The Curry Watersheds Partnership

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Watershed Monitoring Program

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Long-Term Plan

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2020

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The Curry Watersheds Partnership (CWP) Watershed Monitoring Program (WMP) was created in 1997, and has since worked to monitor a large number of parameters and project types related to the restoration and conservation work done by the CWP. This plan was born out of a need to compile and review the copious amount of work done by the WMP over the past 20+ years in order to fully understand the breadth of that work and use it to inform the development of a strategic, long-term plan to guide the WMP forward. This process began with a comprehensive review of the program, which led to the creation of focus areas, priorities, and projects that the WMP will pursue in order to build on the successes of the past while adapting to the wants and needs of the future.

The comprehensive review consisted of reviewing all of the reporting, data, and other materials associated with past monitoring projects. A systematic review process was created to allow for tracking, ranking, and summarizing all projects and data in order to understand how successful the projects were, the information they provided, and how relevant that information and associated data are for the program moving forward. This resulted in the creation and utilization of a standardized summary report and categorical rankings of data in 10 categories related to data quality and current value for each reviewed monitoring project. The results of this process provided a comprehensive understanding of the WMP's past work that was used to inform and guide the development of the projects included in this plan.

The monitoring projects laid out in this plan were developed based on a number of focus areas and priorities that were identified to help guide the WMP. The focus areas of the program moving forward are water quality, aquatic life and habitat, and vegetation. These focus areas make up the vast majority of past project focuses, and encompass a majority of the work the CWP carries out. Priorities within each focus area were also identified by focusing on a few specific, known high-priority limiting factors related to each focus area in order to maximize the effectiveness of the WMP. Projects were then identified that inform one or more of those priorities. The projects included in this plan primarily build on past successful projects and current identified needs in order to carry past successes of the program forward to meet the current moment.

Six projects are included in this plan. Storm Chasers is a project that has been carried out multiple times in the past by the WMP. It is a citizen science focused, broad scale water quality monitoring project that utilizes volunteers to collect water quality grab samples during storm events. These samples are analyzed for turbidity and specific conductivity, and the

resultant data are used to inform the CWP on potential sediment mobilization issues within subwatersheds. The temperature monitoring project is a broad scale, long-term monitoring plan focused on developing summer water temperature datasets to identify areas of substantial warming or cooling throughout thermal regimes to identify potential focus areas and provide information pertaining to project effectiveness. The small stream functional monitoring project was developed by the WMP to be used as a project effectiveness monitoring tool. It utilizes a number of standardized protocols to assess multiple common limiting factors in the CWP's work: temperature, shade, sediment, geomorphology, large wood, and macroinvertebrate communities. The road sediment monitoring project utilizes a standardized protocol developed by the USFS to quantify sediment inputs from road networks, and will be used to assess the effectiveness of the CWP's road enhancement project efforts and also to inform road survey mapping and modeling efforts. The juvenile fish trap monitoring project enhances currently utilized protocols to monitor for juvenile fish presence using hoop-style traps. These enhancements will allow the WMP to monitor for species abundance, and to track important covariates (water level and temperature) that will be used to best understand how many fish are utilizing focus areas and how those numbers are changing over time. The aquatic habitat surveys project builds on past WMP habitat survey efforts by focusing the utilization of this protocol as an assessment and long-term, broad scale monitoring tool. These six projects are representative of much of the past successes of the WMP that align with current focus areas and priorities of the program.

The WMP is fully expected to develop new projects in the future as priorities change, new opportunities present themselves, and our understanding of our watersheds and associated limiting factors evolve. That is why this plan, and the structure of the WMP's focus areas and priorities, were developed to allow for future changes and additions to the plan. The plan also identifies potential partner agencies and organizations that the WMP has worked with in the past and will work with moving forward to ensure that project results and data are utilized as broadly as possible. These actions will build support and sustainability for the work the WMP carries out, and help to guarantee that work is as effective and informative as possible for the health of the watersheds and communities the CWP serves.

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ABBERVIATIONS

CWP .... **Curry Watersheds Partnership**

WMP .... **Watershed Monitoring Program**

SWCD .... **Soil and Water Conservation District**

LRWC .... **Lower Rogue Watershed Council**

SCWC .... **South Coast Watershed Council**

ODEQ .... **Oregon Department of Environmental Quality**

SAP .... **Sampling and Analysis Plan**

QA/QC .... **Quality Assurance / Quality Control**

AWQMS .... **Ambient Water Quality Monitoring System**

ODFW .... **Oregon Department of Fish and Wildlife**

AIP .... **Aquatic Inventories Project**

BLM .... **Bureau of Land Management**

OPRD .... **Oregon Parks and Recreation Department**

USFS .... **United States Forest Services**

WRLT .... **Wild Rivers Land Trust**

OWEB .... **Oregon Watershed Enhancement Board**

OSU .... **Oregon State University**

ESA .... **Endangered Species Act**

GIS .... **Geographic Information Systems**

1. INTRODUCTION

1.1 BACKGROUND

The Watershed Monitoring Program (WMP) was created in 1997, and over the past 20 years has provided services for the Curry Soil and Water Conservation District, Lower Rogue Watershed Council, and South Coast Watershed Council; collectively the Curry Watersheds Partnership (CWP). Since its inception, the WMP has developed and implemented monitoring projects that have provided important information pertaining to many focus areas including water quality, habitat, aquatic species, and vegetation. These data have been used to inform the CWP's efforts to improve ecological outcomes, inspire conservation and stewardship, and improve the economic and community well-being of Curry County.

The service area of the CWP, which includes all of Curry County and a small portion of Coos County within the New River watershed, is a large (>2,000 sq. mi.), ecologically diverse area. It contains 6 separate ecoregions: coastal lowlands, coastal uplands, southern Oregon coastal mountains, redwood zone, coastal Siskiyous, and serpentine Siskiyous. Climatic conditions are primarily marine influenced near the coast, and Mediterranean inland. The orientation of this area paired with the close proximity of mountain ranges to the coastline results in common occurrences of extreme weather, with average precipitation in some areas reaching above 140 inches annually, and sustained wind action along the coast at over 35mph with gusts over 100mph. Historic land use post-European settlement of the area consisted of primarily agriculture and rangeland in the coastal lowlands, and a mix of private timber and mining in the uplands and coastal mountains. This mix of varied ecoregions, extreme climatic events, and historic western land-use practices combine to create incredibly dynamic, ecologically diverse watersheds.

Past monitoring projects were primarily in three focus areas: water quality, project effectiveness, and habitat assessments. Water quality projects focused on quantifying a large number of water quality parameters through a variety of project types such as baseline studies, non-point source searches, and trend monitoring using both continuous and discrete sampling efforts in a variety of both freshwater and estuarine habitats. Project effectiveness endeavors included such efforts as vegetation, habitat, geomorphology, and fish surveys to assess the effectiveness of many of the CWP's restoration projects such as fish passage, bank stabilization, and riparian projects. Habitat assessment project types included salmonid spawning and habitat surveys, and wetland functional assessments to evaluate habitat quality and identify impairments that could be addressed through restoration actions. Data collected through the program have: provided project managers with critical information to ensure that restoration efforts are effectively meeting their goals, informed the development of multiple strategic action plans and focus area assessments, provided agency personnel with data needed to carry out their work, and educated the residents of Curry County on efforts they can take to help manage and maintain their properties and the health of their watersheds.

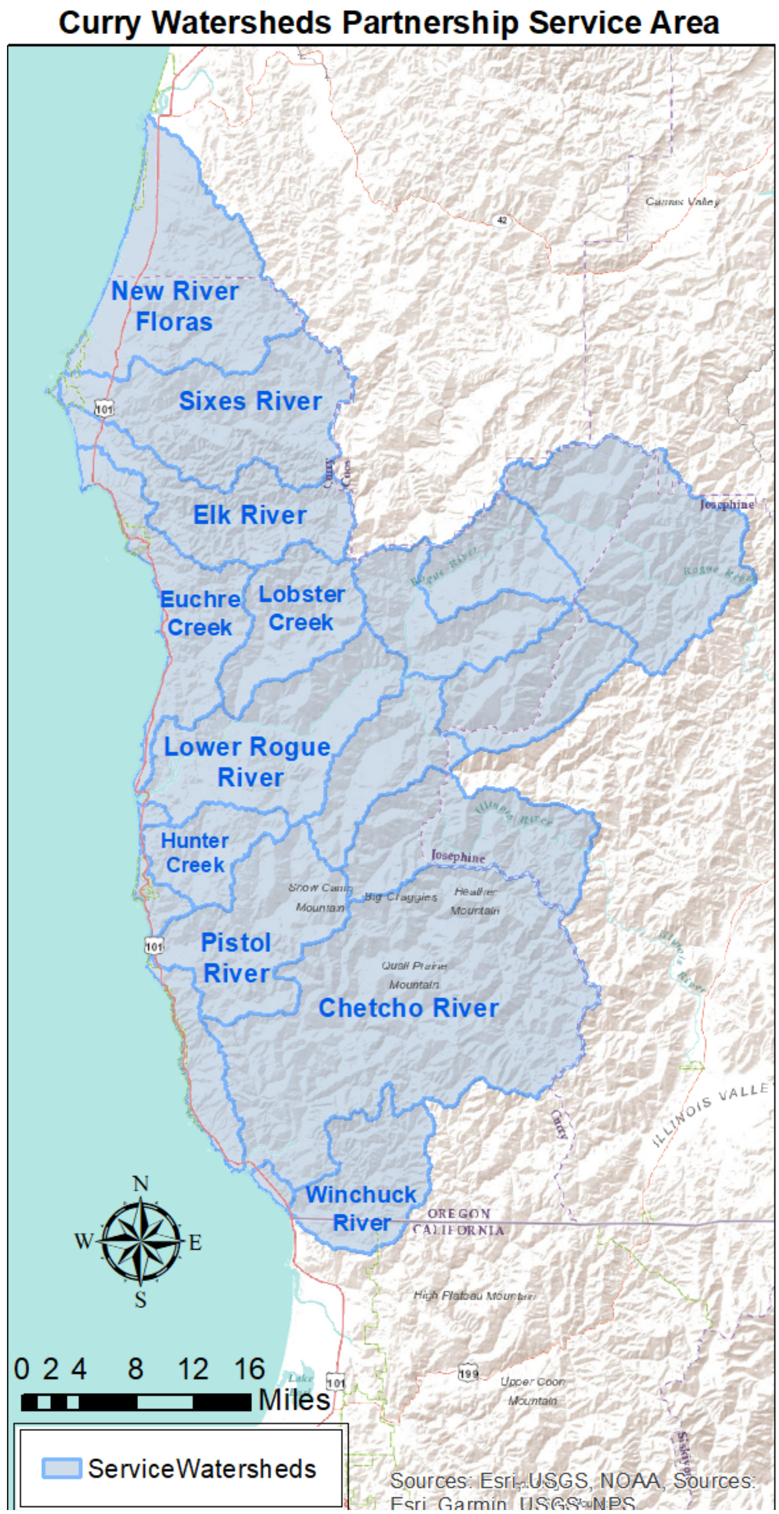

Figure 1: Map of the Curry Watersheds Partnership's service area highlighting primary focus watersheds

The evolution of the WMP over the past 20 years has resulted in a diverse program that has conducted a multitude of project types, collaborated with a large number of partners, and informed an array of projects and programs. The results from this assortment of accomplishments highlights a mix of both strengths and weaknesses of such a dynamic program. The large number of project types that have been carried out over the years have provided high quality data pertaining to a large number of different influential factors of overall watershed health and given the CWP a better understanding of many aspects of our watersheds. However, many of these projects were carried out years ago, and the resultant projects and datasets are becoming less representative of current conditions over time due to a number of variables such as changing land use practices, inherent interannual variability, and the effects of climate change. Many of these projects would benefit from continued monitoring, but the large number of diverse project types, while highly informative, make the long-term sustainability of any one project more difficult due to the limited capacity and funding options currently available to the WMP. This plan aims to enhance the sustainability of the program by building on successes and learning from the past to develop a comprehensive, sustainable path forward for the program.

1.2 GOALS AND OBJECTIVES

This plan will refine the effectiveness of the WMP by providing a comprehensive framework to guide the actions of the WMP over the foreseeable future. This framework aims to build on the past successes of the program, learn from its shortcomings, and provide guidelines for both short and long-term monitoring while being flexible enough to accommodate future alterations and additions to the current suite of monitoring projects laid out in this plan. These expectations are codified in the goals and objectives of the plan (Table 1).

Table 1: Goals and objectives of the plan

GOALS	OBJECTIVES
Build on past monitoring data to strengthen existing datasets, fill data gaps, and enhance past project efforts	• Conduct a comprehensive review of past Monitoring Program projects and associated data • Present highlights and lessons learned from comprehensive review • Identify high priority data gaps and opportunities for past project expansion efforts
Establish and identify projects to monitor primary limiting factors of watershed functions and services, and restoration effectiveness	• Identify monitoring project focus areas based on past monitoring program data and other relevant sources • Determine monitoring priorities to best understand primary limiting factors in focus areas • Identify past monitoring projects or elements than can be integrated into future monitoring projects • Develop project plans for monitoring parameters of interest at appropriate spatial and temporal scales
Determine how projects will be integrated, implementation timelines, and future needs to help guide the program forward	• Identify measurable relationships between projects and focus areas • Develop timelines and phases for all projects laid out in the plan • Schedule project phases and benchmarks for all projects to identify any gaps or needs to develop the WMP program to successfully implement projects • Identify potential next steps for WMP development

1.3 PLAN OVERVIEW

This plan is divided into three main sections. The first section is a comprehensive review of the WMP to date. All past significant projects and associated data were reviewed as part of the development of this plan. Each project received a summary report and all available project data were ranked using 10 parameters associated with data quality and current value to the program. This section describes the methods and results of this review process, and places past work in the context of the plan by describing how these summaries and quantitative data rankings were used to inform the monitoring projects identified in the plan.

The second section lays out the monitoring projects the CWP will employ in the near future. Some projects primarily focus on broad scale, long-term water quality monitoring projects that will help the CWP to better identify and understand limiting factors in our watersheds to inform our work and educate and engage the community in regards to water quality. Other projects will primarily focus on more fine scale monitoring to assess known limiting factors or evaluate the effectiveness of the CWP's work in restoration projects. This section does not attempt to prescribe monitoring to every specific project type the CWP has implemented because every project is slightly different (e.g. size, habitat type, limiting factors, project goals, etc.) and it would be unrealistic to predict all projects that will be implemented in the foreseeable future. This section does, however, include examples of monitoring plans for high priority project-related monitoring efforts to implement in the near future. It also provides guidance for including additional projects in the future, and describes ways in which the WMP coordinates with other CWP programs in their monitoring-related efforts.

The final section of the plan will help to tie the previous sections together in order to provide a comprehensive overview of the plan and how it will be implemented. This section covers how the data from separate projects will be integrated to best understand the parts of the whole that is the functions and services of our watersheds, and lays out implementation efforts in a comprehensive timeline. This helps to ensure that all the goals of the plan are being met. It also covers data sharing and partnership expectations with federal and state agencies, and other local groups. This helps to ensure the effectiveness and long-term sustainability of the WMP by maximizing the number of partners contributing to our work, and accessing and using our data. These implementation and partnership guidelines reflect the long-term perspective of this plan and the need to build sustainability into all of our future monitoring efforts. It is our hope that, in twenty years, we will look back and see that the structure of the WMP is successful due, at least in part, to the strong foundation we laid out in this plan.

2 PROGRAM REVIEW

2.1 THE NEED FOR A COMPREHENSIVE PROGRAM REVIEW

The CWP has been dedicated to monitoring conditions in our watersheds since the WMP was created in 1997. Over the past 20+ years, the WMP has initiated a wide variety of monitoring project types to quantify and better understand a large number of parameters related to watershed health. These projects have varied in size and scope from single site projects looking at one or two commonly sampled parameters, to multi-watershed projects with unique study designs carried out over multiple years. Each one of these projects requires a number of important components: a study design that addresses the need for the project, detailed data collection protocols, robust data management and storage, appropriate data analysis techniques to produce results, and in-depth quality assurance and quality control (QA/QC) procedures to ensure that all said project components are done consistently and to the highest standards possible to ensure accurate and valid results. A project lacking of any of these elements runs the risk of producing inaccurate or incorrect results that can misinform or hurt future CWP efforts.

As the WMP grew and evolved alongside the field of natural resource restoration and monitoring, projects evolved as well to incorporate new techniques, best management practices, and build on past results. It eventually became clear to the CWP that a need for a strategic review of the program was warranted. For nearly 20 years, a majority of the aspects of the WMP's projects were handled by the initial WMP Coordinator until they retired in 2015. In 2016, the CWP received funding to conduct a comprehensive review of the program in order to develop this strategic, long-term plan, and began the search for a new coordinator to carry out this work. That new coordinator was hired in 2018, and over the last two years has been immersed in reports, data, and associated materials of past projects to best understand where the program has been in order to determine the best way forward. This section of the plan will describe that review process in detail, and highlight the important conclusions that drove the development of the projects included in the remainder of the plan.

2.2 COMPREHENSIVE REVIEW PROCESS

The review process was one that evolved over time as the extensive breadth of the WMP became apparent. The beginning stage of the process involved an in-depth inventory and reorganization of all the reporting, data, and associated materials related to past projects in order to assess what materials were available for the review. Next, an initial review of each project was conducted that included a review of all final reports and results that could be found, and a cursory exploration of associated data and materials for completeness. This initial process revealed matters of consideration that were not being addressed through this somewhat rapid review process such as: the completeness of project results and reporting, data management questions, the presence or absence of necessary associated documents and data, and similar issues that are presumed common to a program that has grown and adapted over the years based on mostly short-term funding schedules in a field that has evolved at a rapid pace. The realization of these considerations made it clear that a more comprehensive, standardized review would be necessary to track all project results and conclusions, address disparities between projects, and allow for a more quantitative review of project results.

A more comprehensive review process was developed in order to address the concerns that arose during the initial review. The goal of this comprehensive review was to develop and carry out a standardized review procedure for each project that would reflect the overall quality of the project and its value to current and future CWP monitoring efforts. Previous attempts to review and aggregate environmental monitoring projects and data have highlighted many of the difficulties and considerations that must be addressed, such as the availability and quality of project metadata, protocols, QA/QC procedures, results, and reporting. After additional research, it was determined that developing data pedigree matrices and a standardized reporting format would be an efficient way of addressing these considerations to accomplish the goals of this review.

The data pedigree matrices and standardized reporting format proved to be two highly effective tools to increase the efficiency and effectiveness of the review process. Two data pedigree matrices were developed, one to assess the quality of each project, and another to assess the current and future value of that project to the program (Table 2). Data pedigree matrices are a way to standardize the assessment of projects and data by assigning values to a number of parameters that relate to the goals of the assessment. They are not designed to rank projects as “good” or “bad”, but rather to simplify the iterative review process and help to identify and keep track of conclusions and any issues that arise during the process. The standardized reporting format was designed to complement the pedigree matrices by providing a space to capture the narrative elements of the review process and keep track of each project's results and conclusions. A project review template was created with sections chosen to provide a brief summary of the project including: metrics on the geographic scope and parameters measured, a project overview explaining the goals and methods used, a results and discussion section to explain project results and what they mean, a data overview section to provide the results of the pedigree matrix rankings, a summary section for general conclusions, and a summary statistics/data section to include any relevant tables/figures/data either from the original project or those generated as part of the review process. These standardized reports, combined with the pedigree matrices, were successful at capturing the aspects of past projects that are vital to understanding the tremendous amount of work that the WMP has accomplished over the last 20 years, and how that work can drive and inform the program moving forward.

Table 2: The two data pedigree matrices and the 10 total categories that were used to evaluate projects and associated data. Each category was assigned a value of 1-5 (5 being the highest) based on established qualifiers for each ranking.

Data Pedigree Matrix	Category	Question the category is trying to answer
Data Quality	Validity	Are the available data valid given known QA/QC procedures and general parameter limits?
	Completeness	How much of the original data and metadata are available, and are they comprehensive enough to integrate into future analysis?
	Consistency	Were all instances of data collection, storage, and analysis done using the same protocols?
	Accuracy	How accurate were the resultant data, given the QA/QC procedures that were implemented at the time?
	Accessibility	Are both the raw data and results of any analysis available and accessible for future use?
Data Value	Relevance	Did the resultant data inform projects or decisions, and/or would it be valuable to future projects?
	Uniqueness	Are there other, similar data or projects that have been carried out in the same geographic area of focus?
	Applicability	How applicable is the data now, given its age, quality, and sampling periodicity?
	Representivity	How representative are the parameters measured to overall watershed health, both currently and at the time of sampling?
	Dispersibility	How valuable are these data to other groups and agencies?

The comprehensive review process was carried out on past projects with enough reporting, data, and associated materials readily available to inform all aspects of the review process. Some past projects were left out of the review due to lost or missing data and reporting, or a lack of capacity and resources needed to search for and compile disparate project elements in order to gather enough information for a full review. While it would have been ideal to carry out this review on every aspect of the work the monitoring program has completed in the past, the amount and availability of reporting and data associated with reviewed projects suggested that the projects and program elements that were captured in the review were the elements that are most likely to be applicable to the program moving forward. Correspondence with CWP staff that have been associated with the program for a majority of its lifetime confirmed these assumptions. Twelve projects in all went through the comprehensive review process. The standardized reports of those projects can be found in Appendix 1.

2.3 COMPREHENSIVE REVIEW RESULTS AND TAKEAWAYS

A majority of the 12 projects that were reviewed were large, ambitious projects that aimed to monitor a number of different parameters and focus areas. Comparing this diverse mix of projects highlighted the benefits of the comprehensive review process. Utilizing the results of the data pedigree matrices categorical rankings allowed for graphical comparative analysis of the results. This was done by computing the average of all five categories for the data quality matrix and the data value matrix of each project to generate an overall score for each. These overall scores for data value and quality of each project were then graphed on a scatter plot to visually compare projects (Figure 2). This analysis made clear which projects produced the highest quality data, and which are most valuable to the current WMP.

The results of this comparative analysis, combined with the narrative takeaways of the project review reporting, highlighted a number of similarities shared among the more higher-ranking projects. Common characteristics of the higher ranked projects included; utilization of standardized protocols that were well documented in Sampling and Analysis Plans, sampling of locations over extended periods at frequencies that well represented inherent variability of monitored parameters, the current availability of all data and metadata, quality analysis and reporting that aided in understanding the project's results and significance, and engagement with volunteers whenever possible to expand the quality and scope of a project beyond the WMP's capacity otherwise. In essence, these results highlighted the importance of every aspect of a monitoring project from the initial planning phase to final reporting and data archiving.

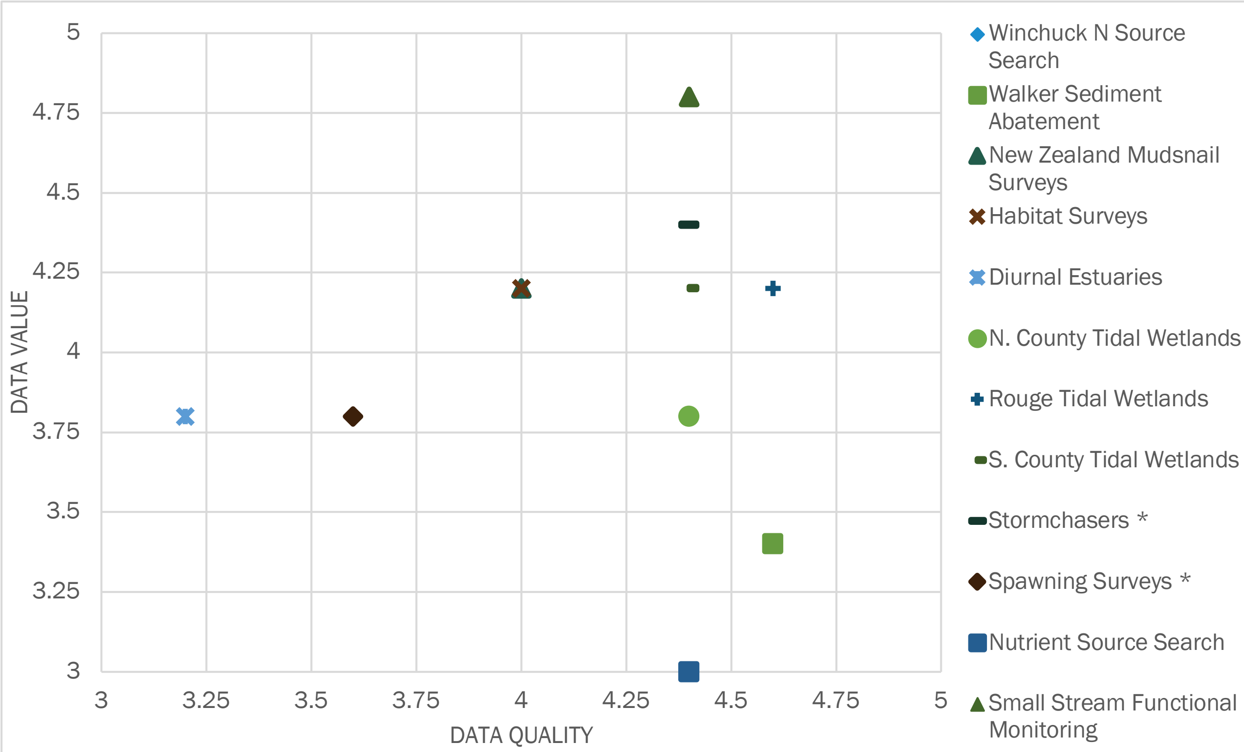

Figure 2: Graphical comparison of averaged data quality and value scores for all projects completed in the comprehensive review process

Along with highlighting the shared aspects of high-ranking projects, this review also highlighted many common difficulties that are often faced when implementing a monitoring project as an organization like the CWP. Two of the program level difficulties the WMP has often faced in the past are the desire to monitor a substantial number of different parameters throughout our service area, and the difficulty of building sustainability into projects that are wholly grant funded. It would be strategically beneficial for the WMP to address these issues in future project planning efforts by selecting only the most important parameters of interest that we can successfully monitor with a high degree of confidence, and build more sustainability into projects. One way to build more sustainability into projects is by utilizing adaptive monitoring principles and a phased approach in which each phase has short term goals that can be accomplished in an average grant funding period, and that compliment and build on each other towards achieving more long-term goals. In other words, monitoring a few parameters well, rather than a lot of parameters less effectively, with both short-term and long-term goals in mind, will help to guarantee success in future projects where past projects often had issues.

It is important that we learn from both past accomplishments and successes, as well as mistakes and difficulties, to improve the program moving forward. The comprehensive review laid bare all of this throughout the process. Some of these lessons learned were project specific, while others were observed across multiple projects. For that reason, we have included a summary of the broad scale takeaways from this process. These helped to inform and drive the development of the projects included in this plan, and it is our hope that they can be utilized by other monitoring programs as well.

- Whenever possible, utilize standardized protocols to increase analytical power, data sharing opportunities, and ease of project development and communication.
- Develop as thorough-as-possible of a study design and sampling plan before implementing a project to avoid potential issues further down the road.
- Highly detailed quality assurance/quality control (QA/QC) procedures, metadata, data management, and data archiving are incredibly important for the longevity and applicability of data.
- Clear and concise reporting is vital to the long-term success of any project. Detailed analysis, results, and conclusions greatly enhance the ability to revisit past projects.
- One can't monitor everything, everywhere, all the time. Focus on identifying primary limiting factors that can be effectively monitored at the appropriate temporal and geographic scales to answer primary monitoring questions.
- Volunteers can be a vital aspect of a monitoring project to increase the capacity of the program.
- Data becomes less representative of conditions over time. Relatively short-term monitoring projects become less representative of conditions as they age. Projects should address this in reporting or build in long-term adaptive or phased monitoring efforts

This comprehensive review process was extremely beneficial to the WMP. The way it streamlined and standardized how projects were reviewed helped to guarantee that important details from past projects weren't lost in the shuffle, which is important when dealing with such a large amount of data, reports, protocols, results, and associated products. We were able to investigate the work done over the past 20 years to a deep enough extent that we are certain the quality of this plan, and the work that will come out of it, are greatly enhanced thanks to the impressive work the program has done up to this point.

3 MONITORING PROJECTS AND FOCUS AREAS

3.1 FOCUS AREAS AND PRIORITIES

The comprehensive review of the WMP helped to identify a number of common monitoring subjects and parameters that were shared amongst projects. Some of these focus areas were common due to state or federal government identified priorities, such as addressing habitat concerns for salmonids. Other focus areas were common due to known regional ecological functions and land-use histories, such as sediment mobilization or riparian vegetation conditions. Regardless of the reason behind why these certain focus areas have been the subjects of multiple monitoring efforts, it would be beneficial for future project planning to identify and codify these focus areas to aid in project prioritization and data sharing efforts. Since we can't monitor everything everywhere, identifying focus areas and priorities will help to ensure that we collect highly relevant and pertinent data that's applicable to both our work and others.

Three overarching focus areas were identified that encapsulate a vast majority of the WMP's monitoring efforts: water quality, aquatic life and habitat, and vegetation. These focus areas are broad enough to cover both past and currently planned monitoring efforts, and should not need to be changed or altered to accommodate future efforts. Priorities within each focus area were also identified to help guide monitoring project planning moving forward. These priorities were selected based on past monitoring, known data gaps, and current CWP focuses and needs. These priorities are specific to current needs and may change in the future based on changes in CWP focus areas, priorities, and the capacity of the WMP.

Table 3: Monitoring Program Focus Areas and Priorities

FOCUS AREA	PRIORITY	DESCRIPTION
Water Quality	Summer thermal regimes	Summer temperature was the subject of multiple past monitoring efforts. These efforts identified a large number of streams that are warmer than the state water quality standard, including all mainstem rivers in our service area. Summer temperature dynamics are broadly understood, but much is still unknown, such as locations of cold water refugia. The need to better understand temperature dynamics has been identified in multiple Strategic Action Plans and data reviews.
	Sediment mobilization	Excess sediment can have negative effects on both aquatic species and their associated habitats, and cause aggradation of streams and erosion of banks and floodplains. The complex geomorphology and extreme precipitation events of our region, coupled with historic land use practices, can result in high amounts of sediment mobilization. Much of the CWP's work is focused on addressing sedimentation and erosion issues, and there is a need to better understand sediment mobilization dynamics and how effective our work is at addressing known issues.
Aquatic Life and Habitat	Salmonid habitat and limitations	Salmonids receive a large amount of focus due to multiple species being either endangered or threatened, and the CWP service area encompasses multiple populations of these species. Much of the work the CWP does goes towards identifying, protecting, and restoring salmonid habitat. Understanding salmonid habitat availability and utilization will help to inform and enhance our work.
	Macroinvertebrate community dynamics	Macroinvertebrates are a high-quality indicator of both habitat and water quality metrics. Past monitoring efforts have helped identify areas of concern and track invasive species. Better understanding community dynamics will allow us to utilize macroinvertebrate surveys as a high-quality assessment and monitoring tool for multiple focus areas and priorities.
Vegetation	Invasive non-native vegetation	Invasive vegetation is a high priority focus for the CWP. It can quickly spread and, if left unchecked, greatly degrade habitat and increase erosion in riparian areas. The WMP will work in coordination with the CWP Weeds Program to enhance their monitoring and assessment efforts.
	Riparian vegetation dynamics	Riparian vegetation is a high priority focus area for the CWP. Understanding and managing for riparian ecosystem health throughout the mix of ecoregions and complex geomorphologies in our service area will help to increase the efficiency and efficacy of our restoration efforts. The WMP will work in coordination with the CWP Riparian Program to enhance their monitoring and assessment efforts.

3.2 MONITORING PROJECTS

This section of the plan will present all the monitoring projects and associated details that have been developed through the planning process. The identification and development of the projects in this section have been designed to meet the moment in terms of where the CWP is and where it's going by building on past successes of the WMP and addressing current and upcoming focus areas and restoration project types.

This is not assumed to be a comprehensive list of projects that the WMP will carry out over the foreseeable future. These projects were primarily identified and developed based on the work the WMP has conducted over the past 20 years. The comprehensive program review, combined with the identification of focus areas and priorities, resulted in the selection of past monitoring projects that will best meet current WMP needs and leverage the successes of past monitoring efforts. Projects were also identified based on current CWP focus areas and project types and the need to gather data associated with those. This focus on building on past successes and immediate needs did not provide the capacity to also develop wholly new, unique monitoring projects. Large and/or complex monitoring plans for future work that don't build on past work still need to be developed, in particular more tidally influenced floodplain, wetland, and estuary monitoring is needed to address current data gaps and CMP priorities, but the complexities required to develop those monitoring plans made completing them as part of this process unrealistic. The development of additional monitoring projects as needed is of high priority to the WMP, and will be carried out based on the foundations laid out in this plan.

Table 4: Monitoring Project Plan Elements

Project Plan Elements
Introduction / Statement of Need
Goal Statement
Objectives
Site Selection Process
Data Gathering Strategy
Methods
Data Quality
Data Storage and Analysis
Timetable and Staff Requirements
Partnerships/Landowner Permissions/Relations
References

This plan is designed to allow for the addition of projects as they are developed by establishing a standardized monitoring project study design format. This will help to expedite the study design process, and provide a place for the WMP to track all potential and implemented projects. These monitoring projects are laid out following a standard format based on those suggested in the OWEB Water Quality Monitoring Guidebook [1]. Future monitoring projects will be developed following this same format and will be added to this plan in order to act as a repository for all monitoring projects developed by the WMP moving forward. Additions of new projects will be tracked using the table below (Table 5).

The projects included in this plan are those that will be led and implemented by the WMP, and does not include the collaborative monitoring efforts the WMP assists other programs in developing and carrying out. These efforts include, but are not limited to, assisting the Weeds Program with invasive vegetation monitoring and the Riparian Program with riparian planting monitoring and associated data analysis. The WMP will also assist restoration project managers with the development of project effectiveness monitoring projects for individual projects as needed.

Table 5: Version tracking to monitor the addition of new projects

Version	Date	Changes	Author
1.0	9/30/2020	Initial projects and plan finalized	Robbie Lascheck

STORM CHASERS: SEDIMENT MONITORING

INTRODUCTION

The Storm Chasers project is a broad scale storm water quality monitoring project that the CWP has successfully carried out a number of times over the years. The initial project was implemented from 2004 through 2008, and a follow-up round of sampling was done in 2015. The aim of this project has been to quantify the mobilization of certain water quality parameters during storm events, with a primary focus on sediment.

