April and mid-May. Patches with higher saturation remain throughout the meadow, notably to the west of the southern entrance and central area. We observed conifer encroachment toward the upland boundary in the north-west corner and, less significantly, along with the northeastern boundary.

Study Approach- Benthic Macroinvertebrate

Using benthic macroinvertebrates as indicators of habitat integrity has become a preferred method for numerous monitoring and assessment programs. In 1986 the Environmental Protection Agency (EPA) set forth to enhance the study and assessment of surface water, targeting documentation of nonpoint source and toxic impact. The need to survey large areas in a shorter amount of time lead the Watershed Protection Division to develop the Rapid Bioassessment Protocols (RBP). The RBP successfully filled the need for accurate, time and cost-efficient standardized methods for biological assessment of aquatic ecosystems (Barbour, 1999).

Included in RBP, is the Benthic Macroinvertebrate Protocols (BMP), these protocols yield a quick evaluation of a sample site overall health using benthic metrics. Benthic metrics, assigning numerical values to pollution thresholds, taxonomic composition, and population features allow for calculations which produce a score associated with a level of ecological health (Reif, 2002). Values are then compared with a predetermined, region-appropriate biotic index (Barbour. 1999).

The principle behind using a metric index to evaluate environmental health is base off of the diversity and evenness of productive ecosystem. For example, a high functioning and healthy ecosystems are expected to support a balanced number of organisms from each trophic level. Whereas in a stressed ecosystem, an overabundance or depletion of specific feeding habits is seen.

The EPT Index is a method applied using the pollution tolerance of three specific orders of macroinvertebrates. The three orders, Ephemeroptera, Plecoptera, and Trichoptera (EPT), are known for a low pollution tolerance. Accordingly, as water quality declines, percent EPT also decreases. Higher percentages indicate healthier streams, countered by lower percents indicating lower quality.

Methods

For the macroinvertebrate survey, we used the Single Habitat approach described in Chapter 7 of the Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition.

We collected samples from three access points along the AC.

For metric values and index analyses references, we used Modified Family Biotic Index, from Benthic Macroinvertebrates in Taxa Tolerance Values, Metrics, and Protocols, 2002.

For initial ecosystem integrity assessment, we used % EPT by taxa richness.
%EPT = X/ Y * 100: where X = total number of EPT taxa, and Y= total taxa richness (Reif, 2002).

Results

From our macroinvertebrates samples (see table 1) we observed a total of twelve different taxa orders and one hundred and three individual organisms. For the order Oligochaeta (worm) we observed 54 individual specimens. In the Bilalva order, family sphaeriidae, we observed 20 individual specimens. In the Amphipoda (scud) order we observed 12 individual specimens. In the Hirudinea (leech) order we observed four individual specimens. In the order Trichoptera (caddisfly), suborder Integripalpia and order Zygoptera (damselfly) we observed three individual specimens of each order. In the Order Diptera, we observed one organism from an undetermined family and one organism from the family Simuliidae. In the orders Ephemeroptera (mayfly), Veneroida subgroup Corbiculidae, Coleoptera family Psephenidae, we observed one individual organism from each order.

Using % EPT by taxa richness (see table 2), we found SM to have a % EPT= 16.67.

Table 2- Percent EPT by Taxa

Total EPT Taxa		Total Taxa Richness	EPT Percent
2	/	12	* 100 = 16.67

Discussion

The %EPT by taxa score (16.67) of Sisson Meadow indicates moderately impacted habitat. Moderately impacted sites are described as having a macroinvertebrate community that is noticeably altered, dominated by pollutant tolerant and facultative organisms such as oligochaetes (aquatic earthworms). Organisms from the EPT group found in limited quantities. Ecosystems that experience agriculture and urban runoff are often fit this level of impairment (Reif, 2002).

The order Oligochaetae contributed to 52% of the total quaintly of organisms found in our survey. There are numerous species in the aquatic oligochaete group, both obligate and facultative. They are often dominant in streams that have reduced water quality. Published research, without species specification regarding their role is minimal. One study conducted in Turkey noted the abundance of various species in waters with high organic pollution. In such an

environment, lack of competition, resulting in high food supply and tolerance to reduced oxygen gives them an advantage (Arslan, 2014).