Excess sediment accumulation can have a myriad of negative effects on watershed functions and services such as: filling interstitial areas between gravel, which degrades habitat for salmonid spawning and macroinvertebrate communities; causing abrasion to gills and reducing ability for salmon to catch prey; decreasing light penetration affecting primary productivity and aquatic vegetation; and leading to stream channel aggradation and increased erosion rates.

Figure 3: Sediment input from Deep Creek into Pistol River Mainstem during storm

Sediment mobilization is of particular concern in our area due to the complex geology of the southern Oregon coast, and the frequency of intense storm events and high annual precipitation that results in flashy systems that are highly susceptible to erosion events such as landslides and earth flows. Studies have shown that some historic land use practices resulted in increased erosion rates in areas as well. For reference, the Oregon Department of Geology and Mineral Industries (DOGAMI) has developed an online, interactive map of all inventoried landslide locations, known as SLIDO. This is an excellent tool to get an understanding of just how prevalent these events are in our area. Past studies and resources like this make clear the need for us to monitor and best understand sediment mobilization in our area, what affects it, and how it changes over time. It is also important that we begin to carry out this work now, as climate change is predicted to result in even stronger storm events, flashier systems, and potential increases in erosional events.

Past Storm Chaser efforts have helped us identify subwatersheds that were contributing excess sediment, and helped us better understand sediment mobilization throughout our service area to target restoration and conservation work, but past efforts were hampered somewhat by technical issues. This plan aims to address those issues and lay out a long-term plan in order to enhance the effectiveness of the Storm Chasers program going forward.

Past efforts were also a successful example of citizen science being used to greatly enhance a project's scope and engage the larger community. Being that these sample events are synoptic (all taken within a short time window), this project would be impossible for the CWP to implement without volunteers. Additionally, multiple CWP staff and past volunteers have expressed joy when hearing that this project was coming back due to their enjoyment participating in past efforts. This project presents a prime opportunity for us to engage with our community in a mutually beneficial way that enhances our understanding of water quality issues and allows us to educate and empower the community in regards to these issues.

GOAL

Monitor sediment mobilization during storm events at a subwatershed scale to identify areas contributing excess sediment, ground truth models, and engage and educate our broader community.

OBJECTIVES

1. Collect grab samples for turbidity and conductivity at all sample sites during at least three storm events per wet season to account for within season variability
2. Establish stage-discharge relationships at each sample site in order to capture flow data for each grab sample event
3. Compare turbidity and conductivity results between sites and over time using discharge-weighted values to identify subwatersheds that contribute excess sediment downstream
4. Compare turbidity and conductivity results to NetMap model outputs to identify any potential disparities between sampled and modeled results in order to enhance our understanding of both products, and use both to best inform potential restoration areas and activities
5. Engage local volunteers in data collection efforts and provide educational opportunities to promote environmental education and stewardship in our local communities

SITE DESCRIPTION

Sampling sites will be established at the lower end of a subwatershed, as near the mouth as possible, where conditions guarantee safe access during high flow events (e.g. bridges, stable banks, etc.) to allow for representative sampling of the upstream subwatershed during storm events. Whenever possible, previously samples sites from past data collection cycles will be used to allow for comparative analysis.

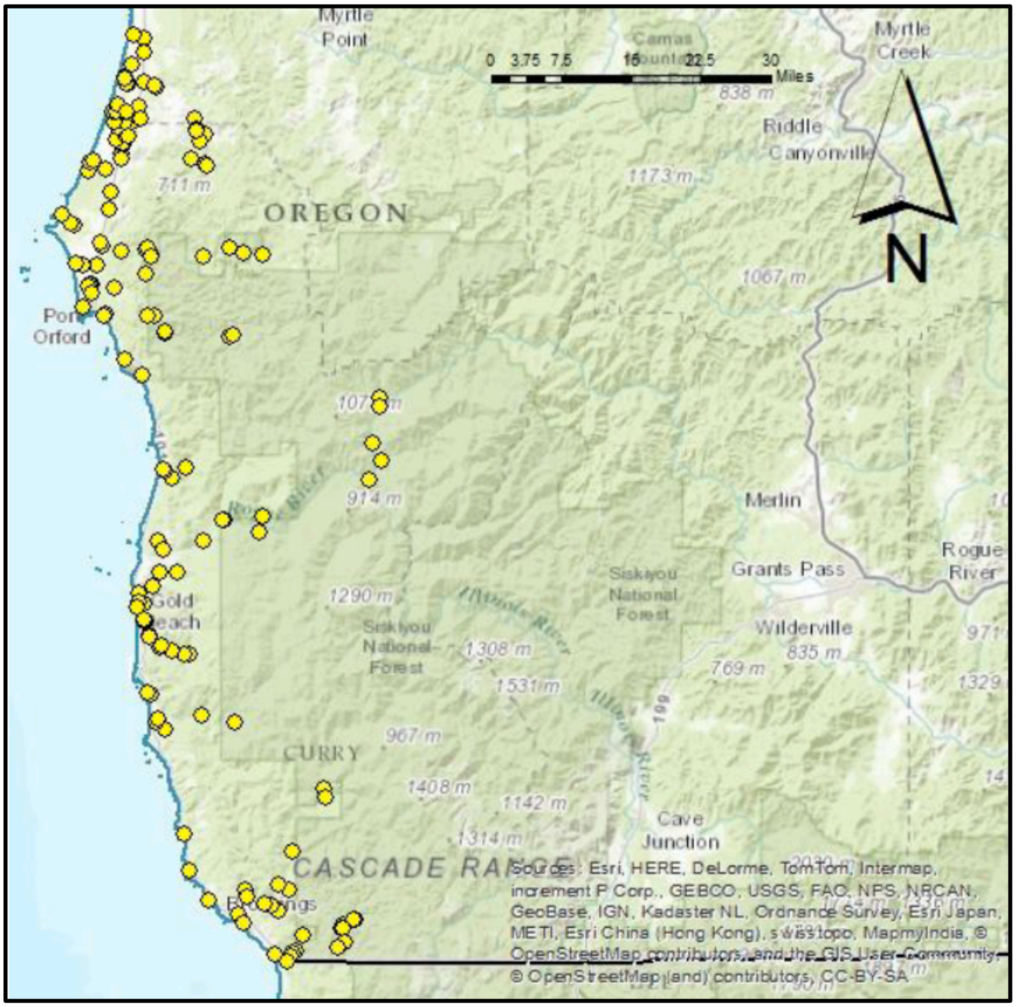

Figure 4: Locations of all past Storm Chaser sample sites.

DATA GATHERING STRATEGY

Phase 1:

- Sample sites will establish stage height collection procedures, primarily via staff gauge plate installations, prior to wet season sampling. A subset of sample sites will receive cross-sectional surveys and multiple discharge measurements at a variety of flows throughout the year to establish a stage-discharge relationship. The subset of sites sampled for discharge will be based on previous data collection efforts and current CWP focus areas. This will allow for water quality grab samples to be normalized based on storm intensity, which will allow for comparative analysis and a better understanding of sediment mobilization thresholds.
- Grab samples will be taken at all sites during, at minimum, three storm events per wet season. Samples will be processed for turbidity and specific conductivity. Best efforts will be made to sample during the first significant storm event of the wet season to capture

the mobilization of accumulated dry season sediment. The remaining samples will be taken throughout the mid to late wet season to account for within season variability. Stage height will also be recorded at the time of sampling. All samples will be collected within a small time-window to allow for synoptic analysis between sites. This will be accomplished by utilizing volunteers to conduct sampling at a majority of sites. Samples will be carried out using standard grab sample protocols dependent on site characteristics (e.g. bridge sampling, pole sampling, wadable sampling, etc.). All samples will be stored on ice, transported to the CWP Water Quality Lab, and processed for turbidity and conductivity within 48 hours of sampling.

Phase 2:

- The number of grab sample sites will be expanded based on the results of Phase 1, current program capacity at the time, and focus areas or other needs of the CWP. The number of sample events per wet season may also be altered based on the preliminary results of Phase 1.
- The subset of sites sampled for discharge will be altered based on the results of Phase 1. Any sites determined to be of particular importance (e.g. extreme sediment loading), or possessing highly variably geomorphology, will continue to be surveyed for discharge. All other sites will enter a rotating panel survey design to allow for additional sites to be surveyed and incorporated into comparative analysis. The number of sites in rotation and the rotation schedule will depend on results from Phase 1 and current program capacity at the time.
- Sampling grab samples for additional water quality parameters (e.g. nitrogen, phosphorous, e. coli, etc.) may be integrated at established sites. This sampling would be done to investigate potential excess levels of these parameters at specific locations, and would be carried out in addition to and outside of the original scope of this project. The determination to include additional water quality parameters will be site specific, and based on additional data or concerns from water quality professionals. Sample processing, analysis, and quality control requirements will be developed for those efforts separate from the Storm Chasers project documents.

METHODS

Grab sample collection, turbidity sampling, and specific conductivity sampling will all be done following standardized protocols described in the OWEB Water Quality Monitoring Guidebook. All volunteers will be trained by professionals with experience in water quality sampling with extra consideration given to sampling conditions at each site. Trained staff will accompany volunteers at a subset of sample events to assure proper protocols are being followed. A rotating panel of sites will be used to assure that each volunteer receives oversight as often as possible. At the end of each sample event time window, staff will collect all grab samples, store them on ice, and transport them to the CWP Water Quality Lab for processing.

All stage, discharge, and cross-sectional survey sampling will be done following standard USGS protocols. Current capacity of the CWP will allow for discharge measurements using mechanical stream current meters (e.g. pygmy or AA meters) and associated equipment. At the time this report is being written, the USGS is developing new technology known as large-scale particle-image velocimetry (LSPIV) that has the potential to greatly increase this project's capacity to collect discharge data. LSPIV uses video of a stream to determine the velocity of said stream. This, coupled with a stage reading and cross-sectional survey, allows one to calculate discharge to a high degree of accuracy without having to conduct a traditional survey. We believe that this technology could be utilized by volunteers to gather discharge data at all sites during all events, greatly enhancing this dataset and increasing the amount of citizen science engagement.

Figure 5: Grab sample collection using a pole sampler

DATA QUALITY

Steps will be taken throughout every stage of this project to ensure high quality data accuracy and validity. QA/QC procedures will be codified in a ODEQ SAP. Duplicate and blank samples will be collected and processed for a specified percentage of sample events to meet ODEQ requirements for 'A' level data. All equipment used in sample collection and processing will be calibrated following standard protocols. Metadata associated with all of these QA/QC procedures will be stored locally alongside all processed data.

DATA STORAGE AND ANALYSIS

All water quality parameter data (i.e. turbidity and specific conductivity) that meets 'A' or 'B' ODEQ data quality levels will be used for analysis. An initial examination of all data from each storm event will be reviewed using summary statistics and graphical analysis to assess each storm event, look for patterns, and identify any potential issues or concerns. Following the initial assessment, each site with an established stage-discharge relationship will receive comparative analysis. Water quality parameters will be weighted based on discharge at the time of sampling using standard analytical techniques [12,13]. Both spatial and temporal comparative analysis will be conducted in order to examine differences at each site over time and between sites. This will allow us to better understand the variability in sediment mobilization at an individual sites and between sites, and help us identify which subwatersheds are mobilizing excess sediment and when.

Results from this analysis will be compared to sediment model outputs in order to enhance our confidence in both these monitoring results and model outputs. At the time this is being written, the CWP is pursuing the development of NetMap models for all major watersheds in our service area. NetMap is a suite of modeling tools designed to provide information pertaining to a number of factors within a watershed. NetMap models a number of parameters associated with sediment mobilization such as landslide potential, gullying, and surface erosion, and calculates estimated sediment budgets for subwatershed. The results of these modeling efforts will be compared to the results of Storm Chasers monitoring efforts by examining relative differences between subwatersheds and areas where the models and monitoring data agree or disagree. If the models and monitoring data suggest different things (e.g. one source suggests a subwatershed contributes relatively high sediment loads when the other source does not) this disparity will be examined in closer detail to attempt to identify the issue, and make any necessary adjustments to enhance future results. If the models and monitoring data suggest similar things, then we can have confidence that the results of both are representative of the conditions and parameters each are meant to represent.

All data and metadata will be stored locally following standard CWP data management procedures. All physical data (e.g. field data sheets) will be digitized and stored in a central water quality monitoring database, along with all associated metadata. Resultant water quality data will also be related to a spatial dataset of site locations in a GIS geodatabase. All water quality data will also be shared with ODEQ to be stored in AWQMS.

TIMETABLE AND STAFF REQUIREMENTS

The number of sites that can be sampled during each storm event will be in part based on the number of volunteers signed up to participate in this project. Each site should have at least one volunteer assigned to it who will sample for an entire sample season (3+ events during the wet season). Trained staff members will oversee portions of the geographic scope of sample sites. Each staff member's responsibilities will include visiting sites during sampling to oversee volunteer efforts, and collecting and transporting all samples in their oversight area to the CWP Water Quality Lab after the sampling event. In past events, one staff member each oversaw ½ of the total range of sites. The number of staff and their oversight ranges may be adjusted based on capacity and need to oversee additional volunteer efforts.

One sampling season is designated as the entirety of one wet season, which generally runs from October to the following May. This is the window of time in which a majority of regional precipitation events occur. However, early sample events in September may be required due to seasonal and climatic variability. Therefore, the sampling season for Storm Chasers will be September to May.

Each phase of Storm Chasers sampling will include a minimum of 2 sampling season. This is required to account for interannual variability and logistical constraints such as common grant funding timelines. While only 2 phases are described in the Data Gathering Strategy section of this plan, multiple instances of phase 2 will be implemented as this project evolves. Each instance of phase 2-type expansion will be done to add additional sites and potential parameters as the capacity and funding for this project evolves over time. See timelines below for more details.

Table 6: Storm Chasers Annual Schedule

Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Prep phase	1st Sample Run			2nd Sample Run			3rd Sample Run			Analysis and reporting	

Table 7: Storm Chasers long-term schedule

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Phase 1		Phase 2.1		Phase 2.2		Phase 2.3		Phase 2.4	

PARTNERSHIPS / LANDOWNER PERMISSIONS / RELATIONS

The CWP has developed an extensive database of landowners, community partners, and engaged citizens that will be utilized for this project to recruit volunteers and acquire necessary landowner agreements. Potential landowner permission issues aren't expected to be significant due to a large number of sample sites being located within public rights-of-ways on bridges and other public lands. However, efforts will be made to contact landowners whenever possible for the sake of transparency and relationship building.

TEMPERATURE MONITORING

INTRODUCTION

Water temperature is a significant water quality parameter for a number of reasons. It influences many other water quality parameters such as dissolved oxygen levels and specific conductivity, drives biological activity such as vegetation and algae growth rates, and is an essential component of aquatic species habitat quantity and quality. The fact that temperature affects so many watershed functions makes it a quality parameter to monitor to better understand overall watershed functions and services. However, because so many factors affect water temperatures, temperature dynamics throughout a watershed can be highly variable over both space and time. These thermal regimes are important to understand in order to best monitor and manage water temperatures throughout a watershed.

The methods and equipment used to monitor water temperatures have evolved to the point where many standard methods and tools are readily available, and equipment is relatively cheap compared to monitoring for other water quality parameters. This allows small organizations like the CWP to effectively monitor for temperature at the scale required to account for much of the spatial and temporal variability in thermal regimes. It has also allowed other organizations to monitor for water temperatures in our service area in the past.

The past combined temperature monitoring efforts of the CWP and others have been of value at both the local and state levels, and provided insights into the dynamics of many of the thermal regimes in our area. At the time this report is being written, ODEQ has assessed all river mainstems in our service area as Clean Water Act Section 303(d) Category 5 for temperature, meaning that past summer temperature data exceeded ODEQ's limits for aquatic species. Category 5 also indicates that this is only based on the amalgam of past data, and more information is needed. ODEQ also regularly assesses available water quality data for current status and trends, however a majority of our watersheds have not recently been assessed, most likely due to a lack of current data. In short, we know past temperature data has exceeded state standards for adequate water quality, but there is not enough current data to assess current status or trends at this time.

Water temperature data is highly relevant to many of the activities the CWP carries out as an organization. Understanding thermal regimes throughout our watersheds can help us identify areas of concern to pursue remedial actions, as well as areas that may be providing cold water refuge to aquatic species during the summer months. Additionally, many of the restoration projects we implement affect water temperatures, such as riparian plantings and in-stream enhancements, and understanding the amount and extent of those effects can help us be as effective as possible in our work. The need to better understand these thermal regimes has recently been identified in multiple strategic action plans for our area. However, a mix of currently available data and the number of years of monitoring data needed to effectively understand these dynamics has hindered past efforts. This plan will establish a path forward for the CWP to begin to answer many of the questions that remain regarding temperature, such as; where are we seeing extreme high summer temperatures and cold-water refuges, what effects are they having on their larger watersheds, and how are they changing over time?

Due to the number of water temperature related questions that can be asked, and differences between watersheds and focus areas in the CWP's service area, this project plan will not attempt to lay out where temperature will be monitored everywhere. Instead, it will provide a detailed framework for ongoing and future temperature monitoring projects to employ to guarantee long-term success and compatibility across projects and watersheds.

GOAL

Establish norms for long-term temperature trend monitoring to enhance our understanding of thermal regimes, how they're changing over time, and focus areas for restoration

OBJECTIVES

1. Identify high priority areas for both the Curry Watersheds Partnership and additional partners where temperature monitoring would be most valuable to inform and direct current and future actions.
2. Identify appropriate geographic and temporal monitoring scales for priority areas based on individual study areas and if/what actions will be taken to address temperature concerns
3. Identify standard protocols and procedures that will be applied
4. Establish proper analytical techniques to apply depending on project specific sample design elements
5. Lay out phases and check-points for projects to allow for adaptive management and monitoring
6. Identify parties and datasets that can provide additional input, assistance, and guidance in project development, implementation, and post-processing

SITE SELECTION

Site locations will be selected to collect representative samples of study areas. Study areas will range from the reach to subwatershed scale. Primarily, long-term sites will be located near tributary confluences: one site in the tributary upstream of the mouth, one site in the mainstem upstream of the tributary, and one site in the mainstem downstream of the tributary. This design will allow for representative sampling of a subwatershed and its effect on the stream it feeds into.

Certain streams deemed high priority focus areas will receive multiple sites in order to examine differences between reaches. These reaches will be segmented based on specific goals of each focus area (e.g. differences between land cover types, effects of restoration vs control reaches, identification of cold water refuge, etc.). One current focus area at the time this report is being written is Morton Creek in the New River watershed. It is currently in its fourth year of a long-term monitoring project.

It will be advantageous to select sites that have been monitored in the past whenever possible in order to conduct comparative analysis on that historic data. A GIS geodatabase has been created that integrates all past CWP temperature monitoring efforts and relevant third-party datasets (e.g. ODEQ's 303(d) category 5 streams layer) to aid in the site selection process. This database displays geographic information on two important parameters of past CWP temperate data: the 7-day average maximum for the site, and the year(s) the data were collected. Sites with a high 7-day average max indicate potential areas of concern that may require additional monitoring. Sites that have been monitored in the more recent past, or monitored for multiple years, will provide higher quality data for analysis than sites that were monitored in the more distant past. This is due to the number of unknowns (i.e. variability) that must be accounted for between monitoring years. Efforts will be made to prioritize sites with relatively recent historic data, preferably with multiple years of data, that also have high 7-day average maximums whenever possible. This dataset also contains additional data layers and summary statistics that can be queried in order to explore additional ways in which historic data can inform the site selection process.

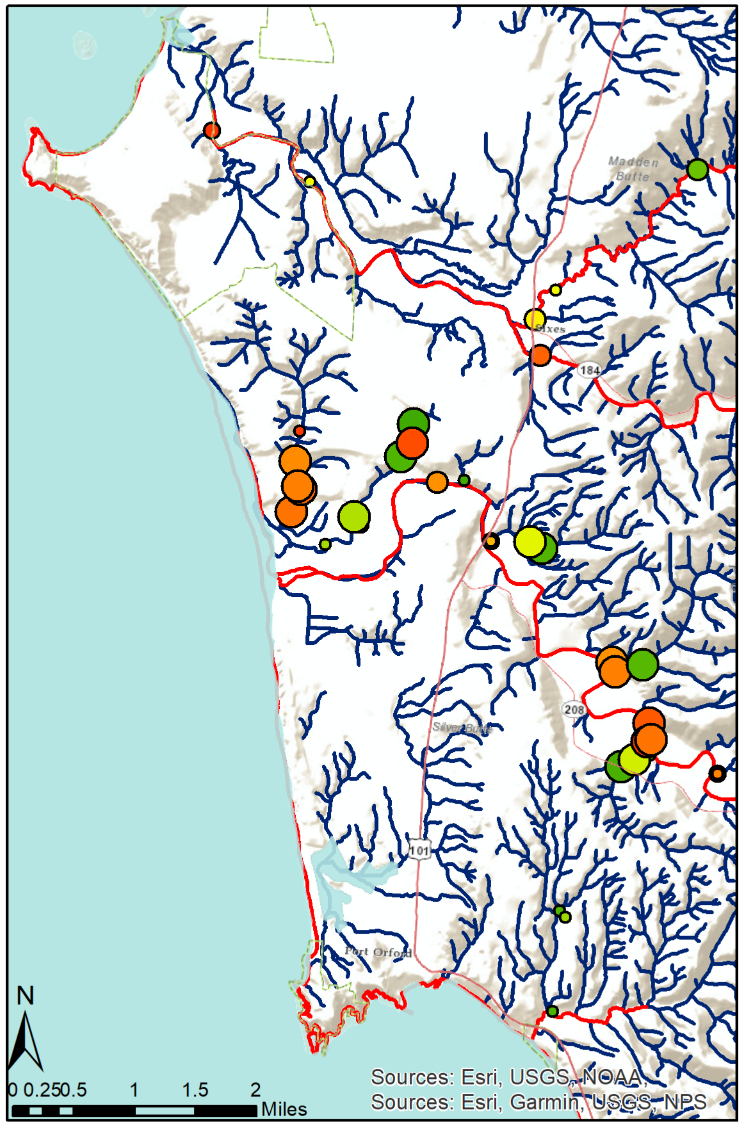

Figure 6: Map of the lower Sixes and Elk River watersheds as an example of temperature data prioritization GIS layers. Circles represent historic CWP temperature data: the color gradation represents the 7-day average maximum from cooler temps in green to hotter temps in red, the size of the circle indicates the age of the data and shrinks the further back in time it goes. Red lines are mainstems listed ODEQ 303(d) Category 5.

While this plan is not prescriptive in identifying individual sites to monitor, certain regions and watersheds within the CWP's service area are currently of higher priority than others at the time this is being written. Both the Elk River and Sixes River watersheds are current focus areas, and both have recently finalized strategic action plans that identify temperature as a high priority data gap and monitoring objective. The lower Rogue and Floras

Creek/New River watersheds are also current high priority areas due to recent assessments and current work being done in each.

DATA GATHERING STRATEGY

Phase 1:

Thermistors will be deployed for a minimum of one summer season at all priority sites in order to determine the status of summer water temperatures. All efforts will be made to deploy thermistors as early in the season as possible, and retrieve thermistors as late in the season as possible before the first significant fall precipitation event.

Phase 2:

Continued sampling will be carried out based on the size and scope of current monitoring efforts. If possible, every site will be monitored every year projects are active. Additional sites will likely be added either based on the results of phase 1, or by the need to expand temperature monitoring efforts into other focus areas or watersheds.

Once the number of sites exceeds the current capacity of the monitoring program, a rotating panel design will be implemented to accommodate these additional sites. This panel design will establish a subset of sites that will continue to be monitored every year, and all other sites will be monitored every other year. If the number of sites exceeds the program's capacity to monitor every other year, these sites will transition to being monitored every three years. The sites monitored every year will account for interannual variability that may be missed if all sites were monitored on a rotating panel. This study design will strike the best balance between assessing status at all sites and still being able to calculate trends over time.

Sites will be monitored for a minimum of 8 years (or 4 years for sites on every other year panel rotation) in order to calculate trends in how water temperatures are changing over time.

Phase 3:

Once trends have been established at sites, continued monitoring will be established based on the goals of each focus area or subwatershed. If the desired goals were met for an area (e.g. determine if restoration efforts resulted in downward trending water temperatures), monitoring will either cease, or a subset of sites will be monitored as legacy sites.

Legacy sites will be used to develop long-term trends that can be highly beneficial to the CWP and others for many applications, such as studying local effects of climate change. Long-term, continuous temperate datasets are currently hard to come by, and highly valued by many in professional, government, and academic realms. These sites will be monitored in perpetuity to establish as rich a dataset of water temperatures as possible.

METHODS

Thermistors will be audited and deployed following standardized protocols laid out in the OWEB Water Quality Monitoring Guidebook and ODEQ Volunteer Water Quality Monitoring QAPP. Pre and post-season audits, and a minimum of three field audits will be conducted each season. All audits will be conducted using NIST-certified thermometers that are annually calibrated by ODEQ. Additional covariates will be noted and addressed throughout the data collection and analysis phases whenever it's applicable.

Table 8: Important covariates that affect temperature. These covariates should be considered and accounted for in any monitoring efforts

Covariate	Description
Stage and Discharge	Water depth and flow can greatly influence temperatures. Integrate flow measurements and data from continuous gauging stations whenever possible. Consider deploying multiple thermistors in the vertical plain at sites with deeper water where there is possible thermal stratification.
Shade	Solar radiation is a primary driver of water temperature. Integrate shade data (NetMap models, riparian GIS data, etc.) whenever possible.
Turbidity	Highly turbid water absorbs more solar radiation due to suspended solids in water column.
Salinity	Saltwater is denser than freshwater, so warmer saltwater can sit below cooler freshwater and cause thermal stratification. Field audits conducted in or near estuaries should be done with a specific conductivity meter and both temperature and conductivity should be recorded.

DATA QUALITY

All temperature data will be collected with the goal of achieving ODEQ data quality level 'A' data [11]. This will be determined following standard ODEQ data quality analytical procedures. The CWP has a history of producing 'A' quality data in the past, and will aim to continue to do so by following all standard protocols.

DATA STORAGE AND ANALYSIS

All temperature data will be processed to determine ODEQ data quality levels. Data that score out to be of 'A' quality will be used in additional analysis. Data that score out to be of 'B' quality may also be incorporated into additional analysis if an extensive review process can identify and account for any errors.

Summary statistics will be calculated for each site, for every year it's monitored. Summary statistics include; daily max, mean, and min, 7-day average max, mean, and min, date of 7-day average max, average diel flux, 7-day average diel flux, and days above 18°C.

Graphical analysis will be completed for each site, for every year it's monitored. Graphical analysis will include an examination of daily max, mean, and min values, and 7-day moving average max values. This analysis will be used for qualitative analysis of sites, and will be utilized as a tool to inform landowners and citizens of temperature monitoring results.

Trend analysis will be conducted using ODEQ standard protocols, which involves the use of the Seasonal Mann-Kendal statistical test. Unfortunately, there is no general set number of years that a site should be monitored in order to calculate a valid trend. The number of years often depends on the objectives of project. For instance, many projects looking at climate change require a dataset of at least 50 years of data. In its latest status and trends analysis, ODEQ required at least 8 years of data to establish a valid trend [7]. This is why Phase 2 of data gathering requires 8 years of data collection to conduct trend analysis.

For instances that require between site comparative analysis (e.g. determining what influence a tributary has on upstream and downstream mainstem sites), a standard t-test will be used to determine if there is a significant change between sites.

All analysis will be conducted in Microsoft Excel and R, and will utilize standard ODEQ excel files and R scripts whenever possible. All data (raw, summary stats, and metadata) will be stored locally in the CWP's water quality monitoring database. Relevant data will also be sent to DEQ for public dissemination through AWQMS.

TIMETABLE AND STAFF REQUIREMENTS

One sample season is defined as one summer season, which regularly runs from late May to late September or early October. However, pre and post season work is required to guarantee that high quality data is collected and properly analyzed and disseminated. All high-level tasks required are summaries on the annual timeline below.

Table 9: Temperature monitoring annual schedule

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	NIST thermo audits		Therm-istor audits	Deploy thermistors		Mid-season audit		Retrieve thermistors		Post-season audit and analysis	

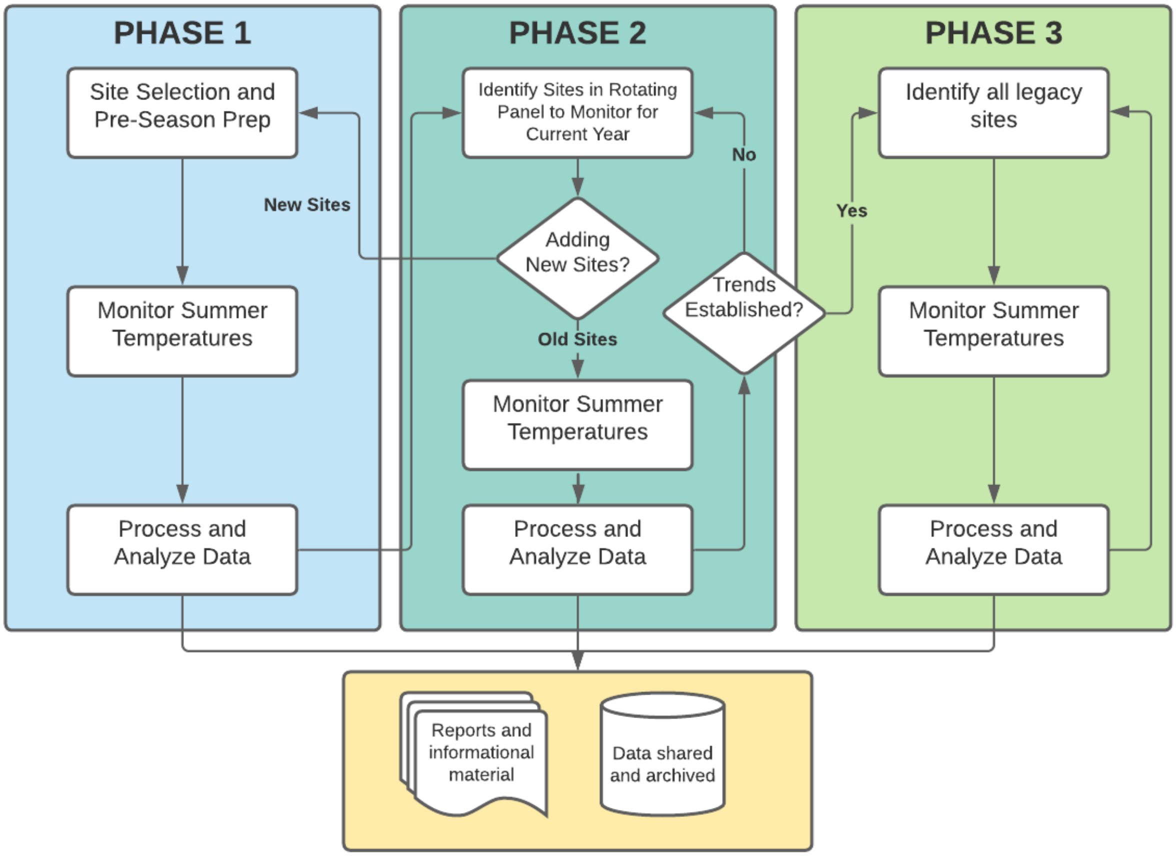

Figure 7: Flow chart of all priority steps and phases in the temperature plan. This phased approach is designed to allow for adaptive management and monitoring at multiple points throughout the project in order to ensure long-term, high quality data collection efforts.

Temperature monitoring can be carried out by a single staff member. A single temperature site must be visited three times per season, and requires a minimum of 4-6 hours per season to complete all field work. This does not account for pre and post-season work. Multiple staff members may be required to carry out temperature monitoring efforts depending on the number of sites in a given season, other projects going on simultaneously, and current program capacity.

PARTNERSHIPS / LANDOWNER PERMISSIONS / RELATIONS

The CWP has an extensive database of willing landowners and partners, and continues to work to build positive relationships with landowners to help guarantee long-term working relationships.

When pursing temperature monitoring sites on private property, it will be made clear that these efforts may become long-term, ongoing ones. The high value of these long-term datasets will be made clear to landowners, and an open dialogue will always be encouraged. Routine reports will be created to provide landowners with the data that is collected on their property, and how that data is being utilized by the CWP. This open dialogue and data sharing will help to ensure long lasting, positive relationships between landowners and the CWP.

When pursing temperature monitoring on public property, a local representative of the agency that manages the land will be contacted and made aware of our monitoring efforts. Efforts will be made to include these agency representatives in the monitoring process as much as possible. Routine reports will be created to provide the agency with the data that is collected on their property, and how that data is being utilized by the CWP.

The results of temperature monitoring efforts will be made available on the CWP website and disseminated to any and all interested parties. Potential interested parties include: ODEQ, ODFW, BLM, OPRD, USFS, WRLT, OWEB, OSU, and Curry County.

SMALL STREAM FUNCTIONAL MONITORING

INTRODUCTION

Curry County has a healthy, substantial agricultural community that owns and operates lands throughout many of our watersheds. The CWP has developed strong relationships with many landowners, and as a result we have implemented a number of restoration projects on small to medium sized streams that flow through these agricultural lands. We strive to support and promote sustainable working lands, and work towards achieving the goals of our mission to, "… inspire conservation and stewardship, and improve the economic and community well-being of Curry County."

The size and scope of these restoration projects have ranged from small projects such as installing fencing or riparian enhancement activities on one small stream reach, to entire channel realignment projects to move a stream out of a ditch and back into its historic channel. These projects have often targeted similar limiting factors to these streams, despite the diversity of project types, and in the early 2000's the CWP developed a suite of monitoring activities to assess those shared limiting factors and understand the effectiveness of these restoration efforts.

The Small Stream Functional Monitoring (SSFM) project combined a number of standard monitoring protocols and techniques to monitor the conditions of multiple limiting factors, primarily water temperature and sediment dynamics. Continuous temperature measurements were recorded upstream and downstream of each reach. Discharge measurements were taken at designated cross sections. Solar radiation was assessed by quantifying shade at multiple transects throughout a reach using a Solar Pathfinder. Sediment dynamics were measured using the Relative Bed Survey (RBS) method. Finally, macroinvertebrate surveys utilized standard models and indices to assess the macroinvertebrate communities for habitat quality related to both sediment and temperature metrics.

The initial monitoring phase for this project established a number of study reaches (both restoration and controls), and conducted two to three rounds of monitoring on each. Unfortunately, funding for this project ceased after year four and additional funding could not be secured at the time (see project review in Appendix 1).

The overall design of this project and the initial results suggest that it could be a highly valuable tool for informing the CWP of our past work by providing information on past project reaches. However, the original project phase did not run long enough to effectively capture change over time, and some issues in the analysis phase hampered the value of some of the results. This project aims to revitalize and enhance the SSFM project by building on past successes and adapting the project to be as effective as possible at monitoring past, present, and future restoration projects.

GOAL

Evaluate the status of multiple common limiting factors and indices related to restoration efforts to determine differences between restoration and control reaches and changes over time

OBJECTIVES

1. Enhance the SSFM project to build on past successes and incorporate current knowledge and resources
2. Identify both historic and new project reaches that would benefit from SSFM
3. Establish norms for each phase of the SSFM process to ensure effective results and reporting
4. Determine how SSFM results will inform project development and adaptive management opportunities

SITE SELECTION

SSFM sites will be selected in a way that best guarantees that results will both properly represent changes in project areas, and show how those changes may be different from non-project reaches. This will be done by implementing a Before-After-Control-Impact (BACI) study design whenever possible. This study design collects data on both a project (impact) and reference (control) reaches before and after project implementation, and is one of the best models for environmental effectiveness monitoring projects [1,2]. Most previous SSFM efforts were established utilizing the BACI design, which helps strengthen the value of those previous data. When establishing new reaches, it is critical to assure that project and reference reaches are as similar as possible. A poorly representative reference reach can have significant negative effects on monitoring results.

Table 10: Priority ranking of past SSFM streams.
The larger watershed each stream is found in is indicated in parenthesis.

Prioritized Streams
1. Morton Creek (New River)
2. Bethel Creek (New River)
3. Willow Creek (New River)
4. Crystal Creek (Sixes)
5. Pea Creek (Euchre)
6. Turner Creek (Hubbard)
7. Crook Creek (Pistol)

Past SSFM projects were ranked and prioritized for follow up monitoring efforts after past projects and associated data were thoroughly reviewed (Table 10). These rankings include both project and reference reaches that were surveyed in each stream. Re-surveying these streams will provide important information pertaining to long-term changes at these sites since no data has been collected at these sites since 2009, and how effective the SSFM methods are at identifying those changes.

New SSFM sites will also be established, as focus areas and priorities for the CWP have changed over the years. At the time this plan is being written, opportunities have arisen in both Morton and Bethel Creeks to apply SSFM in the upper portions of both watersheds, which are located in the southern Oregon coastal mountains ecoregion. This would be an excellent opportunity to compare these portions of the watersheds to the lower portions where past surveys were done, which are located in the coastal lowlands ecoregion. Additional opportunities to utilize SSFM will also be pursued as focus areas and potential project locations evolve.

DATA GATHERING STRATEGY

Restoration effectiveness monitoring projects can be quite difficult to successfully carry out due, at least in part, to the large number of unknowns and variables associated with any given stream reach, and the lengthy time periods that it takes for many monitored parameters to show change. The Monitoring Program and restoration project manager should work in collaboration on all phases of the restoration project to make sure that proper data collection is carried out and any issues that may arise throughout the process are known and accounted for. These data gathering strategies will present best-case scenario conditions that should be followed whenever possible.

SSFM projects will be most valuable if they are performed prior to any restoration actions in a proposed project area. In order to accomplish this, SSFM surveys will be conducted during the initial project planning phase. This will both help to inform project planning and design, and establish pre-project baseline data that is critical to the long-term success of the SSFM project. It is critical that at least one year of pre-project data is collected, however 2+ years of pre-project data will allow for more confidence in any effectiveness analysis and should therefore be pursued whenever possible. This will require communication and coordination between the project manager and monitoring coordinator as early and often as possible during the project planning phase.

Project (impact) and reference (control) reaches will be chosen based on multiple factors. Both reaches should be located near each other, ideally with the control reach located just upstream of the project reach as to not be affected by downstream effects of the project. Conditions in the project and reference reaches should be as similar as realistically possibly prior to implementation in order to minimize variability between sites. Collecting comprehensive, accurate data during the first year of monitoring will be vital to evaluating the variability and differences between sites. Making changes or alterations to the site locations or monitoring activities after year one should be avoided as best as possible to maintain data comparability and reduce additional variability.

Continuous temperature sites will be established at the upstream and downstream ends of each reach. Thermistors will be deployed for as much of the summer season as possible. Three field audits will be carried out during the season: during deployment, mid-season, and during retrieval. Discharge measurements will be taken during each of these audits. All other surveys will be conducted during the mid-season temperature audit. This includes: a benthic macroinvertebrate survey, relative bed stability (RBS) survey, and shade measurements. All data collection efforts will be conducted following standard protocols identified in the Methods section of the plan.

METHODS

Continuous temperature - Thermistors will be audited and deployed following standardized protocols laid out in the OWEB Water Quality Monitoring Guidebook and ODEQ Volunteer Water Quality Monitoring QAPP. Pre and post-season audits, and a minimum of three field audits will be conducted each season. Thermistors will be deployed as early in the summer season as possible (late May – early June) and retrieved as late in the summer season as possible (late Sept. – early Oct.).

Discharge – Discharge measurements will be taken following standard USGS protocols for wadeable streams. A pygmy current meter and wading rod will be used to record all discharge measurements at established cross-sections. Accuracy checks (spin tests) will be done on the pygmy meter before and after every sampling event. Discharge measurements will be collected at a location within the reach that is representative of average flow, preferably near the downstream end of the reach.

Benthic macroinvertebrate survey – Macroinvertebrate surveys will be conducted following ODEQ's Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams [6]. Previously surveyed reaches will follow the version of the protocol that was implemented in order to allow for data comparability. We will coordinate with DEQ to utilize the most up-to-date protocols when surveying new reaches, and will utilize those same protocols on repeat surveys. Samples will be sent to a laboratory facility that offers macroinvertebrate sample sorting and identification services for processing.

Figure 8: Field staff taking water depth and shade measurements

Relative Bed Stability (RBS) survey – RBS surveys will be conducted following ODEQ's standard protocol. These surveys require the establishment of 11 transects to collect channel metrics (bankfull width, height, and slope), 21 transects to evaluate substrate size class, and a thalweg profile of the reach. Every effort will be made to mark or otherwise identify transect locations for repeat surveys.

Shade – Shade measurements will be recorded at each of the 11 RBS channel metric transects using a Solar Pathfinder, and will follow standard OWEB protocols.

DATA QUALITY

All temperature data will be collected with the goal of achieving ODEQ data quality level 'A' data. This will be determined following standard ODEQ data quality analytical procedures. The CWP has a history of producing 'A' quality data in the past, and will aim to continue to do so by following all standard protocols.

Standard QA/QC procedures will be followed for all protocols. Usually this involved taking a duplicate sample for 10% of surveys in order to assess precision of the protocols and staff running them. These procedures will be codified in an approved ODEQ Sample and Analysis Plan developed for this project.

DATA STORAGE AND ANALYSIS

The amount of SSFM data analysis will depend on the number of years of both pre and post restoration implementation data that is available. Whenever multiple pre-implementation years of data are available, comparative analysis between years will be used to assess between year variability. This will help to better understand if post-implementation between year variability has changed, and if so if it appears to be the result of restoration.

Temperature data will be processed and analyzed following standard methods laid out in the Temperature Monitoring Plan section of this plan. Upstream and downstream sites at each reach will be compared to assess within reach variability. Project and reference reaches will be compared using data from downstream sites only, as those sites best represent within reach conditions. Trend analysis will be conducted on each reach after post-restoration year 5, again in year 8, and every year after that. DEQ trend analysis requires 8 years of data, but trends will first be established in year 5 to accompany the analysis of all other surveys in this year.

Discharge data will be process using standard protocols to calculate stream velocity. Data will be analyzed within each reach and between reaches for within season variability and annual variability. Data will also be used to inform the analysis of other parameters, such as potential changes in temperature that may be a result of changes in flows.

Macroinvertebrate samples will be processed by trained professionals in a laboratory setting. The results of sample sorting and identification will be analyzed in house with the assistance of a consulting professional etymologist. Data will be processed using two separate models; the OWEB Level III Multi-metric Assessment and the multivariate Predictive Assessment Tool for Oregon (PREDATOR). These models will provide information on multiple aspects of habitat quality and parameters of interests such a temperature and sediment. We will also work with macroinvertebrate experts at ODEQ to ensure the most up to date methods and models are applied that reflect streams in our region.

RBS data will be analyzed using standard protocols. Standard analytical techniques provide information pertaining to expected substrate size given the channel metrics that are surveyed. This analytical procedure helps one understand if a reach is in equilibrium or not (e.g. too much fine grain sediment deposition). Results from this analysis will be compared between reference and project reaches. The multiple datasets that inform this analysis (channel metrics, slope, substrate size, etc.) will also be analyzed separately to assess variability between reaches.

Solar Pathfinder surveys result in data on the amount of shade at each survey location throughout the year. Data from each transect survey will be combined to determine average shade for the entire reach. Average shade will be compared between reaches each year. Average shade, and direct shade at east transect, will be compared between years to assess changes in time as riparian areas develop.

All data will be stored locally in designated databases. Temperature and macroinvertebrate data will be shared with ODEQ using standard submission forms in order to be integrated into AWQMS.

TIMETABLE AND STAFF REQUIREMENTS

All SSFM monitoring efforts will be conducted before and after restoration efforts. 2+ years of pre-implementation monitoring will be conducted whenever possible. However, even 1 year of pre-implementation is incredibly valuable. Post implementation monitoring timelines will vary depending on the type of monitoring being conducted. Continuous temperature monitoring will be carried out every year in order to collect enough high-quality data to establish trends. All other surveys will be conducted in years 1, 3, and 5 post-implementation. A comprehensive review will be conducted in year 5, at which point a long-term monitoring schedule will be developed based on results. A fine scale schedule (e.g. every other year for 4-6 more years, followed by another review) will be established if the review indicates rapidly changing conditions, otherwise a more broad scale schedule (e.g. every 3-5 years) will be established.

Table 11: SSFM annual schedule

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			Pre-season audits and prep	Deploy thermistors		Mis-season audit and all other surveys		Retrieve thermistors		Post-season audit and analysis	

Temperature monitoring and discharge field procedures can be carried out by one staff member. All other surveys will require at least two staff members to complete.

PARTNERSHIPS / LANDOWNER PERMISSIONS / RELATIONS

The CWP has an extensive database of willing landowners and partners, and continues to work to build positive relationships with landowners to help guarantee long-term working relationships.

When pursing SSFM monitoring sites on private property, it will be made clear that these efforts may become long-term, ongoing ones. The high value of these long-term datasets will be made clear to landowners, and an open dialogue will always be encouraged. Routine reports will be created to provide landowners with the data that is collected on their property, and how that data is being utilized by the CWP. This open dialogue and data sharing will help to ensure long lasting, positive relationships between landowners and the CWP.

When pursing SSFM monitoring on public property, a local representative of the agency that manages the land will be contacted and made aware of our monitoring efforts. Efforts will be made to include these agency representatives in the monitoring process as much as possible. Routine reports will be created to provide the agency with the data that is collected on their property, and how that data is being utilized by the CWP.

The results of SSFM monitoring efforts will be made available on the CWP website and disseminated to any and all interested parties. Potential interested parties include: ODEQ, ODFW, BLM, OPRD, USFS, WRLT, OWEB, OSU, and Curry County.

ROAD SEDIMENT MONITORING

INTRODUCTION

Road systems on forest and agricultural lands are a known source of excess sediment in many watersheds. Excess sediment accumulation can have a myriad of negative effects on watershed functions and services such as: filling interstitial areas between gravel, which degrades habitat for salmonid spawning and macroinvertebrate communities; causing abrasion to gills and reducing ability for salmon to catch prey; decreasing light penetration affecting primary productivity and aquatic vegetation; and leading to stream channel aggradation and increased erosion rates.

Sediment mobilization is of particular concern in our area due to the complex geology of the southern Oregon coast, and the frequency of intense storm events and high annual precipitation that results in flashy systems that are highly susceptible to erosion events such as landslides and earth flows. Studies have shown that some historic land use practices including or related to road systems resulted in increased erosion rates in areas as well [2,6]. Past studies and resources like this make clear the need for us to monitor and best understand road related sediment mobilization in our area, what affects it, and how it changes over time. It is also important that we begin to carry out this work now, as climate change is predicted to result in even stronger storm events, flashier systems, and potential increases in sediment mobilization and erosional events.

Figure 9: Runoff on road. Photo credit Black & Luce (2013)

The CWP has done extensive work inventorying and addressing concerns on road networks in the past. As the knowledge base of sediment related road issues has grown, it has become increasingly important for us to be able to monitor for these effects at a fine enough scale that will allow for highly accurate results. Fortunately, the USFS has developed a standardized protocol for measuring both sediment and discharge from road plots. We will utilize this protocol as an assessment and effectiveness monitoring tool to identify road networks that contribute excess sediment and evaluate our treatment efforts to address those issues.

This protocol can also be used to inform standard models of road sediment mobilization. The same team that developed this protocol also developed The Geomorphic Road Analysis and Inventory Package (GRAIP), which is a standard assessment method for surveying and modeling road networks to understand sediment mobilization dynamics throughout an entire system. The CWP is currently exploring how best to utilize GRAIP surveys in the future. One of the questions that has come up in the past was how to calculate local base erosion rates for our area. This has been a concern because of the unique and complex assemblage of disparate geological formations in our area that hinders our ability to confidently apply a generalized regional base rate. Thankfully, the results of this monitoring protocol will provide localized erosion rates that will greatly enhance the accuracy of any GRAIP models we develop.

GOAL

Quantify the amount of sediment that is mobilized from road networks, and the effects of road enhancement efforts.

OBJECTIVES

1. Identify standard protocols that will be used to collect and analyze data
2. Determine how data will be used to inform and enhance road enhancement projects
3. Identify any restrictions or considerations for applying the standard protocols to the CWP's service area

SITE SELECTION

Sites will be selected based on overall representivity of the site's local geology and the road network being assessed. An initial assessment of the network to examine common geology, slope, construction, maintenance practices, and road and ditch vegetation will greatly aid in this process. Important factors to consider when selecting sample sites include: road surface material, traffic level, road slope, flow-path length, rainfall intensity, soil erodibility, geology, ground water interception, road design, and road grading.

The number of sites needed will depend on the size of and variability within the focus road network. Past studies have used anywhere from one to five plots to represent a road network. Establishing at least two plots will aid in reducing the amount of uncertainty in the results of any analysis.

If only a portion of the road network will be treated, establishing both treatment and control plots will greatly enhance any effectiveness monitoring results. These plots should be as similar as possible to minimize the amount of variability between sites.

DATA GATHERING STRATEGY

Data will be obtained following protocols laid out in Black & Luce (2013). Road plots will be established with water bars to divert all overland flow within the plot to a ditch that drains into a settling tank. The tank will collect sediment that is transported off of the road surface. A tipping bucket will be installed on the settling tank to capture overflow once the tank has reached capacity. This tipping bucket will be equipped with a data logging device that counts the number of times the bucket tips, which will allow for calculating discharge and fine sediment mobilization as well.

Figure 10: Settling basin and tipping bucket. Photo credit Black & Luce (2013)

Settling basins will be routinely checked throughout the wet season, especially after large storm events. Sediment will be processed from basins when they are near capacity. Sediment processing will involve emptying the basin and weighing the sediment and water found in the basin in order to calculate total sediment loads, and evaluating tipping buckets in order to calculate discharge and fine sediment mobilization.

METHODS

Detailed methods for collecting and processing sediment and discharge data are described in Black & Luce (2013). These methods use the difference in weight between wet sediment, a container mass, and the container full of water, adjusted by particle density, to calculate the weight of dry sediment. We will utilize the tripod method described in the protocol because we don't anticipate establishing sites that will collect over 200 lbs. of sediment. This method requires weighing buckets of sediment by suspending them from a 100 lb. capacity digital load cell attached to a tripod until all of the sediment in the settling tank has been processed. A 1 lb. sample will also be taken to the CWP water quality lab, dried, and processed to determine sediment particle density.

The tipping bucket attached to the settling basin consists of a container divided into two equal volumes that are balanced on an axel. One side of the container fills with water from the basin and eventually tips once it reaches capacity, which shifts the weight of the container on its axis so that the other side then begins to fill. Each tipping event is recorded and a time-stamp is logged using a reed switch and an electronic data logger installed in the housing for the container. Each tipping bucket is calibrated by passing a known quantity of water through the system and recording the number of times it tips. This is done at least three times using a range of expected discharge quantities in order to establish a discharge calibration curve. Data from the logger will be downloaded at each site visit and used to generate a hydrograph for the site.

Figure 11: Measuring sediment. Photo credit Black and Luce (2013)

The tipping bucket system also allows for measuring the overall amount of fine sediment suspended in water that flows through the system. This is done by installing a PVC pipe with a small slit cut in it below the point where the tipping bucket dumps out. The slit in the pipe is designed to collect a 5mL sample from each tipping event, which is routed into a 5gal bucket. A sub-sample from the 5gal bucket is then collected at each site visit and processed at the lab by oven drying the sample and weighing it to determine total suspended solids.

DATA QUALITY

All equipment used to collect data will be calibrated following procedures described in Black & Luce 2013. All laboratory procedures used to process samples will follow standard QA/QC procedures and utilize properly calibrated equipment to ensure accurate results. Samples will be sent to a third-party laboratory for processing if these requirements cannot be met at the CWP Water Quality Lab.

DATA STORAGE AND ANALYSIS

The total mass of sediment will be calculated for each settling basin after each sampling event. These totals will be combined to determine annual total mass of sediment at each site.

Total suspended sediment data collected from tipping buckets will also be combined with the total mass results from the settling basin to determine overall total mass of sediment.

Annual hydrographs will be developed from the data collected at each tipping bucket. Both peak and average flow data will be calculated from said hydrograph.

Interannual variability of annual total mass of sediment and discharge will be determined to assess differences between years. Between site variability will also be determined to assess differences between sites. These results will be used to determine the effectiveness of any actions taken by the CWP to repair or enhance roads networks.

All data will be stored locally in a CWP water quality database. Data will also be integrated into any GRAIP-based modeling efforts the CWP conducts (e.g. NetMap).

TIMETABLE AND STAFF REQUIREMENTS

Road plots and settling basins will be installed and maintained for multiple years in order to establish adequate datasets at each site. Efforts should be made to maintain and monitoring plots long enough to capture a range of wet season and storm event conditions. Equipment will be installed during the summer season. Routine site visits will be made monthly during the wet season, and additional visits will be made after every large storm event to assess site conditions and determine if sediment samples need to be processed.

Table 12: Sediment plot annual schedule

July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
	Install or maintain basins		Begin monthly service checks	Monthly service check	Monthly service check	Monthly service check	Monthly service check	Monthly service check	Monthly service check	Monthly service check	

Site visits and sample processing can be carried out by an individual staff member. Installation of equipment will be carried out by a minimum of two staff members.

PARTNERSHIPS / LANDOWNER PERMISSIONS / RELATIONS

The CWP works with private landowners to evaluate and enhance their road networks. Most of these landowners are private timber or agriculture based. We are confident that these relationships that have been built will allow for ample opportunities to deploy these monitoring efforts. Working on private road networks will be beneficial in that it will reduce the potential of equipment tampering or theft. However, opportunities to monitor public road networks will also be explored. We will engage with whichever public agencies have oversight over these road networks (e.g. USFS, BLM, etc.) and work in collaboration with them to ensure proper installation, maintenance, and security of equipment.

JUVENILE FISH TRAP MONITORING

INTRODUCTION

The CWP implements many efforts to protect and enhance habitat and water quality for multiple aquatic species. Many of these projects focus on just one or a handful of focal species, primarily salmonids. Coho salmon (*Oncorhynchus kisutch*) is one species that has received extra attention in recent years, primarily due to its listing as threatened under the Endangered Species Act.

Many recent restoration projects that the CWP has implemented are focused on restoring rearing habitat for juvenile coho, and provide a myriad of benefits for other species as well. Juvenile rearing habitat, in particular habitat for overwintering, has been identified as a primary limiting factor affecting coho survival. These rearing areas provide refuge for juvenile salmonids during high winter flows, offer cover to protect from predators, and are often areas with high biodiversity and nutrient availability. They allow juvenile salmonids areas to rest and feed, which can increase growth rates and enhance survival estimates throughout the outmigration journey to the ocean. While the focus is often on coho, these habitats offer additional benefits to other aquatic species as well such as Chinook, steelhead, and Pacific lamprey.

Traditional monitoring for juvenile salmonids is often done via summer snorkeling, electrofishing, or the use of traps. Many of the CWP's restoration sites are often located in low gradient side channel or floodplain locations with either low visibility or complexities that inhibit the use of these traditional monitoring methods. In 2012, the CWP partnered with ODFW to design and build two small, non-mechanical hoop-type traps designed to operate in these small, low gradient tributary systems. Over the past eight years these traps have been deployed during the spring season to monitor for fish presence in multiple watersheds. The results have provided presence/absence data and indications of when peak coho outmigration occurs, and have confirmed where juvenile coho utilize overwintering habitat.

The success of these hoop traps in their ability to effectively capture juvenile salmonids has sparked an interest in the CWP to enhance our protocols. The ability to examine abundance metrics, rather than just presence/absence, would allow us to understand not just if juvenile coho are utilizing these areas, but how many and how those numbers change over time. By monitoring covariates that are suspected drivers of outmigration, such as water temperature and flow, we would also be able to better understand outmigration dynamics. This would allow us to design restoration projects with those factors in mind, and better understand how those dynamics may change over time due to expected regional changes in climate.

While this plan is focused on monitoring for overwintering juvenile coho, details could easily be altered to monitor for other species as well, such as altering the monitoring season to capture juvenile fall Chinook outmigration. These additional monitoring opportunities will be explored in future planning efforts.

GOAL

Evaluate juvenile coho abundance, and outmigration patterns and influences in restoration focus areas, and how they change over time

OBJECTIVES

1. Identify and establish protocols for conducting mark-recapture surveys for estimating relative abundance
2. Identify and establish protocols for monitoring water temperature and stage and discharge at trap sites
3. Determine how data will be processed and analyzed to identify and isolate changes to local abundance vs overall population-level annual variability

SITE SELECTION

Trap sites will be located downstream of the area of interest. Best efforts will be made to install traps near the head of a pool, just downstream of fast flowing water. If the trap does not span greater than 90% of the wetted width of the channel, netting will be installed on either side of the trap to funnel fish towards the mouth of the trap.

When a trap site will also be monitored for water temperature and stage and discharge, a representative location will be selected near the trap that will allow for the installation of a stilling well. This is best installed next to a bank, outside of the primary flow channel, with a stable anchor point (e.g. large tree or boulder) that can be used to ensure accurate measurements.

Establishing multiple sites is encouraged whenever possible to enhance effectiveness data results. This will most often include monitoring a target subwatershed impacted by restoration and a nearby similar subwatershed to be used as a control. Utilizing this control-impact study design allows for a better understanding of how restoration efforts effect the impacted area. Monitoring in both subwatersheds before and after restoration efforts will also greatly enhance these results.

DATA GATHERING STRATEGY

Traps will be installed and run throughout the entirety of the average juvenile coho outmigration period, which runs from the first week of March until usually the first week of June. Traps will be sampled 3-5 days per week depending on capacity and funding, and stored out of the water on-site during non-sample days.

All species found in a trap during a sample run will be marked on a field data sheet. Salmonid species will further be classified into two groups: fry (<80mm) and smolts (>80mm).

Figure 12: CWP staff coordinating installation of a fish trap

Coho will also be classified as marked or unmarked. Unmarked coho will be transferred to a separate holding container, and all other specimen will be released downstream. Unmarked coho will be anesthetized, marked, and released upstream.

Sites monitored for temperature, stage and discharge will be done so using pressure transducers and routine discharge measurements taken to develop a seasonal stage-discharge relationship. At least one discharge survey will be conducted each month, and additional surveys will be conducted during or directly following storm events whenever possible.

METHODS

Running a trap, handling fish, and all mark-recapture efforts will be done following standard ODFW protocols. All participants in these efforts will receive annual training from a professional ODFW biologist prior to any sampling efforts. Traps will be inspected annually for repairs and maintenance to ensure proper functionality. All efforts will be made to sample traps at the same time on sample days to ensure that residence time in the trap does not exceed 24 hours in order to reduce the potential for excess stress or predation within the trap. Traps will be run as many days of the week as possible, given current funding and capacity. They will be run for the length of the outmigration period, and pulled only when juvenile coho are infrequently present and staff are confident that the majority of the outmigration season was captured. Traps stored on-site will be stored with the open-end against the ground to prevent terrestrial or avian wildlife from entering the trap. Traps will be pulled prior to any forecasted potential flooding events to prevent damage to traps or downstream property or habitat.

Sites that are monitored for water temperature and stage and discharge will be done following standard ODEQ and USGS protocols. Pressure transducers will be set to record stage and temperature readings every 15 minutes throughout the season. They will receive pre and post-season temperature audits, and three field audits throughout the deployment season. A second transducer will be deployed outside of the water to monitor atmospheric pressure unless a weather station is located within 10 miles of the site. Discharge measurements will be taken on a regular monthly schedule during the deployment season, and additionally during below or above average flows or immediately following storm events as conditions permit. Discharge will not be recorded at tidally influenced sites or sites where safe wading measurements cannot be taken.

DATA QUALITY

Fish data will be collected following standard protocols in order to maximize trap efficiency for highly accurate data and results. Routine trap efficiency estimates will be calculated throughout the sampling period and shared with ODFW biologists to ensure traps are properly operating.

Temperature data will be collected with the goal of achieving ODEQ data quality level 'A' data. This will be determined following standard ODEQ data quality analytical procedures. The CWP has a history of producing 'A' quality data in the past, and will aim to continue to do so by following all standard protocols.

Stilling wells and pressure transducers will be installed and operated following standard protocols [10]. Elevations of stilling wells will be surveyed in using professional survey equipment and known benchmarks to ensure as accurate stage data as possible. A second transducer will be installed outside of the water column if no professional weather station is located within a 10 mile radius of the site in order to conduct accurate barometric pressure compensation calculations.

Figure 13: Juvenile salmonid measured for length

All equipment used in sample collection and processing will be calibrated following standard protocols. Metadata associated with all of these QA/QC procedures will be stored locally alongside all processed data.

DATA STORAGE AND ANALYSIS

Data on all species present in the trap throughout the season will be tallied and summary statistics will be calculated for each species including total sum, variances, and daily, weekly, and monthly averages.

Juvenile coho salmon relative abundance estimates will be calculated following standard ODFW analytical procedures. Weekly estimates of trap efficiently will be calculated as long as enough fish we present to do so. If catch numbers are not high enough to estimate weekly efficiency, a single estimate of seasonal efficiency will be calculated instead. These data will be used to calculate abundance estimates and 95% confidence intervals.

Abundance estimates will be compared between years and between paired sites (treatment and control sites) whenever possible to assess difference between sites and changes over time. Temperature, stage and discharge covariates will also be examined using multivariate linear regression to determine their effects on abundance measures. Summer snorkeling data on juvenile coho will also be compared to trap abundance estimates to identify potential population-level patterns in the data. These comparative analyses will increase our confidence in any effects on juvenile coho abundance due to restoration efforts.

All temperature data will be processed to determine ODEQ data quality levels. Data that score out to be of 'A' quality will be used in additional analysis. Data that score out to be of 'B' quality may also be incorporated into additional analysis if an extensive review process can identify and account for any errors. Summary statistics will be calculated for each site, for every year it's monitored. Summary statistics include; daily max, mean, and min, 7-day average max, mean, and min, date of 7-day average max, average diel flux, 7-day average diel flux, and days above 18°C.

Stage and discharge data will be processed and a stage-discharge rating curve will be developed whenever possible.

All data will be stored locally in CWP databases. All fish-related data and results will be shared with ODFW. All temperature data will be shared with ODEQ for upload to AWQMS. The results of any and all analysis will be made available online at the CWP's website.

TIMETABLE AND STAFF REQUIREMENTS

Traps will be installed in early March and run through the majority of the outmigration season, usually until early June. They will run 3-5 days per week depending on available capacity and funding.

Sites monitored for temperature, stage and discharge will have stilling wells installed the summer before the first sampling season whenever possible in order to ensure proper installation and surveying can occur during low flows. Pressure transducers will be installed in stilling wells no later than at the time traps are installed. Transducers will be pulled and data will be downloaded following the removal of traps.

Table 13: Hoop trap annual schedule

July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
		Install stilling wells				Stilling well maintenance check		Install and run trap	Run trap	Run trap	Run trap and analyze data

Sites should be monitored for a minimum of one year prior to restoration project implementation, and at least 5 years post-implementation whenever possible. A comprehensive review will be conducted after this phase of post-implementation monitoring to assess evidence of restoration effectiveness and evaluate the project for potential adaptive management or monitoring efforts.

Two staff members will be required for the installation and removal of traps from a site. All other efforts can be carried out by one trained staff member.

PARTNERSHIPS / LANDOWNER PERMISSIONS / RELATIONS

All trapping efforts will be done in coordination with local ODFW biologists. ODFW will assist the CWP in obtaining all necessary permitting needed to handle and mark aquatic species. CWP will share all data and results with ODFW

The CWP has an extensive database of willing landowners and partners, and continues to work to build positive relationships with landowners to help guarantee long-term working relationships.

When pursing trap monitoring sites on private property, it will be made clear that these efforts may become long-term, ongoing ones. The high value of these long-term datasets will be made clear to landowners, and an open dialogue will always be encouraged. Routine reports will be created to provide landowners with the data that is collected on their property, and how that data is being utilized by the CWP. This open dialogue and data sharing will help to ensure long lasting, positive relationships between landowners and the CWP.

When pursing trap monitoring on public property, a local representative of the agency that manages the land will be contacted and made aware of our monitoring efforts. Efforts will be made to include these agency representatives in the monitoring process as much as possible. Routine reports will be created to provide the agency with the data that is collected on their property, and how that data is being utilized by the CWP.

The results of these monitoring efforts will be made available on the CWP website and disseminated to any and all interested parties. Potential interested parties include: ODEQ, ODFW, BLM, OPRD, USFS, WRLT, OWEB, OSU, and Curry County.

AQUATIC HABITAT SURVEYS

INTRODUCTION

The Aquatic Inventories Project (AIP) is a habitat survey protocol developed by the Oregon Department of Fish and Wildlife in order to, “provide quantitative information on habitat conditions for wadeable streams throughout Oregon”. ODFW has utilized this survey protocol since the early 1990’s for multiple state-wide projects and objectives. The CWP has been utilizing this protocol since 1998; primarily as a tool to assess habitat conditions, identify potential restoration projects sites, and as a project effectiveness monitoring tool.

The Partnership used this protocol on a number of streams between 1998 and 2005 as a project effectiveness monitoring tool in an attempt to assess the success of multiple restoration projects. Surveys were most often completed pre-restoration, one or two years post-restoration, and then again three to five years later. A comprehensive analysis of these surveys was in done in 2005 in an attempt to evaluate the effectiveness of this protocol as a project effectiveness monitoring tool. The results of this analysis were mixed. Some changes in habitat conditions were identified, and a good amount of that change was positive. However, the analysis also highlighted the amount of variability inherent in this protocol and how that variability can make it difficult to detect significant change on somewhat fine geographic (by reach) and temporal (annual to 3-5 year) scales. It also highlighted some potential issues inherent in a survey protocol that segments measurements into distinct categories, such as how key pieces of large wood and ‘stream size’ are categories that may not adequately represent all streams. Some of these concerns have also been identified in additional reviews and analyses of this protocol done by ODFW staff and outside researchers.

The application of the AIP protocol by the Partnership throughout the years has highlighted some of the strengths and weaknesses associated with this protocol. The results of these surveys provide a quality overview of a large number of parameters related to in-stream habitat quality for salmonids and other aquatic organisms. This information is valuable for land managers and agencies in guiding the decision-making process regarding how best to manage and restore habitat in these streams. The protocol can also be used as a tool for monitoring, but this application of the protocol should primarily be used as a broad scale, long-term assessment of change over time, and any project effectiveness monitoring efforts should be coupled with other, more fine-scale monitoring protocols focused on specific limiting factors within a specified reach.

This monitoring plan will build on the lessons learned from past habitat survey applications to make sure we are utilizing these surveys to their full extent while also recognizing their limitations.

GOAL

Establish how AIP surveys will be utilized as an assessment and monitoring tool to identify restoration project locations, develop project effectiveness monitoring plans, and aid in the adaptive management and monitoring process.

OBJECTIVES

1. Identify how AIP surveys will be utilized as an assessment tool
2. Establish ways in which AIP surveys will inform project effectiveness monitoring plans
3. Provide a framework for how the CWP will conduct surveys and work with partners to collect and share relevant, current, and accurate data

SITE SELECTION

Habitat surveys will be conducted in locations of interest for the CWP that are outside of the range of surveys conducted by ODFW. In areas that are routinely or have previously been surveyed by ODFW, the CWP will work with ODFW to obtain any relevant data and determine if additional surveys are required based on the objectives of the inquiry.

In CWP focus areas outside of ODFW survey locations, or are of interest in which the CWP lack comprehensive habitat information, basin (census) type surveys will be carried out throughout the entire area. This will consist of carrying out surveys of multiple reaches until all reaches within the area have been identified and measured. This will provide the CWP with a comprehensive understating of habitat quality and quantity, and how those change throughout the area of interest, and will allow for the identification of potential project areas.

DATA GATHERING STRATEGY

Habitat surveys will be carried out during the summer season when conditions are best to carry out the work effectively and efficiently. If a reach is suspected to potentially go dry it will be surveyed as early in the summer season as possible. Repeat surveys will be conducted as near to the date of the original survey as possible in an attempt to survey under similar conditions, excluding interannual variability.