Out of our 103 samples of macroinvertebrates, the order Bivalvia had the second highest numbers of individuals observed and accounts for 19% of the total samples. Sphaeriidae, commonly known as fingernail clams, can be found in a verity of streams, rivers, and lakes, including season pools and, are often the statistically dominant family in benthic macroinvertebrate surveys (Cooley, 2000). Bivalvia, a filter feeder, play an essential role in the energy and nutrient cycle in aquatic ecosystems, typically being the dominant organisms in this feeding class. Though some Sphaeriidae members are known to have a relatively high tolerance to pollution, populations are sensitive to human disturbance. Alteration in habitat has been known to diminish significantly or deplete entire populations (Strayer, 1999).

Conclusion

Conclusively based on our assessment of the benthic macroinvertebrate community, Sisson Meadow fits the description of a moderately impaired, or suspect, wet-meadow ecosystem. Surrounded by an urban area, having unregulated pedestrian use, and a history of agriculture, finding alterations and degradation to the ecology is expected.

Countering environmental impairments, high diversity and typical evenness within the invertebrate populations, together with vegetation communities dominated by native species, confirms functioning of the biotic communities within the SM ecosystem.

The successful application of BMP and RBP for the evaluation of Sisson Meadow marks the development of a monitoring program with the capacity to sustainably and effectively meet the ecological needs of land stewardship. Additionally, demonstrating a productive collaboration between MSBEC and STL, providing recurrent beneficial services to the land and occupants of Siskiyou County.

Personal Note

Beyond the analysis of ecological indicators, I observed an astounding amount of joy, pride and a personal connection to nature that Sisson Meadow gives to the citizens of Mt. Shasta. Sisson Meadow's rarity goes beyond being a wet-meadow habitat; it is a place of learning for children and adults alike, a place of peace and solitude for those seeking it and a place of pride and purpose for those who have become honorary stewards.

I am grateful to MSBEC and SLT for the opportunity to participate in the assessment and monitoring of Sisson Meadow.

Additional Information

Attached, are table 1 and a soil map of SM.

Work Citied

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Table 1- Taxonomical Identification, Quantity, Feeding Habit and Tolerance of Sampled Macroinvertebrates

Order	Family/ Descriptor	# Organisms	Feeding habit	Tolerance
Oligochaeta	Worm	54	c-g	5
Hirudinea	leech	4	prd	10
Amphipoda	Gammaridae (Scud)	12	c-g	4
Ephemeroptera	Mayfly	1	c-g or scr	0-5
Tricoptera	Suborder: Integripalpia Superfamily: Limnephiloidea (Holzenthal, 2010)	3	shr/scr/c-g	3
Megaloptera	Sialidae	2	prd	4
Diptera (fly)	unknown	1		
	Simuliidae (black fly)	1	c-f	6
Bilalva	Sphaeriide	20	c-f	6
Zygoptera	Damselfly	3	prd	0-2
Veneroida	Corbiculidae (Asian clam)	1	c-f	6
Byrrhoidea	Psephenidae	1	scr	4