Past CWP AIP surveys were conducted at a finer scale than standard ODFW surveys by measuring many parameters that are usually estimated and measuring every occurrence of certain parameters that the standard protocol calls for measuring a subset of. This was done to collect more fine scale data to conduct project effectiveness analysis with. The results of those analyses were inconclusive, so the CWP will carry out AIP surveys at the standard scale unless the use of additional measurements is deemed necessary and approved by ODFW.

Basin surveys will be conducted on all reaches within a focus area that meet the qualifications to be surveyed. These qualifications will be based on the most recent ODFW AIP survey methodology.

METHODS

The most recent version of ODFW Aquatic Inventories Project Methods for Stream Habitat and Snorkel Surveys will be used for all habitat surveys. These methods are sometimes updated by ODFW, and new surveys will be conducted using the most recent version. Repeat surveys of sections surveyed in the past will also use the most recent version unless the methods have been altered to a point where comparative analysis with past surveys is not possible. If this happens, CWP will consult with ODFW to determine how to proceed.

Figure 14: CWP Staff recording survey data

DATA QUALITY

Habitat surveys will be conducted following standard ODFW protocols. The CWP Monitoring Program Coordinator will attend an official ODFW training session to ensure that proper protocols are understood and followed. The Monitoring Program Coordinator is responsible for training additional CWP staff, and will coordinate with local ODFW staff if any questions or issues come up. ODFW and CWP staff will also conduct surveys together every couple of years to calibrate their application of standard protocols. This will help to ensure that data collection efforts carried out by the CWP are comparable to those collected by ODFW staff.

DATA STORAGE AND ANALYSIS

All data will be digitized, analyzed, and stored locally on CWP servers. Survey data will be digitized as soon as possible after each field day. Analysis will be conducted as soon as possible after the conclusion of the data collection season, preferably by a member of the CWP that was involved in data collection in order to address any potential issues that arise during the analysis process. Analysis will be done using standard ODFW techniques and programs to produce stream survey reports of each survey.

Stream survey reports completed for repeat surveys will be compared to past reports to determine any and all changes that have occurred over time, and the magnitude of those changes. Past analysis of repeat habitat surveys by the CWP highlighted difficulties in being able to quantitatively prove project effectiveness through survey results, so future comparative analysis of project sites will focus on describing broad scale, long-term changes in habitat conditions only. This analysis, while not specifically focused on proving project effectiveness, is still highly valuable for the CWP to best understand how current conditions are functioning and if there is need for any adaptive management efforts. Ideally additional monitoring protocols will be carried out as part of a project effectiveness monitoring plan, and the results of those efforts when paired with habitat survey results will provide a fuller picture of change over time and if project efforts were effective.

TIMETABLE AND STAFF REQUIREMENTS

Habitat surveys for assessment purposed will be carried out as opportunities become available. As the CWP moves forward with the development of focus areas and strategic action plans for watersheds, it is expected that opportunities will become available to utilize habitat survey results to identify and prioritize restoration project sites.

Table 14: Habitat survey annual schedule

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			Site identification	Landowner outreach	Conduct surveys	Conduct surveys	Conduct surveys		Data analysis		

Repeat habitat surveys will be conducted in locations where restoration projects are implemented as a result, at least in part, of the survey. If a project is expected to make extensive alterations to channel form and structure, a repeat survey will be conducted 1-2 years post implementation. Otherwise, repeat surveys will be conducted once every 5 years. This will allow the CWP to capture long-term broad scale changes at the site, which will allow opportunities to apply adaptive management if needed.

All surveys will be carried out by at least two trained staff members.

PARTNERSHIPS / LANDOWNER PERMISSIONS / RELATIONS

All habitat survey efforts will be done in coordination with local ODFW biologists. CWP will share all data and results with ODFW

The CWP has an extensive database of willing landowners and partners, and continues to work to build positive relationships with landowners to help guarantee long-term working relationships.

When pursing habitat surveys on private property, the objectives of these efforts will be made clear to landowners, and an open dialogue will always be encouraged. Reports will be created to provide landowners with the data that is collected on their property, and how that data is being utilized by the CWP. This open dialogue and data sharing will help to ensure long lasting, positive relationships between landowners and the CWP.

When pursing habitat surveys on public property, a local representative of the agency that manages the land will be contacted and made aware of these efforts. Efforts will be made to include these agency representatives in the process as much as possible. Routine reports will be created to provide the agency with the data that is collected on their property, and how that data is being utilized by the CWP.

4 PROJECT INTEGRATION AND IMPLEMENTATION

4.1 INTEGRATION OF PROJECTS

This plan has been developed so that each individual monitoring project is able to integrate into and inform the overarching focus areas and priorities of the WMP, which in turn help to best inform and advance the work of the CWP. This programmatic design provides the flexibility to develop and integrate new projects and project types, while also providing enough rigidity and structure to ensure that new projects are still working towards programmatic focus areas and priorities. This layering effect, in which individual, specific project goals help to inform more broad-scale priority goals, which help to inform even more broad-scale focus areas for the WMP helps to build sustainability and synergy throughout the WMP.

The WMP projects included in this plan are all primarily focused on one, or a few program priorities. This helps to keep each individual project focused enough that the goals of each are achievable given available resources and capacity. The more specific and focused a project's goals are, the less variability and unknowns will be associated with the resultant data, which helps to produce highly accurate and informative results. However, that does not mean that each project cannot help to inform other program priorities or focus areas. Many of the WMP priorities are interrelated in many ways due to the nature of ecology. For instance, the results of a project focused on monitoring summer water temperatures can also provide information pertaining to salmonid habitat or riparian vegetation, even if the project was not designed to directly inform those subjects. These secondary relationships are important because they can help inform and develop future monitoring projects or priorities. The WMP will consider these secondary priorities in project analysis and reporting whenever possible to identify additional potential results, conclusions, or considerations that could be beneficial to the program.

Future projects and priorities will be developed within this integrated framework to help ensure success and sustainability in both. The development of these projects and priorities will be based on a number of factors such as; data and observations from current monitoring projects, wants and needs of the CWP to address focus areas or projects, and wants and needs of the larger community. Aligning these wants and needs from both within and outside of the WMP will ensure programmatic success by ensuring future work builds on and integrates with current work, and helps to foster and grow relationships both within and outside of the CWP.

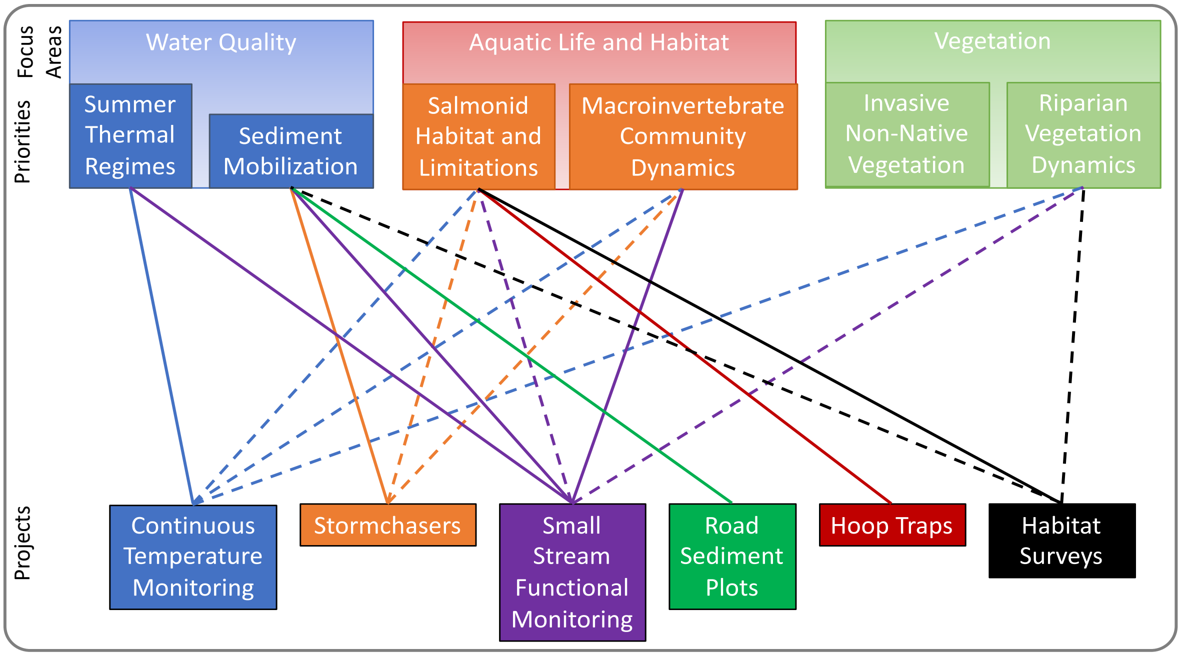

Figure 15: Relationship mapping of Focus Areas, Priorities, and Projects. Solid lines represent primary priorities that projects are focused on. Dashed lines represent secondary relationships in which a priority may not be the primary focus of a project, but which project results may still inform priorities development

4.2 PROJECT PHASES AND TIMELINES

Each monitoring project in this plan includes a section that provides a timeline of activities for each annual phase, or round, of the project. This timeline helps to outline and identify all the tasks associated with a project, and also helps to place the work required within the context of the entire WMP. These timelines, when mapped out in combination, will help the WMP identify the capacity needed to carry out all projects. This helps to ensure that all projects will be carried out to their full extent by allowing the WMP to properly forecast responsibilities far enough in advance to ensure the program is able to take on all projects.

Along with annual timelines, some monitoring projects included in this plan also have associated phases. Each phase represents the amount of time and resources needed to reach short-term goals of the project. These phases are designed to allow for adaptive management and monitoring techniques to be applied to projects by establishing check points (i.e. the end of a phase) where the results of the project can be reviewed, effectiveness can be evaluated, and adjustments can be made if need be. This helps to ensure that projects can grow and evolve to ensure high quality short-term and long-term data collection. Tracking of these phases, what needs to be completed at the end of each phase, and needs to implement the next phase of a project (e.g. pursuing additional funding, outreach to partners, etc.) will be continuously managed by the WMP Coordinator.

Table 15: Annual schedule of all projects

Project	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperat-ure		NIST thermos-meter audits		Thermist-or audits	Deploy thermistors		Mid-season audit		Collect thermistors		Thermi-stor audits	Data analysis
Storm Chasers	3 Storms sampled					Data analysis	Volunteer recruiting	Volunteer recruiting	Potential sample run	3 Storms sampled		
SSFM				Pre-season audits		Deploy therm-istors	Mid-season thermistor audit and all other surveys		Collect thermistors		Thermistor audits	Data analysis
Road Sediment Monitoring	Service check and collect samples	Service check and collect samples	Service check and collect samples	Service check and collect samples	Service check and collect samples		Install or maintain equipment		Service check and collect samples	Service check and collect samples	Service check and collect samples	Service check and collect samples
Hoop Traps			Install and run trap	Run trap	Run trap	Run trap	Data analysis	Install stilling well equipment		Install loggers		
Habitat Surveys				Site identification	Landowner outreach	Conduct surveys				Data analysis and reporting		

4.3 PARTNERSHIPS AND PROGRAM ACCOUNTABILITY

The formation of strong, sustainable partnerships is crucial for the long-term success of both the CWP and the WMP. Partnerships help ensure that the work being done is of the highest quality possible, and the results of the work are able to be widely disseminated and utilized. The WMP has worked with a variety of partners over the years. Many of these partnerships have been with state and federal agencies, and have also included other local groups and academic institutions. These partnerships have helped to enhance monitoring projects by providing technical expertise for all portions of a project from development to data analysis, assistance in carrying out monitoring efforts, training for specific methods and protocols, and access to needed equipment and technologies.

Table 16: CWP Potential and Identified Partners

Partner	Potential Opportunities
Oregon Department of Environmental Quality (ODEQ)	Monitoring efforts related to water quality monitoring data collection and analysis
Oregon Department of Fish and Wildlife (ODFW)	Monitoring efforts related to aquatic and terrestrial species (e.g. salmonids, macroinvertebrates) data collection and analysis
Oregon Department of Agriculture (ODA)	Monitoring efforts related to agricultural practices or focused on agricultural lands
Natural Resource Conservation Service (NRCS)	Monitoring efforts primarily focused on, but not limited to, agricultural lands and practices
Bureau of Land Management (BLM)	Any and all monitoring related activities on BLM public lands and/or related to BLM goals and priorities
Oregon Parks and Recreation Department (OPRD)	Any and all monitoring related activities on OPRD lands and/or related to OPRD goals and priorities
U.S. Forest Service (USFS)	Any and all monitoring related activities on USFS lands and/or related to USFS goals and priorities
Oregon Water Resources Department (OWRD)	Monitoring efforts related to water quantity data collection and analysis
U.S. Geological Survey (USGS)	Monitoring efforts related to water quantity and quality monitoring data collection and analysis
Oregon State University (OSU)	Academic research or access to experts and studies related to monitoring efforts
Wild Rivers Land Trust (WRLT)	Any and all monitoring related activities on WRLT lands and/or related to WRLT goals and priorities

Partnerships will continue to be pursued for any and all relevant instances. In addition to pursuing partnerships for specific projects, the WMP will also look to establish and nurture partnerships at the programmatic level by assembling a monitoring work group of all interested local and regional potential partners. This work group will be focused on identifying and understanding limiting factors related to watershed functions and services within the CWP's service area.

The establishment of partnerships helps to keep the WMP accountable by providing ample opportunities to share data and results from projects. The WMP will also work to uphold that level of accountability beyond just partners by publishing the results of all projects on the CWP's website (www.currywatersheds.org) and making other data and results available to the public. The WMP will utilize available technologies and services to make project data and results easily understandable and digestible to a general audience in order to ensure that the local community understands the results of the WMP's work, and how those results relate to all the work the CWP does.

4.4 FUTURE PROGRAM NEEDS

This plan does not lay out everything the WMP will do, nor everything the WMP needs, in order to be successful for the foreseeable future. It would be impossible for this plan to predict every priority or project type that will be implemented over the next few decades, and the potential funding or partnership opportunities that could make the implementation of those projects and priorities possible. This is at least in part due to our ever-evolving understanding of our watersheds' functions and services, how they change over time, and how our actions impact them; as well as the ever-evolving sciences and technologies that allow us to better understand them. This final section of the plan acknowledges those future potentials by identify some of the concepts, technologies, and potential additional focus areas that could aid in the growth and development of the WMP into the future.

Citizen Science

One concept that has already proven to be vital to the WMP, and could be an even more useful tool in the future, is the application of citizen science. Engaging with citizens and utilizing volunteers can have innumerable benefits for a program like the WMP. Utilizing volunteers for data collection efforts, given the proper training and considerations, can greatly increase the amount of work that the program can get done, and the number of projects it can take on. It also instills stewardship in and educates the community, which are high priorities for the CWP. Outside of the CWP, citizen science is a topic that is currently gaining a lot of momentum in both academic and government institutions. The need to engage citizens more in the scientific process has been recognized by these institutions, and an increasing number of programs and priorities are coming online to address this need. By engaging in citizen science whenever possible, the WMP can position itself to take full advantage of these opportunities for both the sake of the program and the local community.

Additional Priorities and Projects

The monitoring priorities and projects identified in this plan are based on past monitoring efforts and current CWP projects and needs. However, there are a number of additional projects and priorities that could be developed in addition to the ones in this plan, given the capacity and identified need to do so. The following list of priorities are ones that have been identified by the CW, but are either of lower priority than those included in the plan, or are ones that will require additional capacity to develop.

- Recreational water quality: There are currently multiple programs outside of the CWP that monitoring for some aspects of recreational water quality. However, this monitoring is not carried out consistently across the CWP's service area. Additional recreational water quality monitoring efforts could help fill gaps and inform citizens of potential issues surrounding water quality.
- Estuary and lower watershed floodplain and wetland monitoring: Increasing attention is being given to coastal estuaries and floodplains as their importance to many aspects of watershed health are becoming better understood. The CWP is increasingly focusing our efforts on understanding and addressing these issues. Many of the projects in this plan can be utilized in these efforts, however additional monitoring focused specifically on these habitat types will better enable the CWP to best understand and act on limiting factors affecting them.
- Upland monitoring: The vast majority of the WMP's efforts to date have focused on in-stream and stream adjacent ecosystems. However, the CWP has begun to take on more projects focused on managing and addressing issues in upland ecosystems, such as oak and meadow habitats. Monitoring efforts to better understand these systems and the effectiveness of our efforts would be highly beneficial for the CWP.

Developing technologies

The number of technological innovations being made available to the world of natural resource monitoring has been growing exponentially for a number of years now. As these technologies evolve, they eventually become more readily available and accessible to organizations like the CWP. The WMP will work to remain up-to-date on available technologies that could be utilized by the program. This includes technological advancements in both hardware and software that can be used to enhance data gathering, analysis, and reporting.

There are many developing pieces of hardware that could be highly beneficial to the WMP. One example is the growing use of unmanned aerial vehicles (UAVs), or drones, to rapidly collect large amounts of data such as aerial imagery or LiDAR. Once the costs of running a drone and the associated sensors and tools become more accessible, this could be a highly valuable tool to utilize in many data collection efforts. Another subject of hardware that could be highly beneficial to the WMP is continuous water quality monitoring probes and sensors. While these technologies have been quite expensive for many years now, more available options, including crowdsourced, community driven projects are making these technologies more readily available.

The amount of current development in regards to software is even more expansive than hardware. One example is the large number of applications and programming languages that are being utilized for data collection and visualization to help in the collection, analysis, and reporting of all types of data. These apps, many of which are free, can help to explain and display data in ways in which the general public can easily understand and engage with. Many apps can also be utilized by the public to easily engage in citizen science activities.

The WMP will work to stay up-to-date on these emerging hardware and software technologies, and will work to integrate any that may be beneficial to current or future monitoring projects.

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APPENDIX 1:

PAST PROJECT REVIEW SUMMARY REPORTS

Project Name	Summer Estuary Diurnal Water Quality
Year(s) Monitored	2004, 2005, 2006, 2010, 2011
Watershed(s) Investigated (HUC12)	Lower Sixes River (2004) Lower Elk River (2005, 2011) Euchre Creek (2005, 2011) Gold Beach – Rogue River (2005, 2010, 2011) Lower Hunter Creek (2004) Jack Creek – Chetco River (2010, 2011) South Fork Winchuck River (2004)
Parameter(s) Measured	Temperature, DO, pH, Salinity, Turbidity, Specific Conductance, E. coli, Nitrate+nitrite, 5 Day BOD, Total Phospherous

Project Overview

This project took place in multiple estuaries throughout the CWP service area during the summers of 2004 through 2006, and a number of those surveys were repeated in 2010 and 2011 (Elk, Euchre, Rogue, Chetco). The results of the 2004-2006 surveys were finalized in the final report, "Tidal Circulation, Nutrient Capture & Oxygen: Rearing Stress in Oregon South Coast Estuaries." The 2010-2011 results were included in the report, "Water Quality for Summer Rearing and Sources of Nutrients Elk River, Euchre Creek, Rogue River, and Chetco River Estuaries of the Southern Oregon Coast 2010-2011."

The goals of this project were to: 1) determine the magnitude and duration of dissolved oxygen (DO) and pH impairments, and 2) identify mainstem and tributary nutrient sources for the estuaries. The impetus for the project was due to concerns of eutrophication causing high amounts of algae growth in these relatively small estuaries during the summer season. These high amounts of algae can lead to low DO levels as they decay due to bacteria that use up the oxygen via respiration as they process the algal organic matter. This can lead to hypoxia (DO < 5mg/L) or anoxia (DO < 2mg/L) which can be harmful and even lethal to juvenile salmonids and other aquatic organisms. The state standard for DO set by DEQ is: 8.0 mg/L or 90% saturation for freshwater and 6.5 mg/L in saltwater (>200µS).

Three 24-hour sampling events were conducted for each estuary during the summer season (June – Sept.). Two multi-parameter data sondes were deployed during each event that sampled for temperature, DO, pH, and salinity at 15-minute intervals. Grab samples were also taken at multiple locations throughout the estuary every 2-3 hours from dawn to dusk during the sampling events. These grab samples were analyzed for multiple parameters (see Parameters Measured in header table) in an attempt to determine nutrient inputs and better understand the overall water quality of the estuaries.

Results and Discussion

The following results are based primarily on interpretations from summary plots (see Summary Statistics section) and some takeaways highlighted in the original reporting of these surveys.

Sixes – Dissolved oxygen and pH experienced a fair amount of variability overall, with more variability present in mid-summer compared to later sampling dates. Some pH samples were quite high, but the overall average was within an acceptable range. DO dipped below the Oregon DEQ state standard at times, but on average was above said standard. Temperatures were, on average, quite warm. Salinity and specific conductance were quite low, presumably from the estuary mouth closing due to wind action creating a bar-bound estuary that inhibits ocean tidal influence for at least a portion of the summer. Overall results are similar to other estuaries and are representative of the bar-bound, lagoonal estuarine conditions found in many of our south coast watersheds.

Elk – Grab sample results from 2005 were quite similar to 2011. DO and pH experienced diurnal patterns as expected of high peaks in the afternoon likely due to photosynthesis and dips at night likely due to respiration. Extreme peaks were presumably due to ebb tide waters draining backwater areas that experienced more respiration and photosynthesis due to stagnant conditions. Average temperatures were quite warm.

Rogue – Grab sample results from 2005 were quite similar to 2011. DO and pH experienced diurnal patterns as expected of high peaks in the afternoon likely due to photosynthesis and dips at night likely due to respiration. Extreme peaks were presumably due to ebb tide waters draining backwater areas that experienced more respiration and photosynthesis due to stagnant conditions. Average temperatures were quite warm. It was noted in the 2011 report that 2011 was abnormally cooler year in terms of water temperatures and flows were higher than average.

Hunter – The overall range of variability of grab samples is similar to other estuaries sampled. From the reporting, it appears that DO and pH exceed Oregon state standards, at least for a portion of the day, in primarily freshwater sample sites. This occurs in most sites when the mouth of Hunter Creek is bar-bound and closed off from ocean tidal saltwater inputs, and it occurs in the upstream most sites when the mouth is open. This is likely due to large amounts of algal growth that occur upstream of the saltwater influence.

Chetco – Both DO and pH experienced diurnal variability, more-so than the Rogue. There was some evidence that backwatering upstream of the salinity wedge could have been causing DO to drop below the state standard for extended periods.

Winchuck – Only one sample site was located in freshwater conditions, and this was the only site that had issues meeting the DO standard multiple times during the sampling period. All other sites met water quality standards, although average temperatures were somewhat high. The mainstem Winchuck has shown evidence of having low average pH levels, which helped regulate pH in the estuary to not exceed state standards. Some samples had quite high turbidity and nitrate+nitrite levels, but the overall averages were quite low and similar to other estuaries.

The results and discussion of 2004-2006 surveys in the final report, “Tidal Circulation, Nutrient Capture & Oxygen: Rearing Stress in Oregon South Coast Estuaries” were difficult to interpret due to questions regarding potential errors that arose during this review that were not adequately addressed in the report. A majority of these questions were of the analytical processes that were used. Some of the analysis in the report did not accurately reflect relationships between DO and nitrogen. This analysis attempted to see if there was a correlation between nitrate concentrations and peak DO. However, the disparate time-scales and sampling locations used in this analysis compound the variability between these measurements to the point where the interpretation of results that followed is likely an invalid representation of this relationship. The magnitude and duration of change of DO analysis did provide some valuable information, however the sorting of the data within the graphs and the accompanying narrative explanations didn't adequately highlight what the important takeaways of these results were, and made comparison between sites and between years difficult. The report also used other data, such as discharge, in some of the analysis with no reference to where that data were sourced, attempted to account for variables that are not clearly laid out or measured (e.g. amount of tidal restriction), and introduced additional hypothesis and variables throughout the report (including in the discussion and conclusion) that made it difficult to parse out what the most important information and takeaways are from this report.

The 2010-2011 report did a better job of 'telling the story' of the results of the analysis. Results are broken up by watershed, datasets used in the analysis are better referenced, the variables used in the analysis are more consistent throughout the report, and the overall report is more focused with less additional hypothesis and tangents presented. The 2010-2011 report was more focused on the diurnal data collected from the multiparameter data sondes and grab samples and characterizing the estuarine functions represented in said data. This report did still make assumptions of covariates that were not directly measured in this study such as tidal restrictions, wind action, and the spring transition anomaly (when shifting wind and ocean conditions cause increased upwelling of ocean-sourced nutrients in the spring) in order to attempt to explain variability in the dataset.

Data Overview (Quality and Future Value)

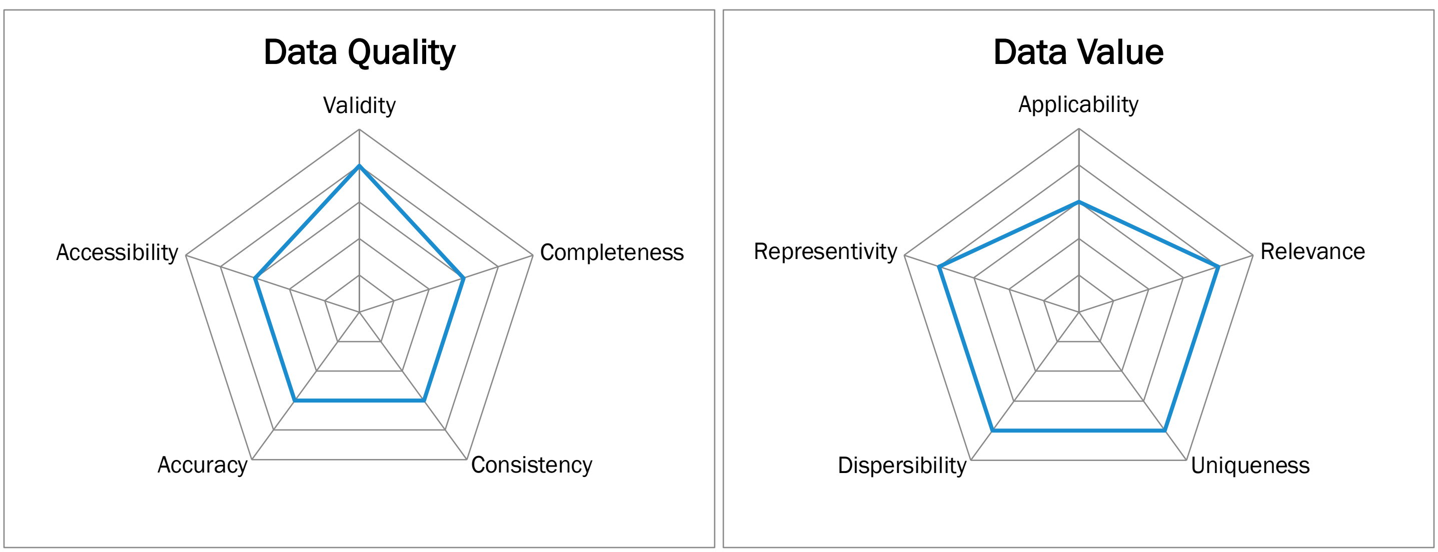


Figure 16: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

The data collected that is still available is of adequate quality, however some of the data could not be located and therefore a full assessment of the quality of the data used in this project could not be completed. The data collected in 2004 and 2005 are available, however all of the data from 2006 that is referenced in the final report could not be located. Of the available data, they appear to mostly be valid measurements that were collected using approved protocols that followed a rigorous QA/QC procedure. The only apparent issue was associated with the nitrate+nitrite samples. The Curry Watersheds Partnership was processing nitrate+nitrite samples in-house for some time until a potential issue was identified when our samples were not falling within an acceptable margin of error when compared to DEQ split samples. This issue was not identified until after the 2006 sampling period. All 2010-2011 samples were sent to a lab for analysis in order to avoid this potential sampling error. Additionally, no DEQ data acceptance for the data could be found so a final grade for overall accuracy of the data is unknown. Further investigation into data accuracy would need to be done if this data were to be utilized in the future.

The value of the data as it pertains to current and future monitoring efforts is somewhat good, albeit a more extensive analysis would need to be completed in order to fully assess said value. The data does provide some valuable qualitative information pertaining to estuarine water quality and the potential limiting factors in said estuaries relevant to the times they were sampled, and therefore could be valuable for an assessment or review of historic conditions in these estuaries.

Summary

This was an ambitious project that attempted to answer a lot of important questions pertaining to estuarine water quality. It's clear from the report that the knowledge base of those involved in the project design was sound, and for the most part the data collection efforts were of high quality. However, the overall project design and analysis could have been improved with more focused questions going into the project and a better idea of how the data would be analyzed and utilized following data collection. The analysis of the data appears to have resulted in many questions that were attempted to be answered with a combination of additional data sources and professional knowledge of how these estuaries function, however parsing out where the additional data came from and a lack of detail in how some of the conclusions related to specific estuary functions complicated the review of this project.

The data that were obtained are of good quality, and could be useful information pertaining to the recent history of these estuaries in order to understand what potential limiting factors could be of issue today. The final report addresses multiple influencing factors on estuarine water quality such as climatic conditions, flow levels, summer estuary mouth restriction, and others that would be important parameters to consider documenting in relation to estuarine water quality monitoring. The data could potentially be integrated into future estuarine water quality monitoring, but it would require a more extensive assessment of the data and specific considerations during the project design phase.

Summary Statistics

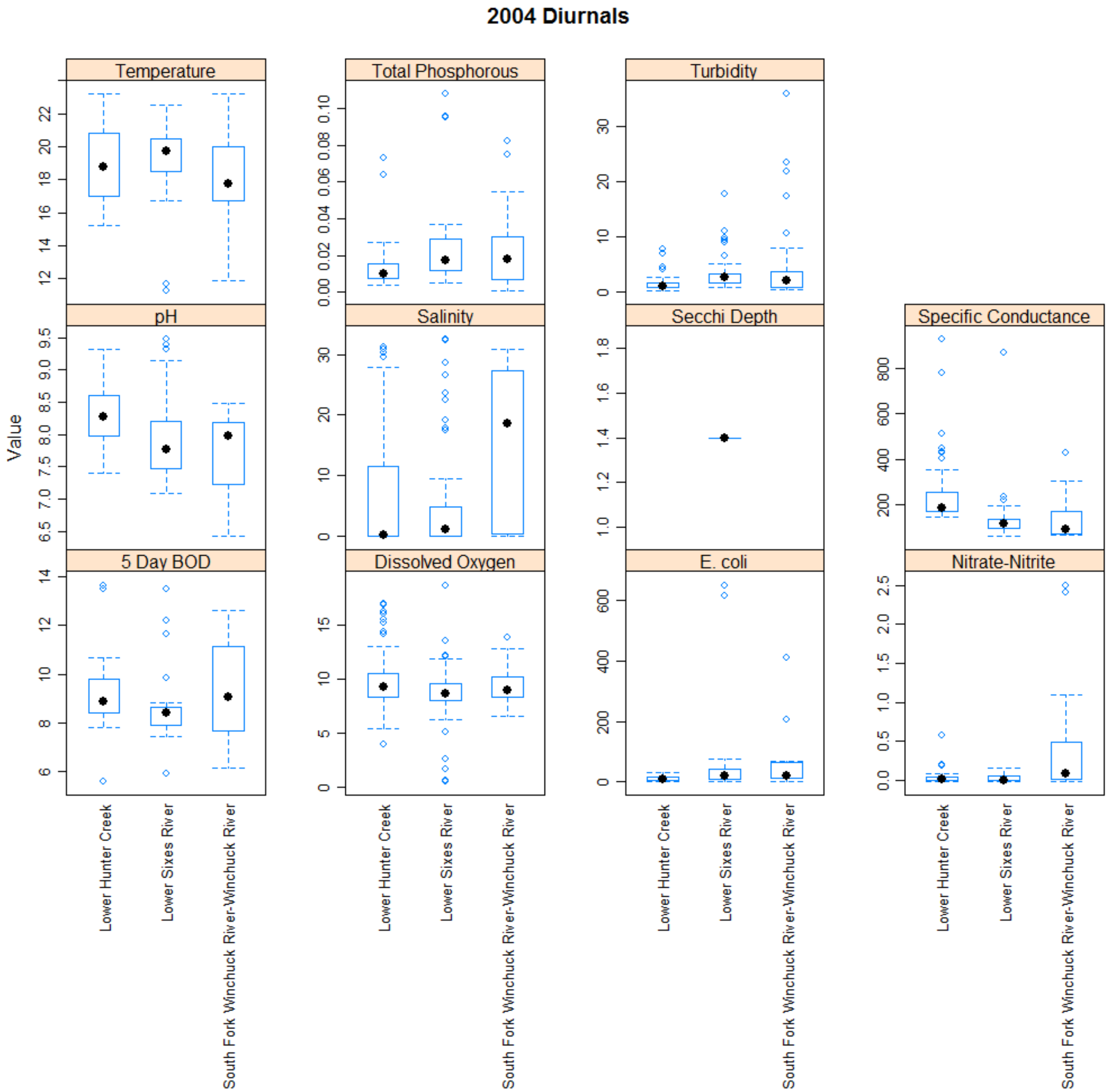
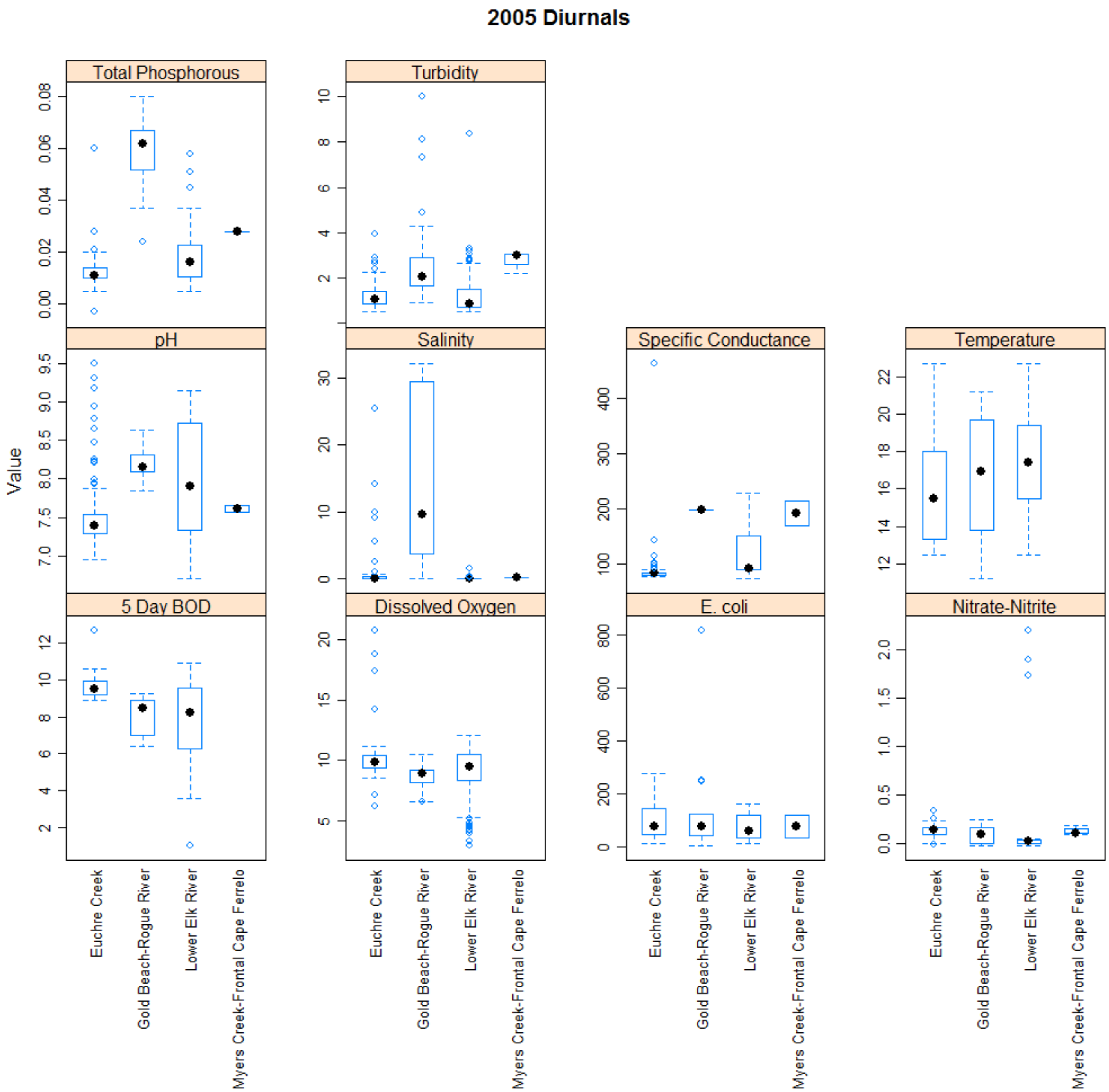
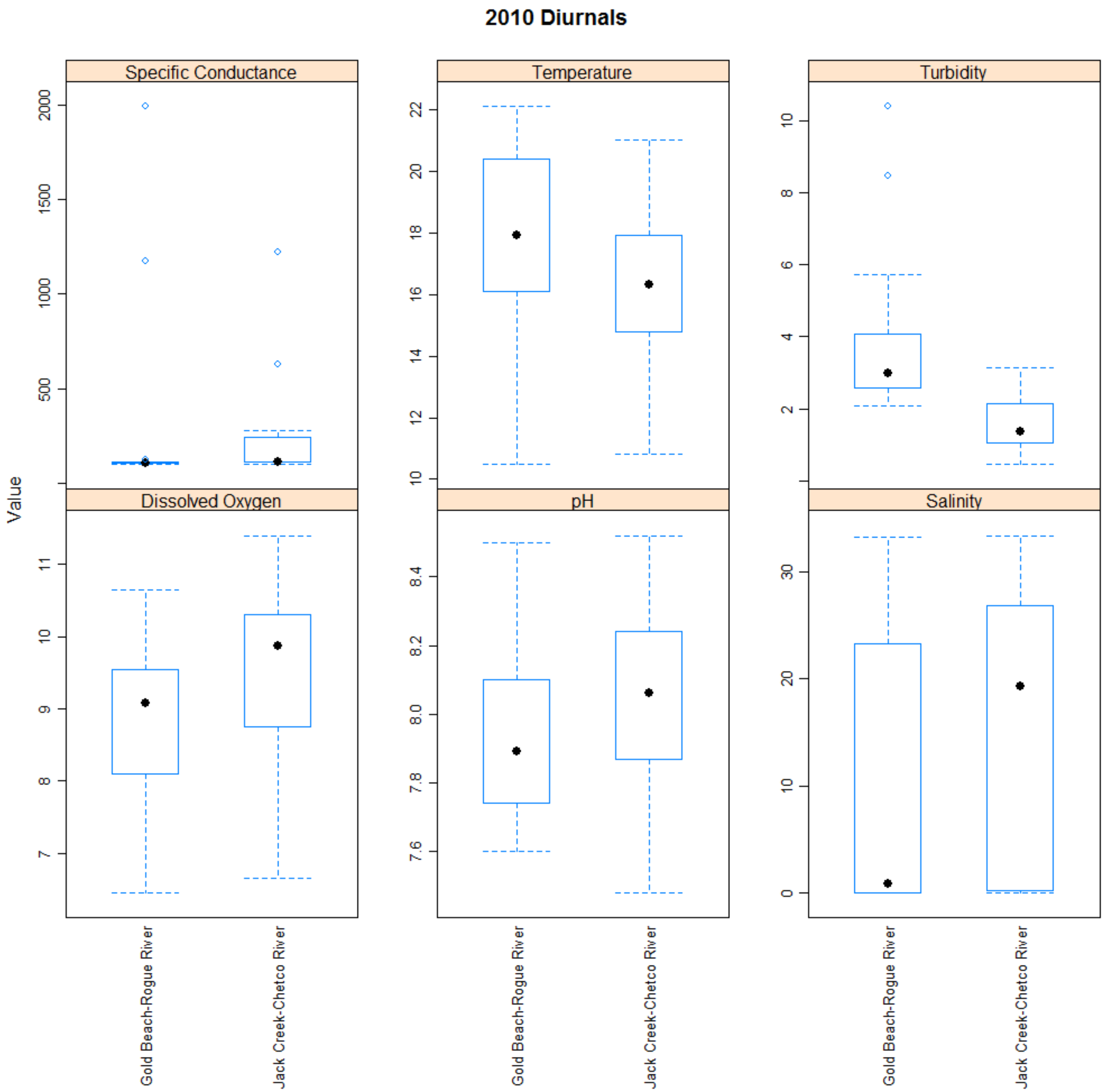
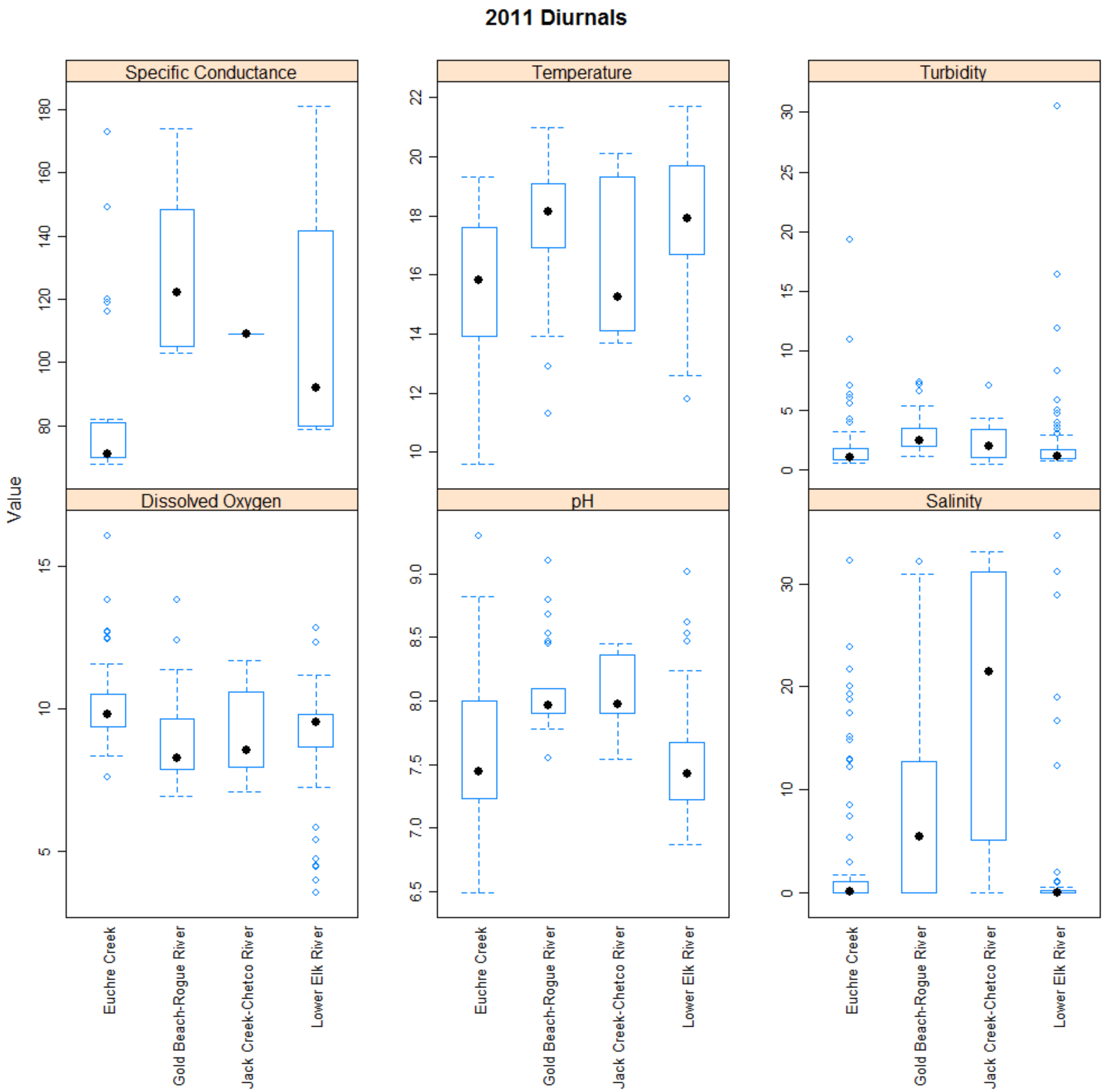


Figure 17: Boxplots of Data by Parameters and Watershed.

Units of measurement: Temp – deg. C : Total P – mg/L : Turbidity – NTU : pH – SU : Salinity – ppt : Specific Conductance - µS/cm : 5 Day BOD – mg/L : DO – mg/L : e. coli – MPN/100mL : Nitrate-nitrite – mg/L


2005 Diurnals
Value
Total Phosphorous
Turbidity
pH
Salinity
Specific Conductance
Temperature
5 Day BOD
Dissolved Oxygen
E. coli
Nitrate-Nitrite
Euchre Creek
Gold Beach-Rogue River
Lower Elk River
Myers Creek-Frontal Cape Ferrelo


2010 Diurnals
Specific Conductance
Temperature
Turbidity
Dissolved Oxygen
pH
Salinity
Value
Gold Beach-Rogue River
Jack Creek-Chetco River
Gold Beach-Rogue River
Jack Creek-Chetco River
Gold Beach-Rogue River
Jack Creek-Chetco River



2011 Diurnals
Specific Conductance
Temperature
Turbidity
Dissolved Oxygen
pH
Salinity
Value
Euchre Creek
Gold Beach-Rogue River
Jack Creek-Chetco River
Lower Elk River

Project Name	Aquatic Inventories Project (AIP) Habitat Surveys
Year(s) Monitored	1998, 1999, 2000, 2001, 2002, 2003, 2005, 2008, 2009, 2012, 2013, 2014
Watershed(s) Investigated (HUC12)	*Crook Creek: Crook Creek – Pistol River 171003120404 *Indian Creek: Lower Elk River 171003060302 *Jacks Creek: Jack Creek – Chetco River 171003120111 *Farmer Creek: South Fork Pistol River 171003120403 *Dan's Creek: unknown *Mill Creek: Nook Creek – Chetco River 171003120109 *Indian Creek: Gold Beach – Rogue River 17100310803 *Boulder Creek: Euchre Creek - 171003060403 *Edson Creek: Middle Sixes River 171003060202 Bethel Creek: Morton Creek – Frontal Pacific Ocean 171003060104 Butte Creek: Morton Creek – Frontal Pacific Ocean 171003060104 Saunders Creek: Gold Beach – Rogue River 171003100803 South Fork Floras: Floras Creek 171003060102 Morton Creek: Morton Creek – Frontal Pacific Ocean 171003060104 Cedar Creek: Euchre Creek 171003060403 *Locational data of survey reaches unknown
Parameter(s) Measured	A variety of parameters associated with in-stream habitat related to factors such as pools (# of pools, pool types, width and depth, tail-out depth), channel dimensions (active channel width, wetted width and depth, entrenchment ratio), erosion, large woody debris (# of pieces, volume, # of "key pieces" (≥10m x 0.6m))

Project Overview

The Aquatic Inventories Project (AIP) is a habitat survey protocol developed by the Oregon Department of Fish and Wildlife in order to, "provide quantitative information on habitat conditions for wadeable streams throughout Oregon" (ODFW 2019). ODFW has utilized this survey protocol since the early 1990's for multiple state-wide projects and objectives. The CWP has been utilizing this protocol since 1998; primarily as a tool to assess habitat conditions, identify potential restoration projects sites, and as a project effectiveness monitoring tool.

The Partnership used this protocol on a number of streams between 1998 and 2005 as a project effectiveness monitoring tool in an attempt to assess the success of multiple restoration projects. Surveys were most often completed pre-restoration, one or two years post-restoration, and then again three to five years later. A comprehensive analysis of these surveys was in done in 2005 in an attempt to evaluate the effectiveness of this protocol as a project effectiveness monitoring tool (Edgar and Swanson 2005). The results of this analysis were mixed. Some changes in habitat conditions were identified, and a good amount of that change was positive. However, the analysis also highlighted the amount of variability inherent in this protocol and how that variability can make it difficult to detect significant change on somewhat fine geographic (by reach) and temporal (annual to 3-5 year) scales. It also highlighted some potential issues inherent in a survey protocol that segments measurements into distinct categories, such as how key pieces of large wood and 'stream size' are categories that may not adequately represent all streams. Some of these concerns have also been identified in additional reviews and analyses of this protocol done by ODFW staff and outside researchers (Strickland et al. 2018, Tippery et al. 2010, Jones at el. 2014).

Those same reports that identify concerns also highlight the benefits of this protocol, at least when used as a regional effectiveness monitoring tool. The CWP has since used the protocol on a handful of streams both as a project monitoring tool and as an initial habitat assessment tool to identify potential restoration project locations. These later surveys highlight the benefits of using this protocol as an assessment tool, and the amount of documentation and metadata available has allowed us to perform a comprehensive review and suggest strategies to enhance the effectiveness of this protocol in the future. The extensive use of this protocol, both on a local level by the Partnership and state-wide by ODFW, has helped to highlight both the weaknesses and advantages of this protocol. This deep knowledge-base will allow us to best understand how to utilize this protocol in future monitoring and assessment efforts.

Results and Discussion

A comprehensive review of each stream in the Partnership's service area that has been assessed and/or monitored using this protocol was outside of the scope of this review. This is primarily due to the amount of and type of information generated by each survey, and the variety of assessment methods that have been used over the years. This section of the review will therefor focus on the general application of this protocol over the years, rather than the results of each individual survey. Further information pertaining to individual surveys can be found in each project's final reporting which is available upon request from the Partnership.

Initial application of the protocol in the late 1990's and early 2000's, and well as the 2005 review, revealed some of the limitations of the protocol. In particular, it highlighted the broad-scale nature of many of the protocol's measurements, at least as it pertains to using the protocol as a project effectiveness monitoring tool. One of the strengths of the protocol is that it is able to summarize a large number of important parameters related to the geology, geomorphology, and hydrology of a stream reach. The other side of the coin, however, is that it does not examine the drivers behind many of those parameters. This makes it difficult to determine causation behind changes observed, especially on a small time (<5 years) and geographic (reach) scale. This was highlighted in the 2005 review of habitat surveys up to that point. Application of the AIP protocol by ODFW staff for regional effectiveness monitoring has also identified this limitation of the protocol (Tippery et al. 2010, Jones et al. 2014). These reports also recommend pairing the AIP protocol with additional monitoring efforts that are able to monitor parameters of interest at a finer scale (ex: longitudinal and cross sectional surveys, pebble counts, flow measurements, etc). Pairing the AIP protocol with additional monitoring protocols can help strengthen ones overall understanding of habitat quality in a reach and increase ones effectiveness to best monitor and understand change over time.

Another issue identified in the 2005 report is the use of categorical benchmarks to measure restoration success. The original habitat benchmarks of "desirable" and "undesirable" rankings of metrics can be too general to be used to determine short-term success of a restoration reach. These benchmarks are generalized to represent conditions in an 'average' stream reach, and should not be used as a final determination of the status of an individual reach. They should instead be but one tool in the overall tool-kit used to assess a reach's habitat condition and change over time. For instance, a significant change in a metric between years, even if it does not alter the metric's benchmark ranking, is an important piece of valuable information that should not be downplayed because it didn't reach "desirable" status. Additionally, complex models have been developed in more recent years that aim to better quantify survey results in terms of habitat quality for salmonids across multiple life-history stages. These models are the Habitat Limiting Factors Model (HLFM) and HabRate, both of which warrant further investigation into their applicability in future monitoring efforts.

The applications of this protocol as a monitoring tool have revealed some of the inherent difficulties associated with repeat surveys that are important to note for future monitoring efforts. Using this protocol as a pre and post-project monitoring tool on channel relocation or re-meander projects is difficult because of the difficulty associated with making repeat measurement following such extensive alteration to the stream. Similarly, changes to reach locations, segmenting of old reaches, or additions of new reaches between years can compound the comparative analysis of changes to stream reaches between the years. Maintaining consistent reach locations between years and including control reaches upstream of target reaches can streamline the analysis process and make it easier to tease out significant change over time.

More recent AIP surveys conducted by the Partnership have shown the effectiveness of using these surveys as an initial assessment of habitat quality in order to better understand a stream and identify potential restoration reaches. These assessments were informative of habitat conditions, and the final reports made suggestions for future restoration actions. This information can then be used to help justify restoration, and guide monitoring efforts by identifying which habitat associated parameters are limiting factors that may require more focused monitoring efforts in order to assess project effectiveness and allow for adaptive management and monitoring. Follow up surveys 5+ years after restoration may be useful to track long-term, broad-scale change over time.

Data Overview (Quality and Future Value)

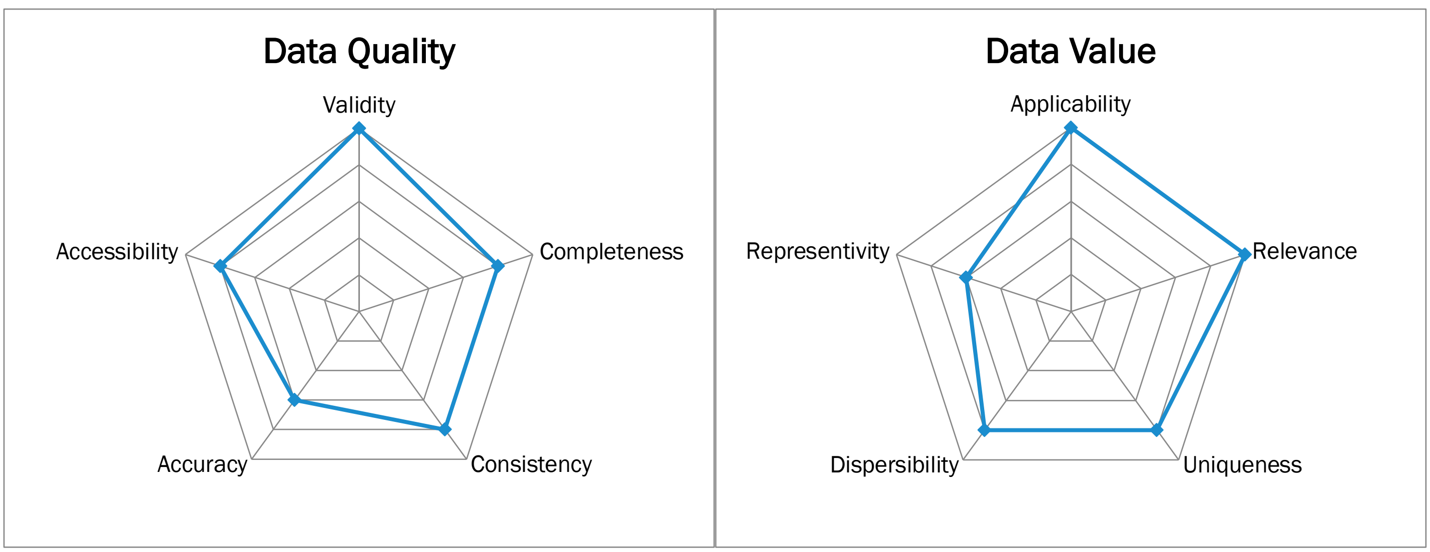


Figure 18: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

Validity: All data are in the correct format.

Completeness: Some surveys appear to be missing values, but there are enough surveys with complete data to conduct future analysis. The riparian portion of the AIP protocol was not conducted on a majority of the surveys so this portion of the protocol cannot be included in comparative analysis.

Consistency: The data was all collected following the AIP protocol, with a few modifications to increase the accuracy of some of the measurements. However, the AIP protocol has changed slightly over the years but these changes should not inhibit statistical comparison between years.

Accuracy: There is not a QAQC procedure for habitat surveys, and repeatability amongst multiple surveyors can increase variability in the results.

Accessibility: There is an in-house Access database with most of the raw data, and the rest can be integrated into the database. The database can also analyze the data and produce results reports, many of which have already been done. However, locational data of a number of the surveys could not be found.

Relevance: These surveys have informed projects before and have been used as a project effectiveness monitoring tool. These could also be used in the future to assess changes in habitat conditions over time and assess broad scale long-term success or weaknesses of past restoration projects.

Uniqueness: Similar other surveys that summarize a number of different parameters have also been done on some of these streams (ex. Proper Functioning Conditions Assessment) as well as survey types that examine similar parameters at a different scale (ex. thalweg surveys, cross sectional surveys). However no other protocol has been as extensively used on these systems.

Applicability: Some of the data is < 5 years old, however a majority of the data is 10 years old or older. This is not as much of an issue with this protocol as, say, water quality parameters because the scale of these surveys is quite broad and past studies have found them to be a more useful tool when used to show long-term change. In other words, this protocol is more adept at showing large-scale change over multiple years vs showing change over a small time window such as annually.

Representativity: This protocol is an adequate representation of many factors contributing to overall watershed health, and could be used as a tool to indicate parameters that may be limiting factors that could require more fine-scale monitoring efforts in order to obtain a more accurate representation of watershed health.

Dispersibility: Valuable information for ODFW, and may be valuable info to a number of other agencies that do not currently utilize the information from these surveys.

Summary

The application of the AIP protocol by the Partnership throughout the years has highlighted some of the strengths and weaknesses associated with this protocol. The results of these surveys provide a quality overview of a large number of parameters related to in-stream habitat quality for salmonids and other aquatic organisms. This information is valuable for land managers and agencies in guiding their decision making process regarding how best to manage and restore habitat in these streams. The protocol can also be used as a tool for monitoring project effectiveness, but this application of the protocol should primarily be used as a broad scale, long-term assessment of change over time, and should be coupled with other, more fine-scale monitoring protocols focused on specific limiting factors within a specified reach.

The long history of AIP surveys throughout Oregon (20+ years) has resulted in a substantial amount of study and scrutiny of the protocol, which has helped to strengthen our understanding of the applicability and benefits of these surveys, and has provided a number of tools to utilize when analyzing survey results. An exploration of the models and assessment tools currently available would be beneficial for future utilization of the AIP survey protocol by the Partnership. AIP surveys could be a valuable assessment tool in the future, and with comprehensive planning and coordination with ODFW, they could also be a valuable long-term monitoring tool as well.

References

Edgar, C., M. Swanson (2005). Smooth cylinder large wood placement in 7 southern Oregon coastal streams: project effectiveness monitoring of summer in-stream habitat conditions. South Coast and Lower Rogue Watershed Councils. Gold Beach, Oregon.

Jones, K.K., K. Anlauf-Dunn, P.S. Jacobsen, M. Strickland, L. Tennant, S.E. Tippery. 2014. Effectiveness of instream wood treatments to restore stream complexity and winter rearing habitat for juvenile coho salmon. Transactions of the American Fisheries Society, 143:2, 334-345.

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Strickland, M.J., K. Anlauf-Dunn, K. Jones, C. Stein. 2018. Winter Habitat Conditions of Oregon Coast Coho Salmon Populations, 2007-2014. OPSW-ODFW-2018-01, Oregon Department of Fish and Wildlife, Salem, Oregon.

Tippery, S., K.K. Jones, K.J. Anlauf, C.H. Stein, M.J. Strickland. 2010. Effectiveness Monitoring Report for the Western Oregon Stream Restoration Program, 1999-2008. OPSW-ODFW-2010-6, Oregon Department of Fish and Wildlife, Salem, OR.

Summary Table

Table 17: Habitat Surveys by year. 'Forms 1 and 2' refers to the reach and unit reports. Forms 1 and 2 and Wood data was obtained primarily from an Access Database. Riparian and longitudinal profile (long pro) data was obtained from Excel spreadsheets, but some of the reach information did not align with data in the database so further comparison would need to be made. Not all reach details were available in the database, so additional investigation into those surveys would need to be done in order to do any future analysis or re-surveying. No associated locational data was found for any surveys completed before 2008.

Year	Stream	Reaches	Forms 1 and 2	Wood	Riparian	Long Pro
1998	Crook Creek	4	X	X	X	X
1999	Crook Creek	4	X	X		X
1999	Indian Creek (Elk)	3	X	X	X	
1999	Jacks Creek	4	X	X	X	X
1999	Farmer Creek	5	X	X	X	X
1999	Dans Creek	1	X	X	X	X
2000	Farmer Creek	5	X	X		X
2000	Jacks Creek	8	X	X		X
2000	Indian Creek	3	X	X		
2000	Dans Creek	1	X	X		X
2000	Mill Creek	3	X	X		X
2000	Indian Creek (Rogue)	5	X	X		
2000	Boulder Creek	1	X	X		X
2000	Edson Creek	2	X	X		
2001	Mill Creek	3	X	X		X
2001	Jacks Creek	4	X	X		
2001	Indian Creek (Rogue)	5	X	X		X
2002	Bethel Creek	2	X	X		
2003	Crook Creek	4	X	X		
2003	Bethel Creek	2	X	X		
2005	Boulder Creek	4	X	X		
2005	Jacks Creek	8	X	X		
2005	Farmers Creek	5	X	X		
2005	Indian Creek (Elk)	3	X	X		
2005	Indian Creek (Rogue)	5	X	X		
2005	Mill Creek	3	X	X		
2008	Bethel Creek	4	X	X		
2008	Butte Creek	2	X	X		
2009	Saunders Creek	2	X	X		
2009	SF Floras Creek	6	X	X		
2008	Morton Creek	5	X	X		
2012	Butte Creek	5	X	X		
2012	Morton Creek	3	X	X		
2013	Bethel Creek	4	X	X		
2014	Cedar Creek	3	X	X		

Project Name	Nutrient Source Searches
Year(s) Monitored	2010, 2011
Watershed(s) Investigated (HUC12)	Elk Euchre Rogue
Parameter(s) Measured	Nitrate+nitrite, Total Phosphorous, Turbidity, Specific Conductivity, e. Coli

Project Overview

This review will cover multiple instances in which the monitoring program attempted to isolate sources of nutrients entering tributaries in multiple watersheds. The impetus for these nutrient source searches came from the results of previous water quality sampling efforts that indicated potential areas of concern in regards to excess nutrient inputs entering estuaries that may be causing eutrophication. The majority of these sampling efforts were summarized in the final report titled, "Water Quality for Summer Rearing and Sources of Nutrients Elk River , Euchre Creek , Rogue River , and Chetco River Estuaries of the Southern Oregon Coast 2010-2011."

Three watersheds were identified for nutrient source searches: The Elk River, Euchre Creek, and the Rogue River. Two tributaries to the Elk River that enter the mainstem just upstream of the estuary, Swamp Creek and Cedar Creek, as well as the mainstem upstream and downstream of the Elk River Salmon Hatchery (located ~13 mi. up river) were sampled on two occasions for nitrate+nitritie and total phospherous. Euchre Creek and two tributaries, Coy and Cedar Creeks, were sampled on three occasions for nitrate+nitritie and total phospherous. Two tributaries of the Rogue River, Ranch and Edson Creeks, were sampled on two occasions, and an off-channel portion of the mainstem known as Jerry's Flat was sampled on three occasions. All Rogue River sites were sampled for E. coli, turbidity, and specific conductivity. A majority of the samples were taken during the summer season, except for the Edson and Ranch Creek samples that were taken in the spring after precipitation events to capture moderate to high flow conditions.

An additional nutrient source search project was initiated in 2013 in Hunter Creek, but the analysis of the results of this project were never analyzed and reported on. This project is being mentioned because it was an ambitious project that appears to have collected high quality data. The estuary of Hunter Creek routinely develops extensive algal mats throughout the summer season, often more so than in similar estuaries on the south coast. This project collected samples of nitrogen in the water column, as well as benthic algae samples, and sent them to a lab for processing to determine if the source of excess nitrogen was ocean-based or coming from upstream, freshwater sources. The lab completed their processing of the samples, but the resultant data has never been analyzed. It would be beneficial to the Curry Watersheds Partnership to attempt to complete the analysis needed to finalize the results from this effort. This project is being highlighted to present a more complete story of the nutrient source search efforts the monitoring program has employed, but because the data was never fully analyzed the remainder of this report will focus on the results from the Elk, Euchre, and Rogue surveys only.

Results and Discussion

- Elk River: Samples taken upstream and downstream of the fish hatchery showed that total phosphorous increased 4.5 times from upstream to downstream. The downstream value peaked at 0.65 mg/mL, which exceeds EPA guidelines and gets an Oregon Water Quality index score of "Fair". Samples taken in Swamp and

Cedar Creeks showed nitrate+nitrite (NO3+NO2) concentrations in Cedar Creek were well above EPA standard.

The increase in pH downstream of the hatchery suggests that the hatchery is the source of this increase. It should be noted that Anvil Creek enters the mainstem Elk just upstream of the hatchery, and it's unclear if the sample location upstream of the hatchery was sampled upstream of the influence of Anvil Creek as well. Sampling at the headwaters of Cedar Creek showed much lower amounts of NO3+NO2 compared to downstream, suggesting that the source of the NO3+NO2 is likely from agricultural fields Cedar Creek flows through.

- Euchre: A pasture adjacent to the estuary had elevated pH (0.08 mg/L) compared to the mainstem. The highest NO3+NO2 concentrations (0.259 mg/L) were found in Coy Creek. Cedar Creek had somewhat high amounts of NO3+NO2 as well, more so downstream of rural residential areas and a golf course than from agricultural sources.

Cedar Creek samples were selected to sample downstream of agricultural and rural residential land use areas, as well as downstream of a local golf course. Higher NO3+NO2 levels downstream of the rural residential area and golf course suggest that agricultural practices are not a primary source of NO3+NO2 in this tributary. While NO3+NO2 were somewhat high in Cedar Creek, the low amount of flow observed in the creek suggests that it may not be able to contribute much to the overall NO3+NO2 in the mainstem during the summer season. Coy Creek had higher on average amounts of NO3+NO2, but no observations of flow were mentioned in the final report so presumptions of how much it is contributing to the mainstem is unknown.

- Rogue: A majority of the E. coli samples exceeded the state single sample water quality standard (406 MPN/100mL) in both Ranch and Edson Creeks. Most of the largest samples were in upstream portions of both Edson and Ranch Creeks. None of the Jerry's Flat samples exceeded the state standard.

The large samples in the upstream portions of the watershed suggest that upland agricultural parcels are likely a higher source of E. coli than bottomland parcels found lower in the watershed adjacent to these streams. These assumptions are made on only a small number of samples made during only two storm events, so further sampling would be needed to enhance our understanding of where exactly this E. coli is being sourced from.

Data Overview (Quality and Future Value)

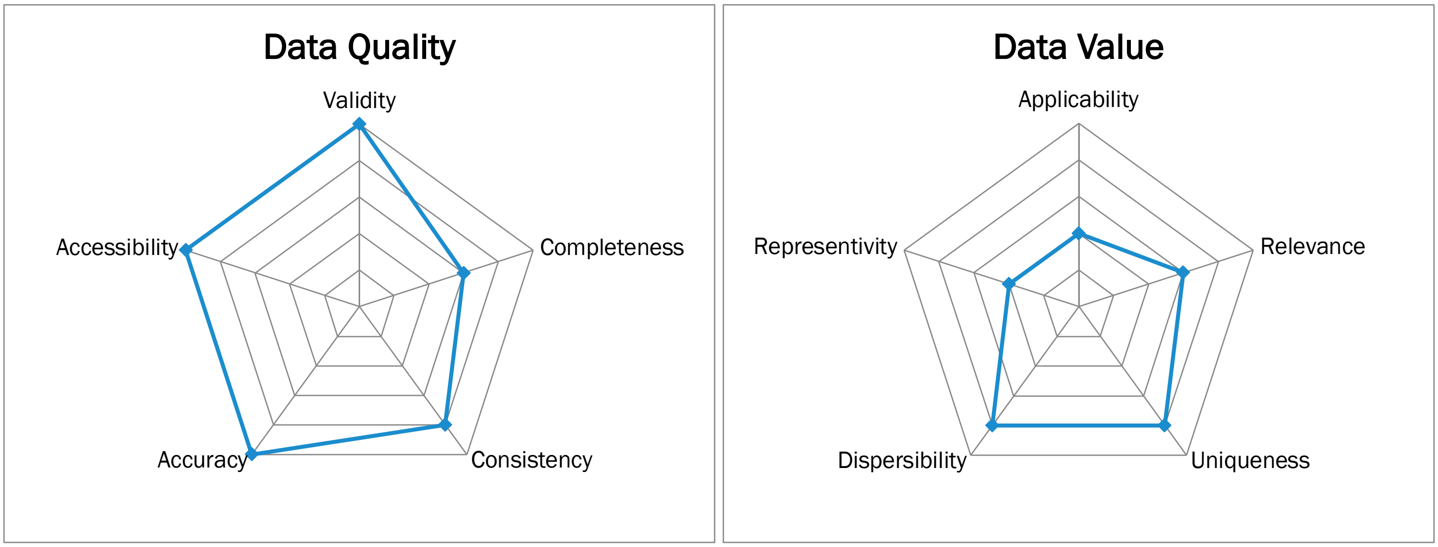


Figure 19: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

Data quality was overall excellent in regards to accuracy and validity. Projects had associated Sampling and Analysis Plans (SAPs) that were laid out in the standard format accepted by DEQ, and these SAPs were sufficient in describing all sampling protocols and QA/QC procedures that were followed. Past project that sampled NO3+NO2 attempted to process the samples in house, but comparisons to DEQ sample data indicated that there were potential issues with how the samples were being processed that were resulting in inaccurate results. The samples taken for these projects were instead sent to a third part laboratory for processing, which greatly increases the reliability of maintaining highly accurate results.