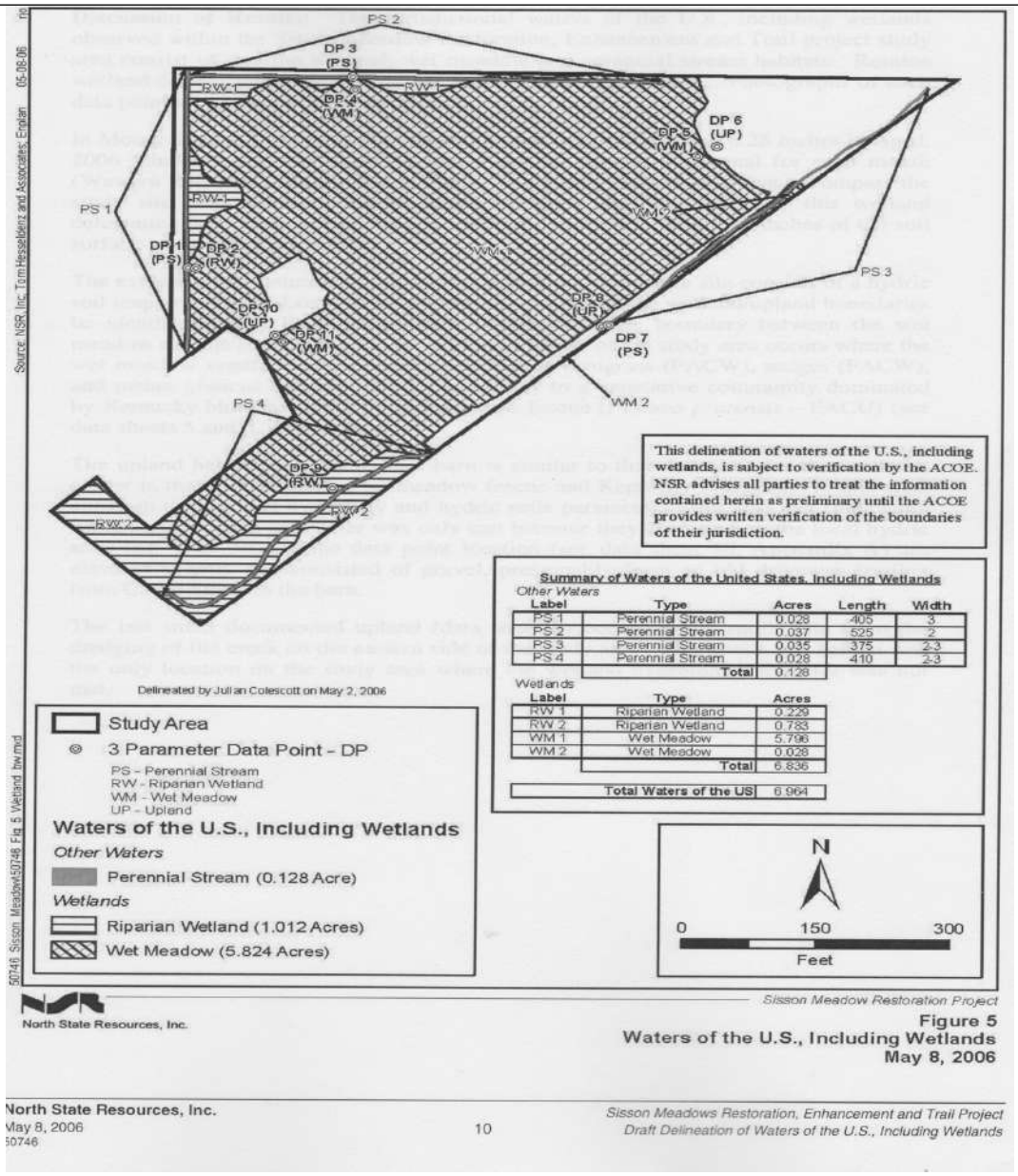
c-f: collector-filterer
c-g: collector-gatherer
prd: predator
scr: scraper
shr: shredder
par: parasite
omn: omnivore
pir: piercer

- Holzenthal, Ralph W., Roger J. Blahnik, Aysha Prather, and Karl Kjer. 2010. Integripalpia. Tube case makers. Version 20 July 2010 (under construction). *http://tolweb.org/Integripalpia/14551/2010.07.20 in*The Tree of Life Web Project, *http://tolweb.org/*

- Feeding habit and tolerance collected from: Soil & Water Conservation Society of Metro Halifax http://lakes.chebucto.org/ZOOBENTH/BENTHOS/tolerance.html#fbi

Soil map of Sisson Meadow

Extracted from North State Resources, Inc. *Sisson Meadow Restoration, Enhancement and Trail Project, Draft Delineation of Water of the United States including Wetlands*. NSR project # 50746. Published May 2006



Summary of Waters of the United States, Including Wetlands

Other Waters

Label	Type	Acres	Length	Width
PS 1	Perennial Stream	0.028	405	3
PS 2	Perennial Stream	0.037	525	2
PS 3	Perennial Stream	0.035	375	2-3
PS 4	Perennial Stream	0.028	410	2-3
	Total	0.128		

Wetlands

Label	Type	Acres
RW 1	Riparian Wetland	0.229
RW 2	Riparian Wetland	0.783
WM 1	Wet Meadow	5.796
WM 2	Wet Meadow	0.028
	Total	6.836
Total Waters of the US		6.964

North State Resources, Inc.

Sisson Meadow Restoration Project

Figure 5
Waters of the U.S., Including Wetlands
May 8, 2006