Data value was overall quite low for these projects, mainly due to the low number of sampling events and the period of time that has passed since the samples were taken. A majority of these samples were taken 8-9 years ago at the time this report is being written. Many changes could have occurred in these watersheds in this time, and it would require an extensive review of those changes to be able to estimate how accurate these samples are to current conditions. Additionally, no data was collected or observed during these sampling events that signify conditions in the streams during sampling. Variables such as precipitation, flow, or even water height could be used to relate water quality levels to watershed functions. Without those measures it is unknown what water quality levels may be like at different flows or in different seasons.

Summary

These projects were successful in collecting good quality data that gave us insight into some aspects of water quality conditions in these watersheds during, primarily, the summer low-flow season. The projects were a result of previous monitoring efforts, most of which were related to understanding estuarine water quality, and the results of these projects pair well with those estuary water quality projects. However, like many of those estuary-focused projects, the small number of sample periods and the amount of time that has passed since sampling dilute the representativeness of these results to potential current conditions. At best, the results of these projects should likely be used as a qualitative examination of water quality conditions at the time these samples were taken. This information could be used to help inform the design of future monitoring efforts and to potentially make broad scale assessments of how water quality may have changed over time. It should not, however, be used in more quantitative trend analysis due to the number of unknowns and variability not accounted for in these projects.

Summary Tables and Statistics

Table 18: Results of grab sample data. Tables were taken from the final report.

SITE_NAME	LocalNID	Date	Time	Primary_Dup	Method Description	NO3_NO2	T_Phos
Elk River: mainstem u/s of hatchery, u/s of Anvil Creek	3035	07-Jul-11	9:27	FP	Pole Sampler	0.023	0.013
Elk River: mainstem u/s of hatchery, u/s of Anvil Creek	3035	07-Jul-11	9:28	FD	Pole Sampler	0.023	0.014
Elk River: mainstem 100 ft d/s of ODFW Hatchery	3035.2	07-Jul-11	9:52	S	Pole Sampler	0.023	0.063
Elk River: Cedar Creek at pit road	3082	07-Jul-11	10:52	S	Pole Sampler	1.438	0.022
Elk River: Cedar Creek @McKenzie Rd bridge	3085	07-Jul-11	13:54	S	Grab Sample by hand	2.355	0.009
Elk River: Swamp Creek at McKenzie Rd Bridge	3090	07-Jul-11	13:40	S	Grab Sample by hand	0.150	0.015
Elk River: Swamp Creek at mouth	3095	07-Jul-11	6:40	S	Grab Sample by hand	0.157	0.088
Elk Estuary: ocean sample north of mouth	3120	07-Jul-11	6:43	S	Pole Sampler	0.351	0.205
Elk River: mainstem u/s of hatchery, u/s of Anvil Creek	3035	04-Aug-11	9:08	S	Pole Sampler	0.022	0.012
Elk River: mainstem 100 ft d/s of ODFW Hatchery	3035.2	04-Aug-11	9:24	S	Pole Sampler	0.023	0.017
Elk River: Cedar Creek headwaters nr Cape Blanco Road	3080	04-Aug-11	11:05	S	Pole Sampler	0.283	0.022
Elk River: Cedar Creek at pit road	3082	04-Aug-11	10:10	FP	Grab Sample by hand	1.883	0.008
Elk River: Cedar Creek at pit road	3082	04-Aug-11	10:11	FD	Grab Sample by hand	1.897	0.009
Elk River: Cedar Creek @McKenzie Rd bridge	3085	04-Aug-11	12:06	S	Pole Sampler	2.416	0.023
Elk River: Swamp Creek at McKenzie Rd Bridge	3090	04-Aug-11	12:25	S	Pole Sampler	0.032	0.017
Elk River: Swamp Creek at mouth	3095	04-Aug-11	6:51	S	Bridge Sampler	0.030	0.062
Elk Estuary: ocean sample north of mouth	3120	04-Aug-11	6:49	S	Pole Sampler	0.392	0.162

SITE_NAME	LocalNID	Date	Time	S_Type	Method Description	NO3_NO2	T_Phos
Euchre Creek: mainstem u/s of Boulder Ck	5030	30-Jun-11	6:50	S	Pole Sampler	0.171	0.01
Euchre Creek: mainstem u/s of Cedar Cr	5050	30-Jun-11	10:13	S	Pole Sampler	0.130	0.01
Euchre Creek: Cedar Creek at mouth	5059	30-Jun-11	10:02	S	Pole Sampler	0.135	0.01
Euchre Creek: mainstem at Ophir Road Br	5065	30-Jun-11	11:35	FP	Bridge Sampler	0.107	0.01
Euchre Creek: mainstem at Ophir Road Br	5065	30-Jun-11	11:36	FD	Bridge Sampler	0.116	0.01
Euchre Creek: Coy Creek at mouth	5070	30-Jun-11	6:18	S	Grab Sample by hand	0.234	0.02
Euchre Creek: mainstem d/s of 101(abv estuary)	5080	30-Jun-11	6:17	S	Grab Sample by hand	0.148	0.01
Euchre Creek: tributary to estuary from wetland	5090	30-Jun-11	6:44	S	Grab Sample by hand	0.007	0.08
Euchre Estuary: ocean sample near mouth	5105	30-Jun-11	7:04	S	Pole Sampler	0.011	0.06
Euchre Creek: mainstem u/s of Boulder Ck	5030	28-Jul-11	7:00	S	Pole Sampler	0.167	0.01
Euchre Creek: mainstem u/s of Cedar Cr	5050	28-Jul-11	8:05	S	Grab Sample by hand	0.158	0.01
Euchre Creek: Cedar Creek u/s of Rock Ck	5052	28-Jul-11	10:13	FP	Grab Sample by hand	0.107	0.01
Euchre Creek: Cedar Creek u/s of Rock Ck	5052	28-Jul-11	10:14	FD	Grab Sample by hand	0.109	0.02
Euchre Creek: Cedar Creek at Cedar Bend Golf U/S	5057.1	28-Jul-11	11:18	S	Grab Sample by hand		0.01
Euchre Creek: Cedar Cr: D/s end Cedar Bend Golf	5058	28-Jul-11	11:42	S	Grab Sample by hand	0.144	0.01
Euchre Creek: Cedar Creek at mouth	5059	28-Jul-11	7:58	S	Grab Sample by hand	0.150	0.01
Euchre Creek: mainstem at Ophir Road Br	5065	28-Jul-11	8:45	S	Bridge Sampler	0.148	0.01
Euchre Creek: Coy Creek at mouth	5070	28-Jul-11	6:14	S	Grab Sample by hand	0.130	0.02
Euchre Creek: mainstem d/s of 101(abv estuary)	5080	28-Jul-11	6:11	S	Grab Sample by hand	0.148	0.02
Euchre Creek: estuary outlet 100 ft u/s of high tide	5100	28-Jul-11	6:23	S	Grab Sample by hand	0.091	0.02
Euchre Creek: mainstem u/s of Boulder Ck	5030	07-Jun-12	14:30	S	Pole Sampler	0.123	0.01
Euchre Creek: mainstem u/s of Cedar Cr	5050	07-Jun-12	14:40	S	Grab Sample by hand	0.136	0.01
Euchre Creek: Cedar Creek u/s of Rock Ck	5052	07-Jun-12	17:10	S	Grab Sample by hand	0.192	0.02
Euchre Creek: Cedar Creek at Cedar Bend Golf U/S	5057.1	07-Jun-12	17:55	FP	Grab Sample by hand		0.01
Euchre Creek: Cedar Creek at Cedar Bend Golf U/S	5057.1	07-Jun-12	17:56	FD	Grab Sample by hand	0.207	0.01
Euchre Creek: Cedar Cr: D/s end Cedar Bend Golf	5058	07-Jun-12	19:06	S	Bridge Sampler	0.227	0.04
Euchre Creek: Cedar Creek at mouth	5059	07-Jun-12	15:35	S	Grab Sample by hand	0.224	0.01
Euchre Creek: mainstem at Ophir Road Br	5065	07-Jun-12	16:35	S	Bridge Sampler	0.146	0.03
Euchre Creek: Coy Creek at mouth	5070	07-Jun-12	20:00	S	Grab Sample by hand	0.259	0.02
Euchre Creek: mainstem d/s of 101(abv estuary)	5080	07-Jun-12	20:10	S	Pole Sampler	0.148	0.02
Euchre Estuary: ocean sample near mouth	5105	07-Jun-12	19:35	S	Pole Sampler	0.033	0.11

Sample bottle split after freezing. Sample had to be discarded

LocalNID	SITE_NAME	Date	Time	Primary_Dup	Sp_Cond	Turbidity	Ecoli
6948.5	Rogue R blw Lobster: Edson Ck: North Fork at mouth	15-Apr-11	15:12	FP	82	17.8	2420
6948.5	Rogue R blw Lobster: Edson Ck: North Fork at mouth	15-Apr-11	15:13	FD	82	16.8	12030
6949.7	Rogue R blw Lobster: Edson Ck: East Fork upstream of grazing	15-Apr-11	14:37	P	101	10.2	18.7
6950	Rogue R blw Lobster: Edson Ck: East Fork at Edson Ck Rd RM 0.02	15-Apr-11	15:27	P	105	13.9	114
6952	Rogue R blw Lobster: Edson Cr u/s of Bridge #256 (Sea People)	15-Apr-11	15:41	P	87	15.4	1300
6955	Rogue R blw Lobster: Edson Creek at North Bank Rogue Rd	15-Apr-11	15:58	P	99	14.9	1120
6974	Rogue R blw Lobster: Ranch Creek at middle crossing	15-Apr-11	17:10	P	68	38.8	727
6974.3	Rogue R blw Lobster: Ranch Creek, West Fork at mouth	15-Apr-11	17:50	P	83	28.6	1414
6975	Rogue R blw Lobster: Ranch Creek at North Bank Rogue Rd	15-Apr-11	18:20	P	78	30.2	488
6980	Rogue R blw Lobster: Ranch Creek nr mouth, at crossing us of slough	15-Apr-11	18:36	P	83	21.8	1046
6948.5	Rogue R blw Lobster: Edson Ck: North Fork at mouth	27-May-11	8:10	P	98	36	3873
6949.7	Rogue R blw Lobster: Edson Ck: East Fork upstream of grazing	27-May-11	7:43	P	123	28	1046
6950	Rogue R blw Lobster: Edson Ck: East Fork at Edson Ck Rd RM 0.02	27-May-11	8:20	FP	133	28.9	920.8
6950	Rogue R blw Lobster: Edson Ck: East Fork at Edson Ck Rd RM 0.02	27-May-11	8:21	FD	133	27.4	807.8
6952	Rogue R blw Lobster: Edson Cr u/s of Bridge #256 (Sea People)	27-May-11	8:33	P	105	32.1	4352
6955	Rogue R blw Lobster: Edson Creek at North Bank Rogue Rd	27-May-11	8:44	P	118	29.2	1733
6961	Rogue Estuary: Edson Creek near mouth	27-May-11	8:53	P	117	28.2	1925
6974	Rogue R blw Lobster: Ranch Creek at middle crossing	27-May-11	9:37	P	86	38.7	4303
6974.3	Rogue R blw Lobster: Ranch Creek, West Fork at mouth	27-May-11	10:07	P	124	28.8	3873
6974.9	Rogue R blw Lobster: Ranch Creek u/s of North Bank Road	27-May-11	10:30	P	94	64.8	7270
6980	Rogue R blw Lobster: Ranch Creek nr mouth, at crossing us of slough	27-May-11	10:41	P	91	27.7	5123

Project Name	New Zealand Mudsnail Distribution and Density by Habitat
Year(s) Monitored	2011
Watershed(s) Investigated (HUC12)	Floras Creek (171003060102) Floras Lake (171003060103) Fourmile Creek – FPO (171003060105) Hubbard Creek – FPO (171003060401) Lower Elk River (171003060302 Lower Sixes River (171003060203) Middle Sixes River (171003060203) Morton Creek – FPO (171003060104) Upper Sixes River (171003060201)
Parameter(s) Measured	Macroinvertebrate species presence and abundance

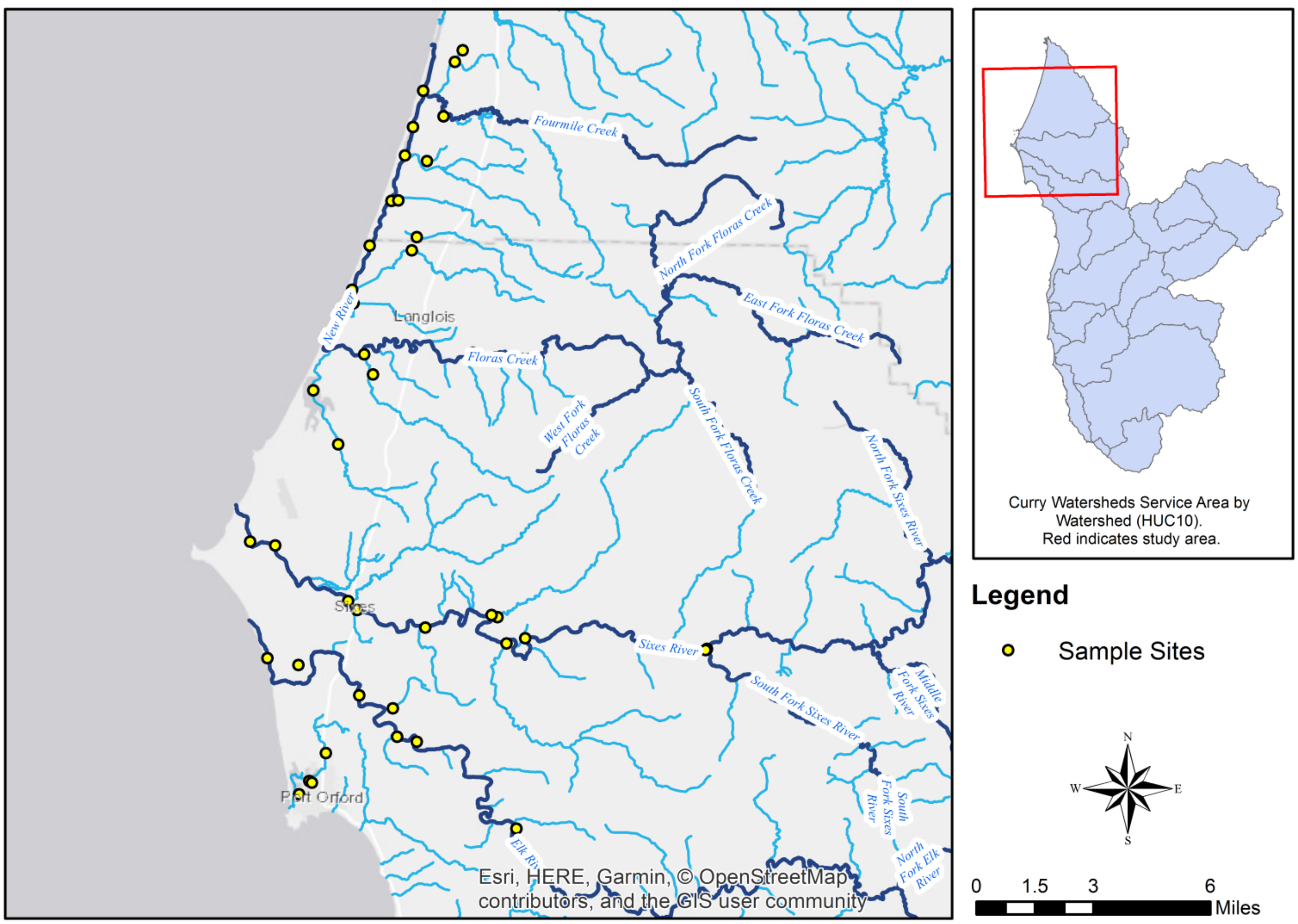


Figure 20: Map of study area with sample site locations

Project Overview

New Zealand mudsnail (*Potamopyrgus antipodarum*) is an invasive aquatic macroinvertebrate species capable of out-competing native species and dominating aquatic ecosystems. Many aquatic species (e.g. salmonids) consume them, but previous studies have shown that New Zealand mudsnails provide less nutrients compared to other macroinvertebrates, which can affect aquatic species growth rates and survival. The presence of New Zealand mudsnails on the South Coast had been confirmed before this study, but their distribution was not well understood.

The primary objective of this study was to detect the distribution of New Zealand mudsnails in a variety of aquatic settings. A secondary objective was to collect quantitative data on macroinvertebrate communities to be used as an indicator of aquatic health and potential restoration needs at a subset of study sites.

The EPA Environmental Monitoring and Assessment Program (EMAP) reach-wide macroinvertebrate sampling protocol was used on sites located in wadeable streams where the protocol could be applied. This protocol provides a quantitative measure of the macroinvertebrate community and can be used to assess aquatic health. A qualitative multi-habitat protocol was used at sites where the EMAP protocol could not be applied (non-wadeable streams, lakes, etc.). This qualitative protocol involved sampling multiple habitat types that are commonly occupied by New Zealand mudsnails (hard substrate, woody material, vegetated banks, submerged macrophytes, sand/fine sediment) in order to determine the presence and relative abundance of the species at these sites. A total of 50 samples were taken: 23 EMAP quantitative samples, and 27 multi-habitat qualitative samples.

Results and Discussion

Multi-habitat qualitative sample results: 26 sample sites were reported out in the results section of the final report for this study (***TABLE 19***). New Zealand mudsnails were found in 15 of these sample sites. Results by habitat type varied between watersheds and riverine vs lacustrine habitats. A majority of New Zealand mudsnails present in New River sample sites and lake samples were found on submerged macrophytic vegetation and in sand/fine sediment, whereas a majority of mudsnails in the Elk and Sixes watersheds were found on woody material and in vegetated banks. The Sixes River watershed had the lowest percentage of sites in which mudsnails were present. They were only present at the downstream-most site (at parking area below Hughes House). The upstream-most site (d/s of South Fork, at campground) had by far the highest tally of mudsnails compared to all other sites sampled, however further analysis showed that these were false-detections, and were in fact native rock snails. The New River watershed had the highest percentage of sites in which mudsnails were present, with only one absent site (Fourmile Creek in riffle reach d/s of HWY 101).

EMAP quantitative sample results: The quantitative samples that were collected were processed off-site by the Utah State University National Aquatic Monitoring Center (Utah Bug Lab). The resultant data were then analyzed using two separate methodologies: the OWEB Level III assessment method, and the Oregon DEQ PREDictive Assessment Tool for Oregon (PREDATOR). It should be noted that both of these assessment methods were developed using reference sites at which only riffles were sampled, and were mostly located in fast-moving wadeable streams. This project used the EMAP reach-wide sampling protocol, which samples more habitat types than just riffles, and some sample sites were in low-gradient, slow moving streams that lacked riffles entirely. Some research has shown that these methods are fairly compatible, but less so in slow-moving systems. Since the EMAP protocol was used at all project sites, comparison between sites should be valid. However, comparison between these project sites and other samples sites outside this project's scope should only be done after close comparison of sample protocol design.

The OWEB Level III assessment method is a multi-metric assessment method that examines a number of different metrics related to macroinvertebrates that have been shown to relate to high quality habitat. The combined results of those metrics can be found in the Summary Statistics section (***FIGURE 22***). In general, the Elk and Sixes watersheds ranked higher than New River and Floras. The most impaired sites were mostly those that are located at the lower end of their watersheds, where it's more likely these sites were low gradient reaches that lack riffles. Most, but not all, of these sites are also ones in which New Zealand mudsnails were detected. This could indicate degraded habitat conditions due to the presence of New Zealand mudsnails, or complications in applying the reach-wide sampling protocol taken at low-gradient sites to an assessment method based on different habitat types.

The PREDATOR assessment is a multivariate assessment method that synthesizes a number of different variables associated with macroinvertebrates and quality habitat into a single number. This assessment method, like the OWEB Level III assessment, is based on reference sites in which primarily riffles were sampled in fast-moving streams. The results from this analysis were similar to the OWEB Level III results (*TABLE 20*). The Elk River watershed ranked highest on average (0.464), with the Sixes ranking second highest (0.376), followed by Floras (0.331) and New River (0.191). The lowest scoring sites were primarily in low-gradient reaches towards the lower end of the watersheds. Some of these sites were also where New Zealand mudsnails were present.

Data Overview (Quality and Future Value)

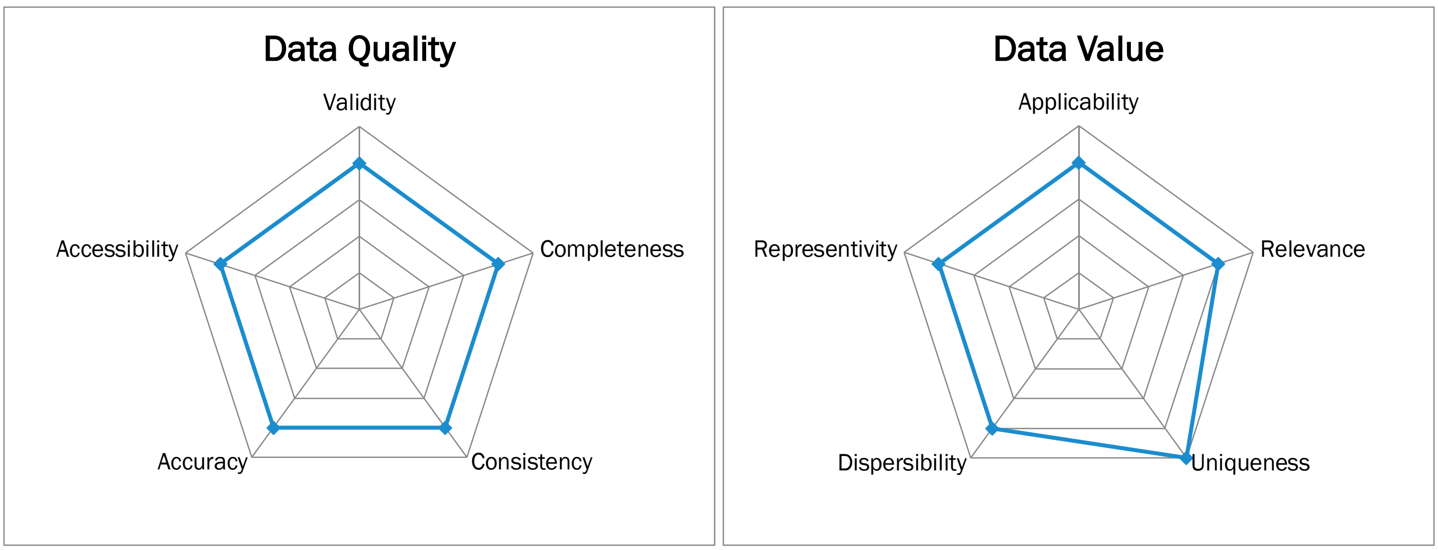


Figure 21: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

- Data Quality
    - Validity: Some of the qualitative results are out of the expected range or are unexpected values that are not explained in text.
    - Completeness: Quantitative sampling results could potentially be used for statistical analysis, as long as the sampling protocol used in all instances is the same. All samples in this study used the reach-wide protocol, which is not the protocol used by the state to conduct surveys (they use a riffle-only sampling protocol). Therefor these results cannot be compared to results collected using the riffle-only protocol.
    - Consistency: There were errors in the data collection efforts at a few sample sites, and at least one qualitative sample was analyzed for quantitative results, but a majority of the data collection and analysis efforts were carried out uniformly

  - Accuracy: Errors were found in at least one qualitative sampling event.
  - Accessibility: Some analysis had to be redone in order to complete the review, but the raw data is available for future use.
- Data Value
  - Relevance: This information could inform future projects or monitoring. However if future monitoring is going to be carried out, special attention should be given to what sampling protocol is used and how comparable it is to this dataset.
  - Uniqueness: Only study of this size to examine macroinvertebrate communities, and the only study completed by the monitoring program looking at New Zealand Mudsnail presence
  - Applicability: Data could be compared to future monitoring efforts, however sampling protocols will dictate if future monitoring can be compared to this data or other regional datasets
  - Representivity: A quality indicator of overall watershed health, but any trend analysis would be difficult given the gap between sampling years
  - Dispersibility: DEQ collects macroinvertebrate data, and this data may be valuable to others such as ODFW as well.

Summary

This project highlighted many of the benefits, and difficulties, associated with macroinvertebrate sampling. Macroinvertebrate communities are an integral part of all aquatic habitat types, and understanding aspects of their composition can provide a myriad of insights into overall aquatic health. However, these communities are also very complex and highly variable. This makes sampling for macroinvertebrates, and analyzing the resultant data, somewhat complicated. Standardized protocols and analytical techniques used in this project help in simplifying that process, but it's important to understand the limitations of those techniques to fully understand what the results from this project tell us. This project highlighted the difficulties associated with sampling in many areas of interest in our watersheds such as lowland streams, lakes, and backwater areas. The results from this project do give us a much better understanding of macroinvertebrate communities than we had before, and could be highly beneficial in informing future macroinvertebrate sampling efforts.

The New Zealand Mudsnail focus of this project provided a lot of good information pertaining to this species' overall distribution within our watershed. The large populations of these snails in some places could be cause for alarm, and warrants further monitoring to determine how the size of these populations may be changing and if they are expanding their range within our watersheds. Data from this study would be highly beneficial to inform future New Zealand Mudsnail sampling efforts.

Summary Tables and Statistics

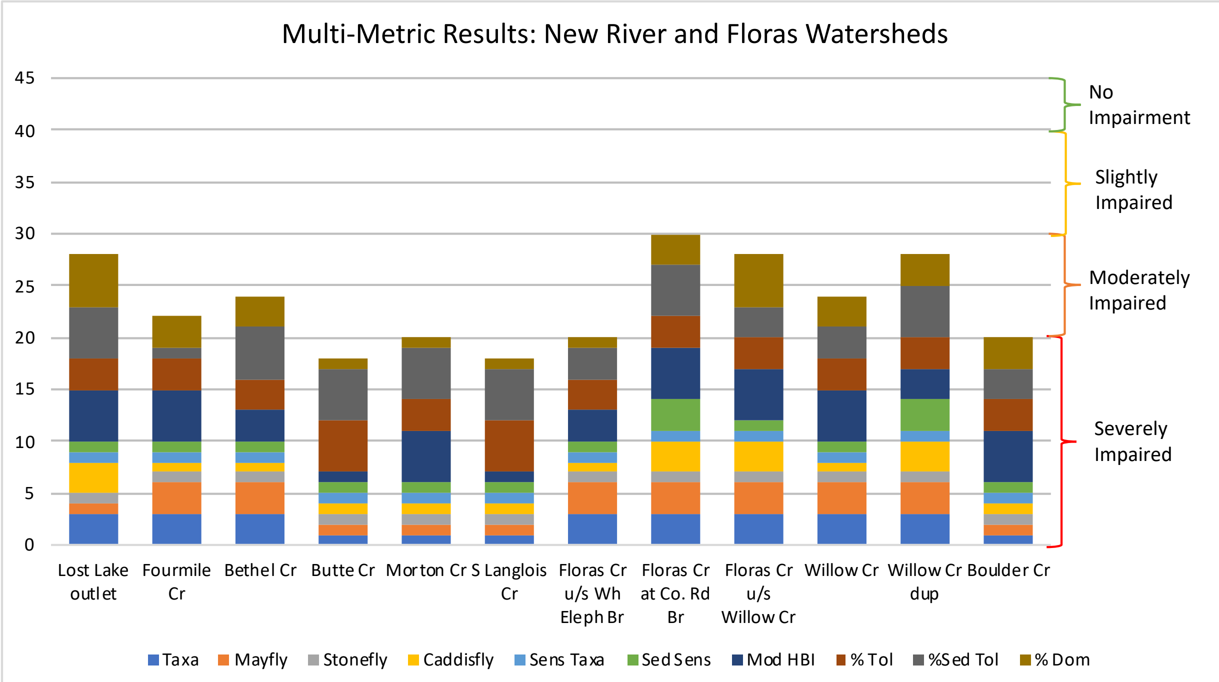
Table 19: Results from the qualitative, multi-habitat sampling showing how many New Zealand Mudsnails (by groupings of 0, 0-50, 50-100, 100-1000, >1000) were identified within each habitat type at all sample sites. The cells highlighted in peach were recorded in error (these results were due to misidentification of native rock snails at New Zealand mudsnails at this site). It was unclear from the final report and associated documentation how the composite lake samples were taken or what the resultant numbers highlighted in yellow are meant to represent.

Location	Hard Substrate	Woody material/ snags	Submerged veg banks	Submerged macro-phytes	Sand/fine sediment
Fourmile Creek in riffle reach (d/s of Hwy 101)		0	0	0	0
New River at mouth of Fourmile Creek			50-100	>1000	50-100
New River nr Storm Ranch boat ramp			100-1000	100-1000	10-50
New River south of Croft Lake Outlet		50-100		>1000	100-500
New River south of New Lake Outlet			100-1000	>1000	100-1000
New River at Clay Island Breach				>1000	100-1000
New River south of Bono Ditch				>1000	50-100
New River S of 12/28/08 breach (nr Hanson slough)				100-1000	50-100
Floras Creek at County Rd Br	0	0	0	0	0
Sixes River d/s of South Fk, at campground	100-1000	100-1000	50-100	100-1000	50-100
Sixes River at Boat slide, 0.6 mi u/s of Little Dry Cr	0	0	0	0	0
Sixes River d/s of Edson Creek	0	0	0	0	0
Sixes River u/s of Beaver Cr, RM 7 (ODFW boat ramp)	0	0	0	0	0
Sixes River at Hwy 101	0	0	0	0	0
Sixes River at parking area blw Hughes House	2-10	50-100	50-100	10-50	10-50
Elk River u/s of hatchery	0	0	0	0	0
Elk River u/s of Bagley Creek	2-10	0	1-2	0	0
Elk River nr "Iron Head" boat ramp	0	0		0	0
Elk River nr mouth, d/s of "Fox Island"	2-10	0	50-100	2-10	2-10
Laurel Lake composite			0	0	0
Croft Lake composite			10	20	70
Floras Lake composite			10	40	50
Garrison: Buffington Pond	Absent				
Garrison: Mill Creek on Mill Pond Rd	Absent				

Garrison Lake nr Pinehurst St boat ramp	Abundant, density by habitat not recorded
Garrison Lake nr 12th St boat ramp	Abundant, density by habitat not recorded

Table 20: Results of the PREDATOR multivariate model analysis. O/E is the number of the Observed taxa / number of Expected taxa based on reference reaches established in the model. Lower numbers indicate a lower number of the expected taxa were present, which could indicate degraded habitat conditions compared to the expected reference conditions.

Site Name	O/E
Lost Lake outlet at BLM trail crossing	0.254
Fourmile Creek in riffle reach (d/s of Hwy 101)	0.254
New River: Bethel Creek at bridge near mouth, u/s of New Lake outlet	0.254
New River: Butte Creek at D/S Bridge	0.127
New River: Morton Creek at D/S end of flow	0.127
New River: South Langlois Creek at S bend	0.127
Floras Creek: mainstem 1.3 RM u/s of Wh Eleph Br	0.382
Floras Creek at County Rd Br	0.451
Floras Creek upstream of Willow Creek	0.326
Floras: Willow Creek at County Road Bridge	0.318
Floras: Willow Creek at County Road Bridge dup	0.381
Floras Lake: Boulder Creek	0.130
Sixes: South Fork nr mouth	0.589
Sixes: Dry Creek	0.254
Sixes: Edson Creek	0.509
Sixes: Edson Creek dup	0.382
Sixes River d/s of Edson Creek	0.325
Sixes: Crystal Creek	0.317
Sixes: Orchard Hole tributary to estuary	0.254
Elk: Bald Mountain Cr nr mouth	0.650
Elk River u/s of hatchery	0.389
Elk River u/s of hatchery dup	0.389
Elk: Bagley Creek	0.571
Elk: Indian Creek	0.740
Elk River near Iron Head boat ramp	0.317
Elk: Cedar Creek at McKenzie Road Bridge	0.190



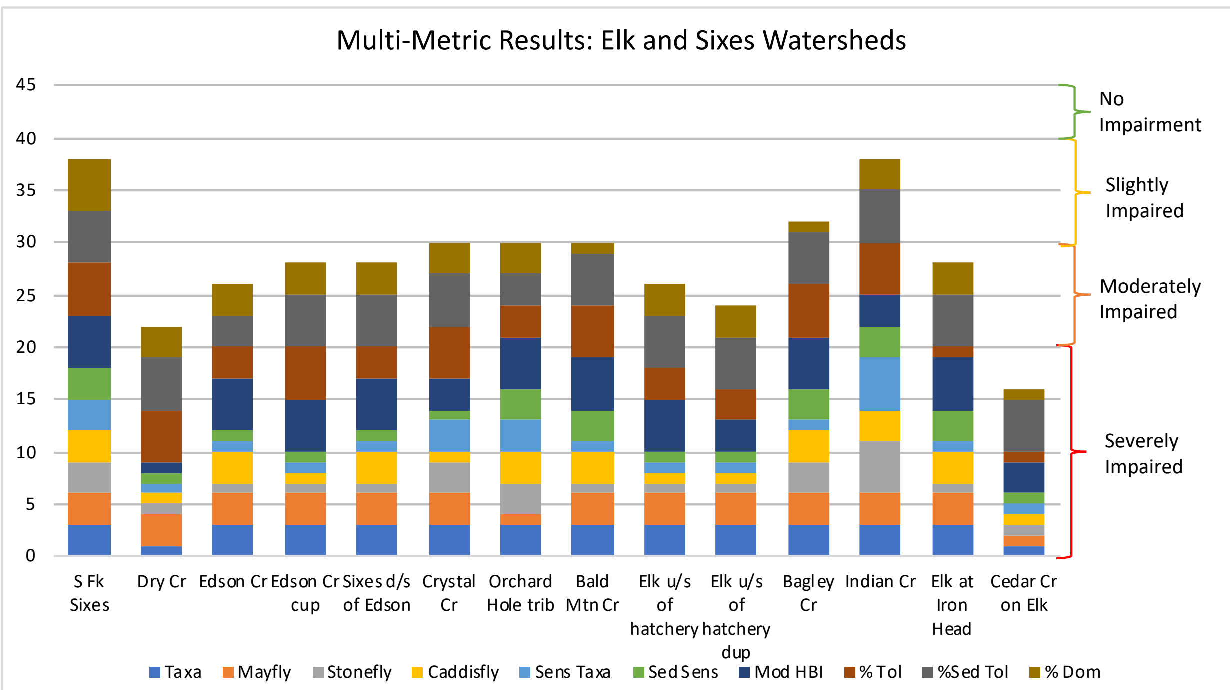


Figure 22: Results of the multi-metric Level III assessment. Each bar color represents a different metric. See OWEB's protocol for a full description and definition of each metric.

Project Name	South Coast Lowland Streams Riparian Function Monitoring
Year(s) Monitored	2004, 2007, 2008, 2009
Parameter(s) Measured	Temperature – continuous Macroinvertebrates Shade Relative Bed Stability (RBS) Stage and Discharge

Project Overview

The Curry Watersheds Partnership (CWP) has been conducting riparian enhancement and bank stabilization projects in small, coastal lowland streams since the 1990s. This project was designed to examine the effectiveness of these efforts by measuring multiple parameters, primarily associated with riparian areas and bank stability, that are known indicators of stream health. The goals of this project were to answer multiple questions, including: What is the rate of recovery of stream temperature, shade, streamflow, fine sediment, and macroinvertebrates along small low-gradient streams? Will straightened, incised channels be able to develop diverse macroinvertebrate communities? Will other upstream pollutants prevent the recovery of healthy macroinvertebrate assemblages? Can we detect differences among riparian project types or designs in attaining healthy aquatic communities?

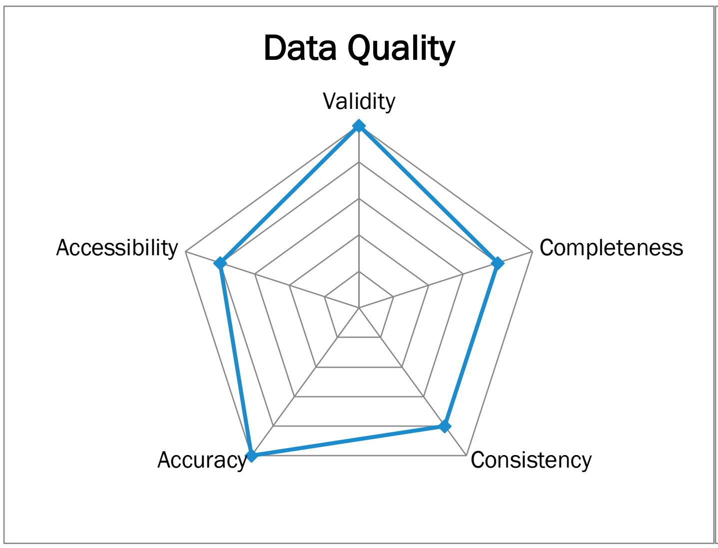
This project monitored both treatment and control reaches on a number of small, coastal lowland streams ***(TABLE 21)***. Surveys were initiated in 2004 and included: (1) deployment of continuous temperature loggers for the entire summer season at the upstream and downstream ends of each reach, (2) shade surveys at multiple transects using a Solar Pathfinder, (3) benthic macroinvertebrate surveys following DEQ's Mode of Operations manual, (4) stream discharge measurements using USGS standard protocol. Surveys in the following years (2007, 2008, and 2009) included all of the previously mentioned protocols, plus the Relative Bed Stability (RBS) protocol that measures bed sediment and channel metrics. A number of reaches surveyed in 2004 were re-surveyed in 2008 or 2009.

Results and Discussion

A majority of the reporting of the results of these surveys focused on comparing the results of each protocol to all sites surveyed, and comparing parameter results to each other to determine if there were any strong correlations between parameters. Continuous temperature data showed evidence of reductions in temperature in two streams that had been monitored prior to 2004, Pea and Crook Creeks. Other streams exhibited signs of strong groundwater influences, which complicated the analysis of the impact of shade on stream temperature. Shade measurements were quite informative, but did not change significantly between survey years in most cases due to slow riparian growing conditions and channel widths in many reaches. Discharge readings were helpful to relate to other parameters in order to quantify current conditions during surveys, but the lack of a continuous record prevented any conclusive determinations to whether or not summer seasonal flow levels had increased. Macroinvertebrate survey results were mixed; some taxa showed signs of being potential indicator taxa for sediment conditions, but the results from the two standard analytical techniques (OWEB Level III Multi-metric Assessment and the multivariate Predictive Assessment Tool for Oregon [PREDATOR]) were inconsistent on which reaches were recovering, declining, or stagnant between years. The Relative Bed Stability survey results indicated that almost all reaches, both reference and treatment, contained too much fine sediment according to the RBS model and were considered unstable. Correlative analysis did not indicate that any parameters correlated very strongly to any others.

The overall results from this project indicate that these surveys could be effective monitoring methods to track change over time related to restoration projects, but the analytical approach to the reporting made it difficult to determine how effective these methods could be. This is primarily because the reporting focused on comparing the results of each metric across all surveyed reaches rather than focusing on all of the results of each individual reach. This made it difficult to examine all of the results for each reach in order to get the "big picture" of how each reach is individually functioning and how it may be changing over time. Also, treatment reaches received a variety of different restoration actions (livestock exclusion, fencing, planting, large wood placement, re-channelization, etc.), which makes comparison between reaches even more complicated. The correlative analysis resulting in weak correlations, and the comparison between macroinvertebrate analytical techniques having mixed results indicate that additional examination of how representative these analyses are of the stream types examined in these surveys is warranted. An additional examination of these protocols and analyses, as well as examining each individual stream reach separately and in more detail, would aid in better understanding the effectiveness of this project in assessing riparian restoration effectiveness.

Data Overview (Quality and Future Value)



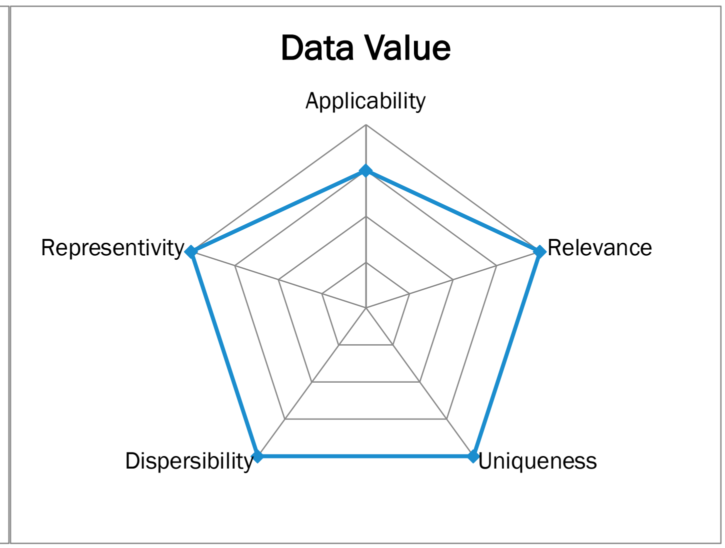


Figure 23: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

The data review for this project was somewhat difficult due to the number of different types of data that were collected. Two aspects of this project that aided greatly in this regard were that: (1) all of the protocols used were standardized ones developed either by agencies or academics that have been applied by many other organizations and refined over time, which increases the confidence in their application, and (2) a DEQ Sampling and Analysis Plan (SAP) was developed for this project that laid out, in detail, all of the data collection and analysis steps and QA/QC procedures, which was a very helpful tool for this review and also increased the confidence that the data collected were of high quality. A cursory review of the raw data indicated that all of the data appear to be readily available, although the data are currently stored in a number of different files and databases and should be compiled before future use. Most sites received all surveys during each survey year, however some sites did not get surveyed for every protocol and the RBS surveys were not implemented until 2007 which hinders some comparative analysis between years and sites.

The use of standardized protocols in this project increases the likelihood that these results could be applied in future monitoring efforts, as long as potential issues with the age of the data and protocols are addressed. The results of these surveys are now over 10 years old, meaning that any comparative analysis that may be done in the future will have to address the large amount of variability in how conditions in each reach have changed over time. Also, investigations would need to be done into how each of these standardized protocols have developed over the last decade, and if they're still valid, standard protocols being implemented today. Addressing these concerns would greatly enhance our understanding of how applicable the results of these surveys could be for future monitoring efforts on these reaches.

Summary

This was a very ambitious project that attempted to answer a large number of important questions relevant to understanding how effective our past riparian restoration efforts have been. Examining such an extensive number of parameters across a wide-range of streams is a difficult task. This project made a number of decisions in the development phase that helped alleviate some of those difficulties, such as selecting from standardized protocols, developing a Sampling and Analysis Plan, and establishing both control and treatment reaches. While these decisions did help, there are still aspects of this project that make evident the difficulties in taking on such an ambitious task. For instance, comparing all stream reaches to each other and looking for correlations in parameters across all sites produced mixed results because this type of analysis is dealing with a large amount of variability between sites. Examining all parameters on a site-by-site basis would help in being able to reduce the between-site noise, and would give a better overall picture of how each site is functioning. However, the comparative analysis did indicate some potential weaknesses in these standardized protocols, such as the mixed results from the macroinvertebrate analysis techniques used. These mixed results may indicate that these standardized analytical methods, which are often based on reference streams outside of the South Coast, may fail to represent the complex geomorphological settings many of our streams developed in. It would be beneficial to conduct further examination of these standardized models and how they can best be calibrated to our region if they are to be used in the future. This deeper understanding may also allow us to re-analyze past raw data to refine our results. This ambitious project has potential for future monitoring applications, given our ability to reassess and refine the process and protocols to make sure we are collecting standardized data that accurately represents our stream reaches and the effectiveness of the restoration actions we take to enhance them.

Summary Tables and Statistics

Table 21: Summary of surveys by stream reach including what survey metrics were measured each year

Stream/Reach Type	Parameter	2004	2007	2008	2009
Morton / Riparian	Temperature	X	X	X	
	Shade	X		X	
	Macroinvertebrates	X		X	
	Discharge	X		X	
	RBS			X	
Morton Creek / Channel Relocation	Temperature		X		
	Shade			X	
	Macroinvertebrates				
	Discharge			X	
	RBS			X	
Bethel Creek / Channel Relocation	Temperature	X	X	X	
	Shade	X	X		
	Macroinvertebrates	X	X		
	Discharge	X	X		
	RBS		X		
Willow Creek Upper / Riparian	Temperature	X		X	
	Shade	X		X	
	Macroinvertebrates	X			X
	Discharge	X			X
	RBS				X
Willow Creek Lower / Riparian	Temperature	X		X	
	Shade	X		X	
	Macroinvertebrates	X			X
	Discharge	X			X
	RBS				X
Crystal Creek / Riparian	Temperature		X		X
	Shade	X		X	
	Macroinvertebrates	X			X
	Discharge	X			X
	RBS				X
Pea Creek / Riparian	Temperature	X			X
	Shade	X		X	
	Macroinvertebrates	X			X
	Discharge	X			X
	RBS				X
Turner Creek / Riparian	Temperature	X	X	X	
	Shade	X	X		
	Macroinvertebrates	X	X		
	Discharge	X	X		
	RBS		X		
Turner Creek / Control	Temperature		X	X	
	Shade		X		
	Macroinvertebrates		X		
	Discharge		X		
	RBS		X		
Crook Creek / Riparian	Temperature	X			X
	Shade	X		X	
	Macroinvertebrates	X			X
	Discharge	X			X
	RBS				X
Fourmile Creek Upstream / Riparian	Temperature		X		
	Shade				
	Macroinvertebrates		X		
	Discharge		X		
	RBS				

Fourmile Creek / Riparian	Temperature		X		
	Shade		X	X	
	Macroinvertebrates				
	Discharge				X
	RBS		X		X
Butte Creek / Control	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge			X	
	RBS			X	
Butte Creek / Riparian	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge			X	
	RBS			X	
Butte Creek / Channel Relocation	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge			X	
	RBS				
North Langlois / Control	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge			X	
	RBS			X	
North Langlois / Riparian	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge			X	
	RBS			X	
East Fork Floras / Control	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge				X
	RBS				X
East Fork Floras / Wood Placement	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge				X
	RBS				X
North Fork Floras / Control	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge				X
	RBS				X
North Fork Floras / Wood Placement	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge				X
	RBS				X
East Fork Edson Creek / Control	Temperature				
	Shade		X		
	Macroinvertebrates		X		
	Discharge		X		
	RBS		X		
East Fork Edson Creek / Wood Placement	Temperature				
	Shade		X		
	Macroinvertebrates		X		
	Discharge		X		
	RBS		X		

East Fork Edson Creek / Riparian	Temperature				
	Shade		X		
	Macroinvertebrates		X		
	Discharge		X		
	RBS		X		
Jacks Creek / Control	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge			X	
	RBS			X	
Jacks Creek / Riparian	Temperature				
	Shade			X	
	Macroinvertebrates				
	Discharge			X	
	RBS			X	
Edson Creek / Control	Temperature		X		
	Shade				
	Macroinvertebrates				
	Discharge				
	RBS				
Edson Creek / Wood Placement	Temperature		X		
	Shade				
	Macroinvertebrates				
	Discharge				
	RBS				
Edson Creek / Riparian	Temperature		X		
	Shade				
	Macroinvertebrates				
	Discharge				
	RBS				

Project Name	Spawning Surveys
Year(s) Monitored	2004, 2005, 2006, 2007, 2008, 2009, 2010, 2012, 2013, 2014, 2018
Watershed(s) Investigated (HUC12)	
Parameter(s) Measured	Spawner and redd presence/absence and abundance

Project Overview

The Curry Watersheds Partnership (CWP) assisted the Oregon Department of Fish and Wildlife (ODFW) for a number of year in conducting salmon spawning surveys on streams throughout our service area. These surveys were conducted primarily on streams outside of the scope of ODFW's surveys. These surveys are located in streams that the CWP has identified as areas of interest (ex. areas associated with potential fish passage barrier issues that the CWP are investigating).

The CWP followed all ODFW standardized spawning survey procedures when conducting surveys, and were overseen by staff trained in the ODFW protocol. The CWP also received additional assistance when necessary from the local ODFW field office.

Results and Discussion

ODFW uses spawner survey results to estimate adult spawner abundance numbers using an Area Under the Curve (AUC) estimate method. The AUC method requires a number of thresholds to be met in order to meet minimum accuracy standards. These standards include surveying during the entire "critical period" (when 90% of spawners return) and at a periodicity that minimizes the chance of missing peak abundance (usually fewer than 12-15 days between surveys). Unfortunately, a majority of the CWP's surveys did not meet the minimum requirements of the AUC calculator, so spawner abundance statistics cannot be calculated. However, surveys have been utilized as a presence/absence indicator to map the geographic extent of spawning activity and where salmon are utilizing spawning habitat.

Failing to meet the AUC calculation requirements often occurs due to limitations in funding or access difficulties due to weather. Additional complications include water clarity issues after storm events and gaining access to reaches from year to year. These complications are not isolated to CWP surveys. ODFW staff often encounter a number of these barriers as well, which hinders their own ability to apply AUC calculations.

Data Overview (Quality and Future Value)

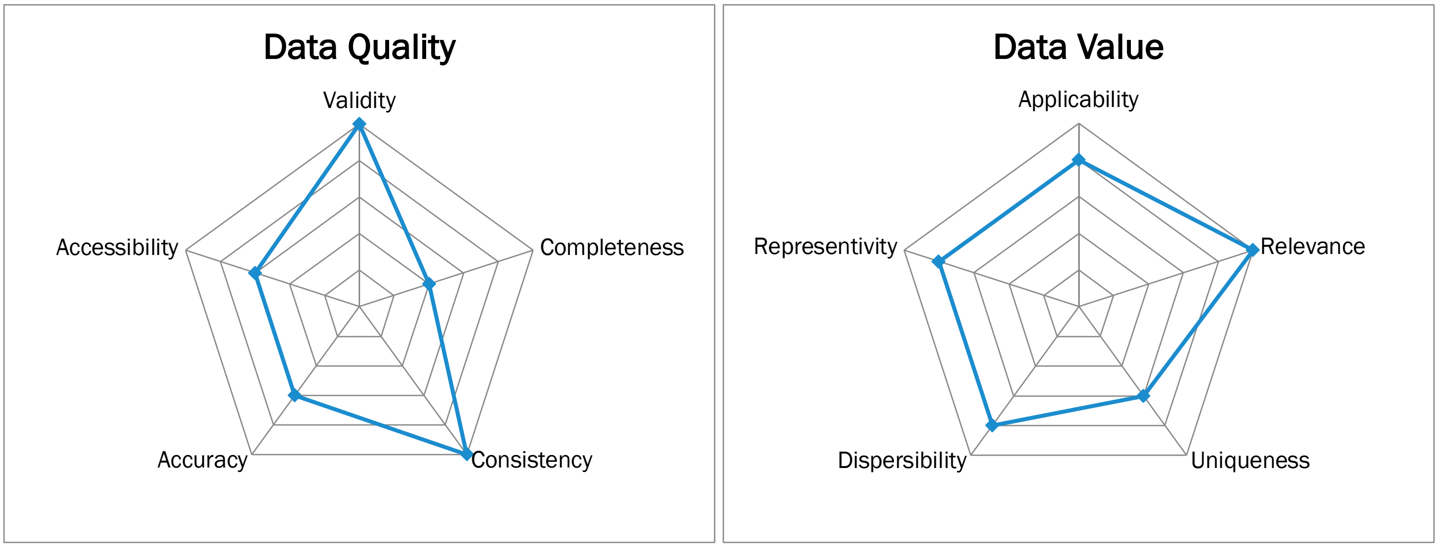


Figure 24: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

The data are of high quality in regards to validity and consistency because the CWP has followed a standardized protocol and taken steps to ensure that the data collected during surveys were of top quality. However, other elements of data quality suffered due to the issues discussed in the previous section. Many of these issues are often out of the CWP's control and can be very difficult to plan for or work around.

The value of this data is quite high overall because the data have informed both the CWP and ODFW of the range of streams salmonids return to during spawning season. The relevance of data such as these are not as tied to the time period they were collected in like many of our past water quality monitoring projects because enhancing and increasing salmonid spawning opportunities is an ongoing focus of the CWP, and historical data like this is still highly informative to our future efforts.

Summary

These spawning survey monitoring efforts have provided a sizeable amount of quality data over a substantial time period in a number of high priority streams. They are a good example of how cooperative efforts can benefit multiple partners. The CWP has been able to highlight the importance of a number of streams associated with salmonid spawner presence, and ODFW has enhanced its database of spawning surveys on the south coast. The only downside of these surveys is that many of them could not be used for spawner abundance estimates using the AUC calculator, but that does not mean that the data collected isn't of good quality and importance. Many of the issues encountered in conducting these surveys highlight the common difficulties of conducting long-term environmental monitoring efforts. These survey efforts serve as an example of how, even with these complications, this data can still be highly valuable for multiple partners and utilized to benefit the overall health of our watersheds.

Summary Tables and Statistics

Table 22: Summary of all surveys for every survey year. A 'x' in the year column indicates that surveys were conducted on that reach in said year.

ESU	REACH_ID	Reach Name	Length (m)	Length (mi)	2003	2004	2005	2006	2007	2008	2009	2010	2012	2013	2014	2018
SONC	43.00	Bear Creek	914	0.57	-	-	-	-	-	-	-	-	-	-	-	X
OR COAST	22	Bethel Creek Segment 1	1385	0.86	-	-	-	-	-	-	-	-	-	-	-	-
OR COAST	22	Bethel Creek Segment 2	664	0.41	-	-	-	-	-	-	X	-	-	-	-	-
OR COAST	22	Bethel Creek Segment 4	1306	0.81	-	-	-	-	-	-	X	-	X	X	-	-
SONC	13	Boulder (Euchre) Creek Segment 1	754	0.47	X	X	X	X	X	X	-	X	X	-	-	-
SONC	13	Boulder (Euchre) Creek Segment 2	278	0.17	X	X	X	X	X	X	-	-	-	-	-	-
SONC	13	Boulder (Euchre) Creek Segment 3	444	0.28	X	X	X	X	-	-	-	-	-	-	-	-
SONC	13	Boulder (Euchre) Creek Tributary Segment 4	263	0.16	X	X	X	X	-	-	-	-	-	-	-	-
OR COAST	3	Boulder (Floras) Creek Segment 1	891	0.55	X	X	X	X	X	X	-	X	X	-	-	-
SONC	17	Brush Creek Segment 1	972	0.60	-	-	X	-	X	-	-	-	-	-	-	-
SONC	17	Brush Creek Segment 2	1705	1.06	-	-	X	-	X	-	-	-	X	-	-	-
SONC	17	Brush Creek Segment 3 (Trib)	687	0.43	-	-	X	-	X	-	-	-	-	-	-	-
SONC	17	Brush Creek Segment 4	1063	0.66	-	-	-	-	-	-	X	-	X	-	-	-
SONC	17	Brush Creek Segment 5	729	0.45	-	-	-	-	-	-	X	-	X	-	-	-
SONC	17	Brush Creek Segment 6	1266	0.79	-	-	-	-	-	-	X	-	X	-	-	-
SONC	31	Bull Gulch Segment 1	705	0.44	-	-	-	-	-	X	-	-	-	-	-	-
OR COAST	21566.3	Butte Creek Segment 3	1347	0.84	-	-	-	-	-	-	-	-	-	-	-	-
OR COAST	21566.3	Butte Creek Segment 4 (upper)	1049	0.65	-	-	-	-	-	-	-	-	-	-	-	-
SONC	1	Cedar (Elk) Creek Segment 1	456	0.28	X	X	X	X	X	X	X	X	X	-	-	X
SONC	18	Cedar (Euchre) Creek Segment 1	1340	0.83	-	-	-	-	X	X	X	X	X	X	X	-
SONC	18	Cedar (Euchre) Creek Segment 2	885	0.55	-	-	-	-	X	-	-	-	X	X	-	-
OR COAST	25	Chesley Creek Segment 1	118	0.07	-	-	-	-	-	X	X	-	X	X	X	-
OR COAST	25	Chesley Creek Segment 2	1285	0.80	-	-	-	-	-	X	X	X	X	X	-	-
SONC	14	Crew Canyon Creek Segment 1	1119	0.70	X	X	X	X	X	X	-	X	X	-	-	-
SONC	9	Crook Creek Segment 1	921	0.57	X	X	X	X	X	X	X	X	-	X	-	-
SONC	9	Crook Creek Segment 2	670	0.42	X	X	X	X	X	X	X	X	-	X	-	-

OR COAST	21534	Crystal Creek Segment 2	2129	1.32	-	-	-	-	-	-	X	-	-	-	-	-
OR COAST	21534	Crystal Creek Segment 3	1584	0.98	-	-	-	-	-	-	X	-	-	-	-	-
OR COAST	36	Crystal Creek Segment 4 (Trib, Keller)	340	0.21	-	-	-	-	-	-	X	-	-	-	-	-
SONC	26	Deadline Creek Segment 2	1666	1.03	-	-	-	-	-	X	X	X	X	-	-	-
SONC	0	Deer Creek Segment 1	586	0.36	-	-	-	-	-	-	-	-	-	-	-	-
OR COAST	5	Donaldson Creek Segment 1	505	0.31	X	X	X	X	X	X	X	X	X	X	X	-
SONC	12	Edson (Rogue) Creek Segment 1	519	0.32	X	X	X	X	X	-	-	-	-	-	-	-
SONC	12	Edson (Rogue) Creek Segment 2	533	0.33	X	X	X	X	X	X	X	X	-	X	X	-
SONC	12	Edson (Rogue) Creek Segment 3	717	0.45	-	-	-	-	-	X	X	X	X	X	X	-
OR COAST	12	Edson (Rogue) Creek Segment 4	229	0.14	-	-	-	-	-	-	-	X	X	X	X	-
OR COAST	21	EF Floras Creek Segment 1	892	0.55	-	-	-	-	-	-	X	X	X	X	-	-
OR COAST	21	EF Floras Creek Segment 2	1063	0.66	-	-	-	-	-	X	-	X	X	X	-	-
SONC	0	Elk Creek Segment 1	907	0.56	-	-	-	-	-	-	-	-	-	-	-	-
SONC	33	Farmer Creek Segment 1	599	0.37	-	-	-	-	-	-	-	-	-	-	-	-
SONC	33	Farmer Creek Segment 2	1068	0.66	-	-	-	-	-	X	-	-	-	-	-	-
OR COAST	21560.76	Fourmile Segment 1	2036	1.27	-	-	-	-	-	-	-	-	-	-	-	-
OR COAST	23	Gallagher Creek Segment 1	721	0.45	-	-	-	-	-	X	X	X	X	X	-	-
OR COAST	24	Guerin Creek Segment 1	763	0.47	-	-	-	-	-	-	X	X	X	-	-	-
SONC	34	Hamilton Creek Segment 1	998	0.62	-	-	-	-	-	X	X	X	X	-	-	-
SONC	16	Hubbard Creek Segment 1	236	0.15	-	-	X	X	X	X	-	-	X	-	-	-
SONC	16	Hubbard Creek Segment 2	253	0.16	-	-	X	X	X	X	-	X	X	-	-	-
SONC	16	Hubbard Creek Segment 3	839	0.52	-	-	X	X	X	X	-	-	-	-	-	-
SONC	16	Hubbard Creek Tributary Segment 4	297	0.18	-	-	X	X	X	X	-	-	-	-	-	-
SONC	2	Indian (Elk) Creek Segment 1	820	0.51	X	X	X	-	X	X	X	X	X	X	-	X
SONC	2	Indian (Elk) Creek Segment 2	734	0.46	X	X	X	-	X	X	X	X	X	X	-	X
SONC	2	Indian (Elk) Creek Tributary Segment 3	944	0.59	X	X	X	-	X	X	X	X	X	X	-	X
SONC	20031	Jack's Creek Segment 2	3381	2.10	-	-	-	-	-	-	X	-	-	-	-	-
OR COAST	6	Jenny (aka Jim) Creek Segment 1	280	0.17	X	X	X	X	X	X	X	X	X	-	-	-
SONC	35	Jordan Creek Segment 1	783	0.49	-	-	-	-	-	X	X	X	X	-	-	-
SONC	27	Kimball Creek Segment 1	1265	0.79	-	-	-	-	-	X	X	X	X	-	-	-

SONC	44	Kermit Creek Segment 1	896	0.56	-	-	-	-	-	-	-	-	-	-	-	X
SONC	44	Kermit Creek Segment 2	296	0.18	-	-	-	-	-	-	-	-	-	-	-	X
SONC	0	Koontz and Davis Segment 1	674	0.42	-	-	-	-	-	-	-	-	-	-	-	-
SONC	29	Little SF Hunter Creek Segment 1	943	0.59	-	-	-	-	-	X	-	-	-	-	-	-
OR COAST	21552	Middle Fork Sixes (lower)Segment 1	1787	1.11	-	-	-	-	-	-	-	-	-	-	-	-
OR COAST	21552.6	Middle Fork Sixes (upper) Segment 1	1495	0.93	-	-	-	-	-	-	-	-	-	-	-	-
OR COAST	19	Morton Creek Segment 1 (Trib)	612	0.38	-	-	-	-	-	X	X	X	-	-	X	-
OR COAST	19	Morton Creek Segment 2	1325	0.82	-	-	-	-	-	-	X	X	-	X	X	-
SONC	0	Mountain Home Drive Creek Segment 1	793	0.49	-	-	-	-	-	-	-	-	-	-	-	-
OR COAST	8	N. Langlois Creek Segment 1	668	0.42	X	X	X	X	X	-	-	-	-	-	X	-
OR COAST	8	N. Langlois Creek Segment 2	315	0.20	X	X	X	X	X	X	-	-	X	X	-	-
OR COAST	20	NF Floras Creek Segment 1	1605	1.00	-	-	-	-	-	-	X	X	X	X	-	-
SONC	15	Pea Creek Segment 1	429	0.27	X	X	X	X	X	X	-	-	-	-	-	-
SONC	15	Pea Creek Segment 2	364	0.23	-	-	-	-	X	X	-	X	-	-	-	-
SONC	11	Ranch Creek Segment 1	726	0.45	X	X	X	X	X	X	X	X	-	X	-	-
SONC	11	Ranch Creek Segment 2	207	0.13	X	X	X	X	X	X	X	-	-	X	-	-
SONC	28	Saunders Creek Segment 1	254	0.16	-	-	-	-	-	X	-	-	-	-	-	-
SONC	28	Saunders Creek Segment 2	1845	1.15	-	-	-	-	-	X	X	X	-	-	-	-
SONC	32	Scott Creek Segment 1	768	0.48	-	-	-	-	-	X	-	-	-	-	-	-
OR COAST	40	SF Fourmile Segment 1	2911	1.81	-	-	-	-	-	-	-	X	-	-	-	-
SONC	42	SF Hubbard Creek Segment 1	2937	1.82	-	-	-	-	-	-	-	X	X	X	-	-
SONC	20210	SF Lobster Creek Segment 2.1	1680	1.04	-	-	-	-	-	-	X	-	-	-	-	-
SONC	30	SF Pistol River Segment 1	2188	1.36	-	-	-	-	-	X	-	-	-	-	-	-
SONC	30	SF Pistol River Segment 2	1339	0.83	-	-	-	-	-	-	-	-	-	-	-	-
SONC	37	Silver Creek (Rogue) Segment 1	711	0.44	-	-	-	-	-	X	-	-	-	-	-	-
SONC	37	Silver Creek (Rogue) Segment 2	1576	0.98	-	-	-	-	-	X	-	-	-	-	-	-
OR COAST	41	South Langlois Creek Segment1	773	0.48	-	-	-	-	-	-	-	X	X	X	X	-
OR COAST	7	Sullivan Creek Segment 1	311	0.19	X	X	X	X	X	X	X	X	X	-	-	-
SONC	39	Swamp Creek (Elk) Segment 2	755	0.47	-	-	-	-	-	-	X	-	-	-	-	-

OR COAST	4	Swanson Creek Segment 1	522	0.32	X	X	X	-	X	X	X	X	X	X	X	-
OR COAST	4	Swanson Creek Segment 2	517	0.32	X	X	X	-	X	X	X	X	X	X	X	-
SONC	38	Taylor Creek Segment 1	462	0.29	-	-	-	-	-	X	-	-	-	-	-	-
SONC	10	Turner Creek Segment 1	564	0.35	X	X	X	X	X	X	-	-	-	-	-	-
OR COAST	21569	Willow Creek Segement 2	2450	1.52	-	-	-	-	-	-	-	-	-	-	-	-
OR COAST	21569	Willow Creek Segment 3	715	0.44	-	-	-	-	-	-	-	-	-	-	-	-

Project Name	Stormchasers
Year(s) Monitored	2004, 2005, 2006, 2007, 2008, 2015
Watershed(s) Investigated (HUC12)	
Parameter(s) Measured	Turbidity, Temperature, Conductivity, E. coli, Nitrate+nitrite, Total Phosphorous

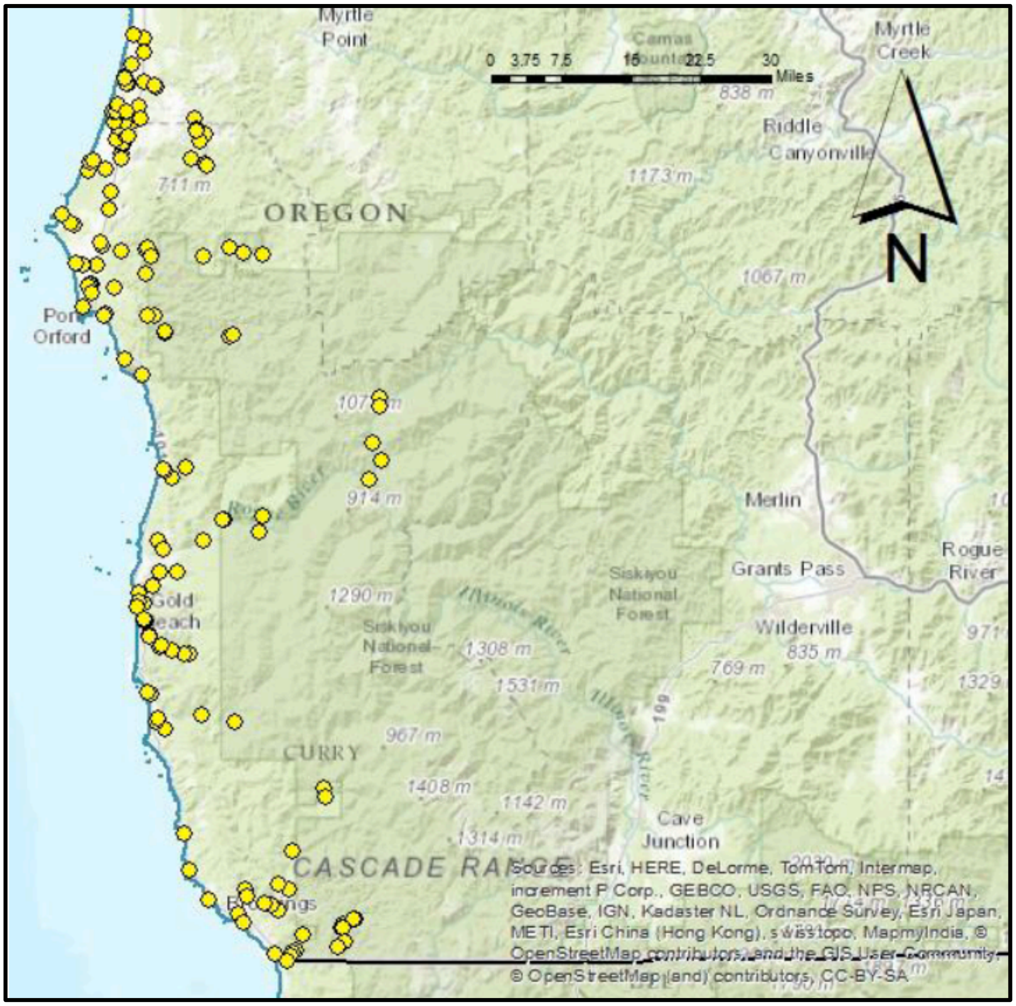


Figure 25: Map of sample site locations

Project Overview

The Stormchasers water quality sampling program was a large scale, synoptic water quality storm sampling project that mobilized a large number of volunteers throughout Curry County. The goal of the project was to attempt to determine which tributaries throughout our watersheds contribute the highest loads of sediment, nutrients, and bacteria during storm events. Volunteers collected grab samples of water quality during multiple storm events each year the project was active, focusing on the "first flush" initial storm event of the fall-winter-spring season and at least one subsequent large storm event later in the season. All grab samples were processed for turbidity and conductivity, and select samples were also processed for nitrate+nitrite, total phosphorous, and/or E. coli. The selection of which sites to sample for said additional parameters was based on previous sampling efforts that indicated potential issues in those areas.

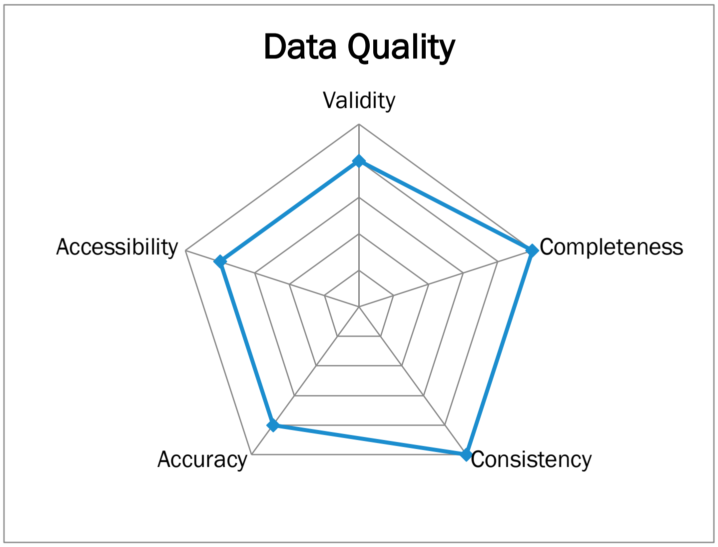
Data from these collection events have been analyzed both in-house and by a contracted statistician. Initial analysis included a comparative analysis between sites and watersheds that attempted to correlate results on a storm-by-storm basis due to limited precipitation and flow data that hindered the ability to compare results between storms. Subsequent analysis conducted by a statistician included two multivatiate analytical methods (multiple linear regression and maximum likelihood factor analysis) to examine potential relationships and limiting factors between stormchasers data and datasets such as land use cover and geology. Results from this project were complicated by the large amount of variability between watersheds and storms and the lack of covariates to account for some of that variability. Additionally, QAQC concerns of the nitrate+nitrite and total phosphorous samples lowered the confidence of the results due to accuracy concerns.

Results and Discussion

The initial analysis of the data examined results by storm, breaking up the service area into the north county and south county areas. This results summary is based on turbidity results from the most recent stormchasers sampling year (2015) which summarized results from 2004-2008 and provided results from the 2015 sampling event (***TABLE 23***). In the north county, the highest overall turbidity samples were in the Sixes River and Floras Creek watersheds and the lowest, on average, were found in the Elk River. In the south county, the highest 2015 results were in Edson and Billings Creeks, tributaries of the Rogue, and the Winchuck had the lowest results. The multivariate analyses found that earthflow density appears to be a strong driver of turbidity and phosphorous; grazing appears to be a strong driver of E.coli and conductivity; and drainage area is also a strong driver of conductivity.

The results from these analyses, while attempting to shed some light on what's driving increases in water quality parameters during storms, should be viewed as more exploratory than explanatory. This is due to complications in the study design and data collection phases that inhibit the ability to conduct a strong, statistically rigorous analysis on this dataset. It is encouraging that the results from the analyses that have been done support agreed upon theories of what is likely driving the presence of these parameters, such as earthflows having a strong effect on turbidity and agricultural grazing being associated with E. coli presence. However, additional refinement of the project design and sampling plan would need to be done to enhance the analytical techniques that could be used to get more definitive results in the future.

Data Overview (Quality and Future Value)



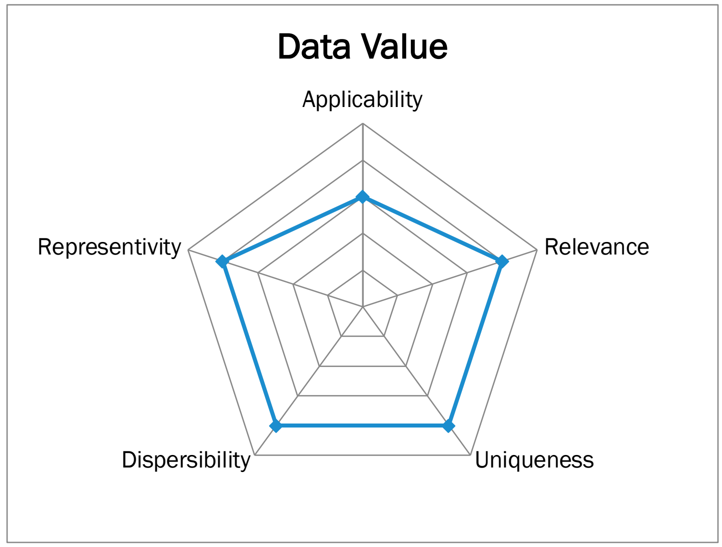


Figure 26: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

The quality of the data collection efforts was quite good. This is impressive given the number of sampling sites that were collected in a small time window by a large number of volunteers. The use of standardized data collection and sampling methods helped in this effort. A DEQ Sampling and Analysis plan and rigorous QAQC procedures also helped in guaranteeing high quality data. However, the QAQC procedures indicated a potential issue with the nutrient sampling efforts, which downgraded the overall accuracy and validity of the results.

The value of this data is still decent, but the majority of the dataset being over a decade old now limits its applicability to current and future conditions. The limited number of covariates to associate with this data also limits its ability for quantitative analysis. However, this is a large dataset that can inform some broad-scale qualitative efforts to examine the effects of storms on water quality. It also could act as pilot data for a more refined design of this study in the future.

Summary

This was an incredibly ambitious project that covered a substantial geographic range and mobilized a large volunteer base. It produced a sizeable dataset of mostly high quality data that has helped to shed light on this hydrologically and geologically complex area. That complexity is readily apparent in the many difficulties that have been associated with analyzing this dataset over the years. These difficulties have shed light on aspects of the study design that could be refined for future monitoring efforts. One of the primary issues associated with analyzing these data is that every storm varies in intensity both on a storm by storm basis and geographically. These variations can potentially be accounted for by examining precipitation and streamflow data, but the small number of available stations in our service area limits one's ability to do so. Additionally, the disparate number of sites sampled for nutrients and bacteria complicated the multivariate analysis, which would have been more powerful if all sites were sampled for all parameters during each event. However, the qualitative evidence of where we see increased turbidity is helpful in determining potential focus areas of interest for future restoration efforts. Also, regardless of the quality of the data that was collected, this project mobilized a large number of volunteers in a substantial citizen science effort. The importance of this should not be understated because engaging with a community like this has a myriad of benefits outside of the strength of one's analysis, such as getting people interested and engaged in their watersheds. This helps to highlight the work we do and the importance of better understanding these issues and how everyone can aid in the effort to enhance the health and wellbeing of our watersheds.

Summary Tables and Statistics

Table 23: Summary of north county sites from 2015 study

Site_UID	SITE_NAME	Sp_Cond µS	SpC %tile	Turbidity, NTU	Turb %tile	2004-2008 Median
2	Floras Lake: Swanson Creek at 101	68	0.33	49	0.40	0.14
15	Floras Lake Outlet at BLM trail bridge	127	0.94	5	0.08	0.63
26.5	New River: South Langlois Creek at Blanco School	70	0.40	64	0.44	0.13
26.7	New River: South Langlois at confluence with the "lane"	98	0.77	20	0.27	ND
35	New River: Morton Creek at Hwy 101	121	0.85	118	0.54	0.51
37	New River: Morton Creek at RM 0.99 (u/s of riparian reach)	121	0.85	111	0.52	ND
50	New River: Morton Creek at d/s end of CREP fence, relocated channel	122	0.90	133	0.60	0.63
75	New River: Butte Creek @ Hwy 101	132	0.96	92	0.48	0.34
79	New River: Butte Creek near mouth	132	0.96	86	0.46	0.42
100	New River: Fourmile Creek at Hwy 101	103	0.79	300	0.88	0.92
105	New River: South Fork Twomile Creek at Hwy 101	91	0.73	5.9	0.15	0.49
110	New River: Twomile Creek at Hwy 101	88	0.71	98	0.50	0.74
1020	Floras Creek: East Fork off Langlois Mtn Road	62	0.19	272	0.81	0.64
1028	Floras Creek: North Fork: Williams Creek at mouth	59	0.17	124	0.56	0.44
1030	Floras Creek: North Fork @ Langlois Mtn Road	79	0.65	291	0.85	0.72
1035	Floras Creek: North Fork @ mouth	68	0.33	248	0.79	0.87
1040	Floras Creek: South Fork @ mouth	56	0.10	338	0.94	0.77
1050	Floras Creek: mainstem at White Elephant Br.	58	0.15	244	0.77	0.88
1060	Floras Creek: mainstem at Mormon Camp	68	0.33	198	0.73	ND
1064	Floras Creek: Sullivan Creek	119	0.83	224	0.75	ND
1066	Floras Creek: mainstem at Hwy 101	73	0.54	191	0.71	0.92
1088	Floras Creek: Willow Creek @ County Bridge	65	0.31	19	0.25	0.37
2007	Sixes River: mainstem d/s of Rusty Buttes bridge	74	0.56	396	0.96	0.85
2008.5	Sixes River: Big Creek at Sixes River Road	47	0.04	538	0.98	0.80
2008.7	Sixes River: Otter Creek at Sixes River Road	45	0.02	586	1.00	0.45
2016	Sixes River: mainstem d/s of South Fork	72	0.50	330	0.92	ND
2025	Sixes River: mainstem at Moon Mtn Rd Br (blw Elephant Rock Ck)	64	0.27	325	0.90	0.81
2034	Sixes River: mainstem u/s of Dry Creek	71	0.46	181	0.69	0.86
2037	Sixes River: Dry Creek at mouth	57	0.13	4.3	0.06	0.33
2040	Sixes River: mainstem u/s of Edson Creek	70	0.40	148	0.65	0.78
2046	Sixes River: Edson Creek u/s of Sixes R Rd Br	62	0.19	134	0.63	0.51
2060	Sixes River: mainstem at Hwy 101 bridge	71	0.46	59	0.42	0.73
2065	Sixes River: Crystal Creek mainstem at Hwy 101 bridge	64	0.27	27	0.29	0.51
3016.5	Elk River: Lost Creek at road	50	0.06	6.3	0.17	0.15
3029	Elk River: mainstem u/s of Bald Mountain Creek	63	0.25	3.7	0.04	0.36
3032	Elk River: Bald Mountain Creek near mouth	51	0.08	48	0.38	0.15
3035	Elk River: mainstem u/s of hatchery, u/s of Anvil Creek	62	0.19	9.3	0.23	0.40
3037	Elk River: Champman Creek u/s of Elk R Rd	74	0.56	8.8	0.19	0.21
3050	Elk River: Bagley Creek near mouth	36	0.00	36	0.35	0.21
3070	Elk River: mainstem at Highway 101	70	0.40	5.1	0.10	0.55
3085	Elk River: Cedar Creek @McKenzie Rd bridge	72	0.50	8.8	0.19	0.18
3090	Elk River: Swamp Creek at McKenzie Rd Bridge	169	1.00	2	0.02	0.13
4019	Garrison Lake: Mill Creek at west culvert on Mill Pond Rd	115	0.81	5.5	0.13	0.10
4025	Garrison Lake: Mill Creek @ Arizona Street	123	0.92	1.8	0.00	ND
4088	Hubbard Creek: mainstem at Hwy 101	94	0.75	28	0.31	0.38
4093	Brush Creek: Beartrap Creek at Hwy 101	82	0.67	31	0.33	0.11
5030	Euchre Creek: mainstem u/s of Boulder Ck	74	0.56	166	0.67	0.67
5058	Euchre Creek: Cedar Cr: D/s end Cedar Bend Golf	82	0.67	288	0.83	0.46
5065	Euchre Creek: mainstem at Ophir Road Br	78	0.63	130	0.58	0.67

Table 2: Summary of south county sites from 2015 study

Site_UID	SITE_NAME	Sp_Cond µS	SpC %tile	Turbidity, NTU	Turb %tile	Area Median
6080	Rogue: Billings Creek mouth	146	1.00	1090	1.00	0.68
6150	Rogue: Foster Creek at mouth	135	0.97	4.3	0.08	0.36
6800	Rogue: mainstem u/s of Lobster Ck (at Br)	107	0.73	16	0.35	0.44
6895	Lobster Creek: mainstem at mouth, ODFW trap	92	0.54	7.8	0.16	0.42
6940	Rogue R blw Lobster: Jim Hunt Creek at mouth	79	0.35	16	0.35	ND
6949.5	Rogue R blw Lobster: Edson Ck: West Fork u/s of East Fork	109	0.81	391	0.95	0.42
6950	Rogue R blw Lobster: Edson Ck: East Fork at Edson Ck Rd RM 0.02	110	0.84	330	0.89	0.51
6955	Rogue R blw Lobster: Edson Creek at North Bank Rogue Rd	117	0.89	740	0.97	0.41
6967	Rogue R blw Lobster: Saunders Creek at RM 0.49	97	0.59	14	0.32	0.75
6975	Rogue R blw Lobster: Ranch Creek at North Bank Rogue Rd	123	0.92	55	0.70	0.57
6989	Rogue R blw Lobster: Indian Creek u/s of tidal influence	107	0.73	84	0.78	0.66
7001	Rogue R Estuary: Dean Creek at culvert outlet to Rogue	108	0.78	63	0.76	0.50
7003	Gold Beach Coastal Area: Riley Creek across from Power sub-station	125	0.95	129	0.81	0.45
7007	Gold Beach Coastal Area: Cuniff Creek at mouth RM 0.00	80	0.38	300	0.86	0.90
7039	Hunter Creek: mainstem at High Bridge	80	0.38	29	0.51	0.54
7069	Hunter Creek: mainstem at bridge 0.92 RM d/s of Rose Cr	84	0.43	33	0.54	0.71
7075	Hunter Creek: mainstem at Mateer Bridge	85	0.49	39	0.59	0.73
7085	Hunter Creek: mainstem at low County Br.	102	0.68	44	0.65	0.71
8069	Pistol River: mainstem u/s of Deep Creek	73	0.32	23	0.43	0.84
8071	Pistol River: Deep Creek at mouth	63	0.19	24	0.46	0.57
8084	Pistol River: mainstem at Pistol Loop Bridge	67	0.24	36	0.57	0.86
8089	Pistol River: Crook Creek at Pistol Loop Br	97	0.59	28	0.49	0.59
8400	Coastal Area: Whaleshead Creek near mouth	87	0.51	9.8	0.22	0.84
8500	Coastal Area: Lone Ranch Creek near mouth	95	0.57	4	0.05	0.95
8700	Coastal Area: Harris Creek	116	0.86	368	0.92	0.97
9050	Chetco River: South Fork near mouth	62	0.16	13	0.30	0.36
9058	Chetco River: at USGS gage (2nd bridge) RM 10.4	71	0.30	12	0.27	0.54
9079	Chetco River: North Fork near mouth	46	0.00	7	0.14	0.70
9087	Chetco River: Jacks Creek: Hamilton Creek at Mouth	54	0.03	178	0.84	0.33
9090	Chetco River: Jacks Creek: just downstream of Fish Trap	57	0.11	43	0.62	0.55
9092	Chetco River: mainstem @Social Security hole	67	0.24	9.6	0.19	0.62
9096	Chetco River: Joe Hall Creek at North Bank Chetco R Road	84	0.43	53	0.68	0.50
9150	Chetco R Estuary: Fish House Creek, outlet by fish cleaning	99	0.65	58	0.73	0.75
9200	Chetco Estuary: Tuttle Creek at Driftwood RV park	102	0.68	16	0.35	0.47
9515	Winchuck River: East Fork upstream of Wheeler Ck	56	0.08	2.8	0.03	0.09
9550	Winchuck River: mainstem @ Winchuck Estates	55	0.05	1.9	0.00	0.16
9559	Winchuck River: 1.3 mi upstream of Hwy 101	58	0.14	11	0.24	0.22
9570	Winchuck River: South Fork near mouth	64	0.22	5	0.11	0.40

Project Name	New River, Sixes River, Elk River, and Euchre Creek Tidal Wetlands Assessment
Year(s) Monitored	2014
Watershed(s) Investigated (HUC12)	New River – Frontal Pacific Ocean (HUC10 – 1710030601), Lower Sixes River (171003060203), Lower Elk River (171003060302), Euchre Creek (171003060403)
Parameter(s) Measured	Variety of parameters related to wetland functions, values, alterations, and restoration potential associated with the Hydrogeomorphic Rapid Assessment Method (HGM RAM) (Adamus 2006).

Project Overview

Project Objectives:

1. Provide data that promotes strategic planning for conservation and restoration of tidal wetlands, and facilitates outreach about wetland functions, historic extent, and alterations.

2. Select tidal wetlands in each estuary and conduct surveys of hydrogeomorphic indicators (rapid assessment method) to determine functions and values provided by each wetland.

3. Evaluate risks to integrity and sustainability of the tidal wetlands evaluated.

4. Provide baseline data on indicators of wetland function that can be used to predict and monitor effectiveness.

5. Provide baseline data on species composition and cover to assist with project planning and implementation.

This project examined wetlands in four watersheds located in the northern half of Curry County. The primary components of the project included summarizing relevant information pertaining to the formation and function of wetlands within each of these watersheds, and conducting hydrogeomorphic rapid wetland assessments on a select number of wetlands within each watershed. The wetlands assessed were:

- New River: Hanson Slough, New Lake Outlet, Fourmile Creek, Clay Island Breach
- Sixes River: Orchard Hole, Sweet Ranch, Sixes River Mouth, Sullivan Gulch
- Elk River: Swamp Creek
- Euchre Creek: Euchre Creek Mouth

Hydrogeomorphic (HGM) Rapid Assessment Method (RAM): Ten tidal and nearby floodplain wetlands in a variety of geomorphic settings were surveyed using the HGM protocol. The HGM survey scores 55 indicators, including botanical transects, used to rank wetland functions (calculated by indicator scoring models). Wetland descriptions were compiled that include lists of plant species by transect and management observations/proposed restoration actions. Additional HGM assessment results including wetland integrity and risk assessment results were also conducted, leading to additional restoration recommendations.

This project and report was completed following two other wetland assessment reports carried out by the Monitoring Program: Rogue River Estuary Tidal Wetlands Assessment (2013), and Oregon South Coast Estuaries: Hunter Creek, Pistol River, Chetco River, & Winchuck River Tidal Wetlands Assessment (2013). The assessment methods used in all three of these projects were similar, except the other projects also employed the OWEB Estuary Assessment method along with HGM-RAM. The OWEB Estuary Assessment method is mentioned in the introductory portion of this report, but any results from this assessment are not included (e.g. table of prioritization of tidal wetlands within each watershed). Narrative information from the portion of the report that describes each watershed could be used towards completing this assessment, but there is no evidence that this was done. Therefore, the results of this work are solely based on narrative information and HGM-RAM results.

Results and Discussion

The bulk of the report is broken up into three primary sections. The results of each are summarized below:

South Coast Estuaries – This section provided information pertaining to each watershed, as well as the HGM-RAM botany survey results. The following list provides a summary of pertinent information. See the full report for HGM-RAM botany survey results.

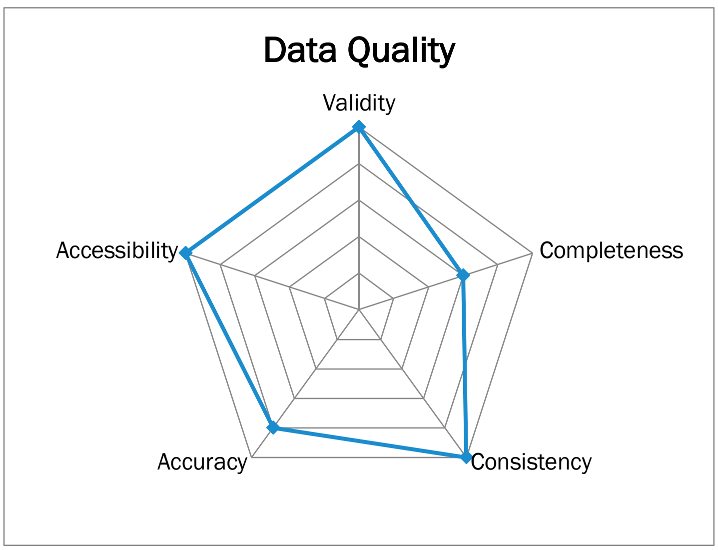
- New River Watershed: This is a very dynamic watershed, as the mainstem of New River primarily runs perpendicular to the ocean, separated by a foredune, and multiple drainages exit out into this 12-mile stretch of stream. The New River/Lower Floras Creek complex has the largest amount of wetland acreage of any of the South Coast watersheds (>2,300 acres, 67 individual wetlands). Much of this area has been identified as salmonid habitat, as well as being recognized by the Audobon Society of Portland as an Important Bird Area due to the presence of Snowy Plover and utilization of wetland resources by many other migratory bird species (e.g. up to 100,000 Aleutian Canada Geese use this area every spring). Four sites were identified for HGM-RAM evaluations.
- Sixes River Watershed: There are an estimated 1,372.5 acres of wetlands in the watershed. Previous studies have identified increasing temperatures as a known issue of concern in the Sixes River. The lower 2.5 miles of the river are subject to tidal influence. This area experiences dramatic change during the summer months due to high northwest winds depositing sand and sill across the river's mouth; resulting in the river becoming bar-bound and disconnecting from the ocean. This results in high waters in the estuary that provide access to additional side-channels and wetland areas otherwise not accessible during summer months. The Sixes estuary is the most complex of any on the South Coast due to its size and the amount of available habitat and large wood. A study conducted in 2003, the results of which are included in this report, identified and prioritized 15 wetlands within the lower watershed for conservation and/or restoration. Four of these sites were selected for the HGM-RAM evaluation portion of this project.
- Elk River Watershed: The Elk River has historically supported multiple native salmonid species: Chinook, coho, cutthroat, and steelhead. All of these species can still be found in the watershed today, albeit in much smaller numbers than what the presumed historic population sizes once were. One factor that has likely led to this decline in populations, especially for coho, is habitat modifications primarily in the lower watershed. Wild Chinook populations have also been affected due to interactions with hatchery fish; an ODFW Chinook hatchery has been active in the Elk since the early 1970's. An extensive evaluation of factors associated with fish abundance and habitat associations was conducted in the early 2000's, and found that one of the primary habitat types to focus on for conservation and restoration is unconstrained valleys and nearby valley segments. Many of these unconstrained valleys are found in the lower floodplain both upstream and within the estuary. One common characteristic of these unconstrained valleys is an abundance of wetlands within their natural floodplain. In addition to this evaluation, the study that was conducted on the Sixes in 2003 to identify and prioritize wetlands for conservation and/or restoration was also completed on the Elk. One of these wetlands was identified for an HGM-RAM evaluation.
- Euchre Creek: Euchre Creek is one of the smallest watersheds along the South Coast. In relation to this, the estuary is quite small: only the first 0.8 miles of the mainstem is estuarine. There are 90 acres of wetlands within the watershed; a majority of which are in the lower watershed. Less than half of these

wetlands have been identified as highly altered, and more than a third have seen very little alterations. One wetland located within the estuarine reach was identified for an HGM-RAM evaluation.

Hydrogeomorphic Tidal Wetlands Rapid Assessment Method – This section provides background information on the HGM-RAM methodology an how it was implemented in the study, along with the results of the surveys and how each wetland ranks in regards to wetland integrity and potential risks to said integrity. The tables of these results can be found in the Summary Statistics portion of this report. All of the wetlands ranked relatively high in regards to wetland integrity. This is purported to be due to the relatively undisturbed conditions of many of these wetlands. The risk assessment to wetland integrity looked at 12 functions and how each wetland's functional score compared to both a theoretical max score as well as a best reference tidal wetland. Refer to the report for a detailed analysis of each function and explanations for why certain wetlands scored as they did.

Restoration Opportunities/Limitations – This section provides a broad set of recommendation actions for each estuary as a whole. Some common recommendations include utilizing conservation easements and working with agencies to maximize restoration potential on government owned land. Refer to the report for more details and specific recommendations.

Data Overview (Quality and Future Value)



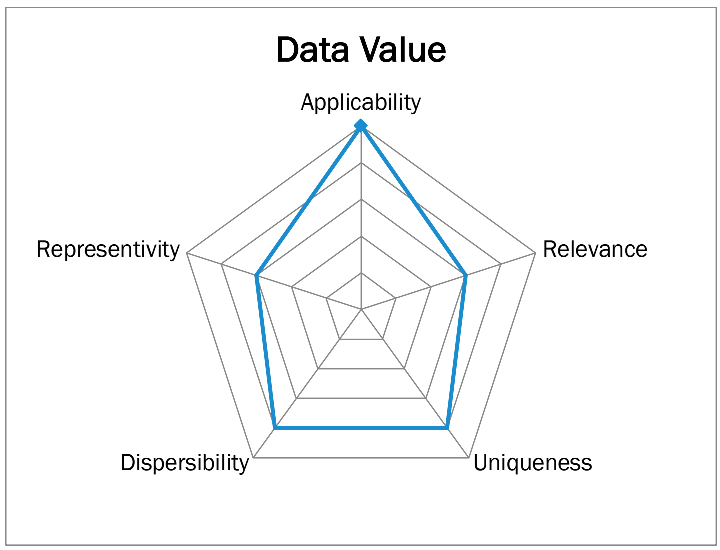


Figure 27: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

- Data Quality
  - Validity: Data collection efforts followed established protocols and no indication of invalid data collection is present.
  - Completeness: The OWEB Estuary Assessment portion of the tidal wetland assessments completed for the other estuaries in the county was not done for this report. Therefor comparisons and evaluations between estuaries cannot be done. The HGM-RAM assessments were completed..

- Consistency: All data collection efforts followed the same protocols and did not deviate from them.
- Accuracy: HGM-RAM protocols appear to be properly carried out. Vegetation transect surveys followed standard protocols, and data were properly recorded and archived.
- Accessibility: HGM assessment data is all available and all botany data was assembled into a database that contains a large amount of high quality information.

- Data Value
    - Relevance: This data was recently collected, and has already informed restoration project efforts. However, the HGM-RAM protocol is now somewhat outdated, being replaced in many instances by a new functional assessment method, ORWAP (Oregon Rapid Wetland Assessment Protocol). A comparison between HGM-RAM and ORWAP would need to be done to understand if this project's data could be transferred or if there is a way to compare HGM and ORWAP results.
    - Uniqueness: Others have examined some of the wetlands in these estuaries before, and newer remote sensing technologies have added to our understanding, but other surveys of this extent have not been conducted.
    - Applicability: The applicability of the vegetation survey data is quite strong. However, as mentioned before, the HGM-RAM protocol has mostly been replaced by ORWAP, which would likely be the preferred method to use in future wetland assessments.
    - Representability: These protocols look at a number of representative ecological functions. However, many are not direct measurements and are synthesized from a number of parameters that are ranked using best professional judgement. Also, The OWEB estuary assessment method would make this report more applicable and comparable to the other wetland assessments carried out during this period.
    - Dispersibility: This information may be valuable to multiple partners but does not directly relate to one partner's scope of responsibilities, except possibly the Department of State Lands.

Summary

This project leverages the HGM-RAM tool, along with past assessments, reports, and evaluations, to examine a number of tidally influenced wetlands within the northern half of Curry County in an attempt to best quantify tidal wetland extent and functions, and determine areas of priority for restoration and conservation actions. This project was completed in concert with two additional projects that examined the remaining estuaries in Curry County, however those projects employed additional assessment methodologies that were not included in this report. Those methodologies, when combined with HGM-RAM, help to tell the overall story of each wetland; how it likely formed, how it's currently functioning, what limiting factors are effecting it, and what potential restoration actions could be taken to enhance it. The reporting from the HGM-RAM evaluations do a good job of synthesizing a lot of this information, and could be a tool to assess these wetlands in the future for potential restoration actions.

The applicability of utilizing the protocols carried out in this project for future monitoring efforts is mixed. The vegetation transect surveys, and the additional information in the accompanying database, are quality monitoring tools that could be used to track change over time in the vegetation communities in these wetlands. The HGM-RAM protocol could also potentially be used to assess changes to wetland functions as well, since multiple parameters are assigned scores that can be reassessed and compared to past scores. However, many of these parameters don't rely on direct measurements. They instead rely on the person carrying out the assessment to use their best professional judgement to assign a score to each parameter. This method introduces the potential for bias, and the uncertainty that can result in two different scores from two individuals using their unique backgrounds and knowledge bases to inform their best professional judgement. As a monitoring tool to track change over time, this assessment method would likely not be able to measure short-term changes and would best be used after a significant period of time (5+ years) in order to assess broad-scale changes that have occurred in the wetland. Additionally, the HGM-RAM protocol is no longer the standard wetland functional assessment protocol used by the state of Oregon; it has been replaced by the Oregon Rapid Wetland Assessment Protocol (ORWAP). Additional investigation into how ORWAP compares to HGM-RAM, if their scores could be compared, and which protocol to use in the future to either carry out additional rounds of assessments to track changes over time or to assess other wetlands would need to be carried out before conducting future assessments. Paul Adamus is the creator of both protocols and would be a great resource to reach out.

Summary Tables and Statistics

Wetland Integrity Value Comparison

Indicator	NR Clay	NR Four	NR NL	NR Hanson	SR Mouth	SR Sullivan	SR Orchard	SR Sweet	ER Swamp	EC Mouth
SpDeficit	0.25	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0
DomDef	0.50	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
NnDef	1.0	0.50	1.0	0.75	0.75	0.5	0.75	0.50	0.01	0.5
AnnSp	0.01	0.01	0.01	0.01	0.01	1.0	0.01	0.01	0.01	.01
TapSp	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.01	1.0
StoSp	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.25
TuftSp	0.01	1.0	1.0	0.75	0.75	.01	1.0	1.0	1.0	1.0
Mean Score	0.54	0.79	0.86	0.79	0.79	0.72	0.82	0.79	0.72	0.68

Table 6: Wetland Integrity Values **SpDeficit** = Difference between actual and predicted species per plot, **DomDef** = Difference between actual & predicted dominance proportion of plots with>90% cover, **NnDef** = Difference between actual & predicted proportion of plots containing non-native species with >20% cover, **AnnSp** = Proportion of quadrats that contain annuals, **TapSp** = Mean percent-cover of tap-rooted wetland species among all quadrats, **StoSp** = Mean percent-cover of stoloniferous species among all quadrats, **TuftSp** = Mean percent-cover of tuft-rooted wetland species among all quadrats. **NR** = New River, **SR** = Sixes River, **ER** = Elk River, **EC** = Euchre Creek

Figure 28: Wetland Integrity Values for all wetlands that received an HGM-RAM evaluation.

Wetland Function Scores, HGM Rapid Assessment Method											
Function	New River				Sixes River				Elk River	Euchre Creek	
	Hansen Slough	New Lake Outlet	Fourmile Creek	Clay Island Breach	Orchard Hole	Sweet Ranch	Sullivan Gulch	Mouth	Mouth of Swamp Creek	Mouth	
	Function capacity compared to theoretical score for function										Average
Produce Aboveground Organic Matter	0.39	0.37	0.40	0.43	0.47	0.40	0.33	0.33	0.41	0.42	0.395
Export Aboveground Plant & Animal Production	0.37	0.34	0.29	0.45	0.53	0.38	0.25	0.23	0.41	0.41	0.366
Maintain Element Cycling Rates & Pollutant Processing; Stabilize Sediment	0.42	0.58	0.64	0.41	0.68	0.64	0.22	0.35	0.64	0.43	0.501
Maintain Habitat for Native Invertebrates	0.46	0.43	0.46	0.41	0.63	0.38	0.40	0.52	0.45	0.47	0.461
Maintain Habitat for Anadromous Fish	0.28	0.28	0.03	0.08	0.32	0.29	0.00	0.26	0.18	0.17	0.189
Maintain Habitat for Visiting Marine Fish	0.23	0.04	0.01	0.03	0.15	0.21	0.00	0.18	0.13	0.02	0.1
Maintain Habitat for Other Visiting & Resident Fish	0.22	0.20	0.03	0.10	0.39	0.27	0.00	0.00	0.34	0.13	0.168
Maintain Habitat for Nekton-feeding Wildlife	0.21	N/A	N/A	N/A	0.22	0.30	N/A	0.21	0.22	N/A	0.232
Maintain Habitat for Ducks and Geese	0.34	0.45	0.38	0.17	0.36	0.50	0.42	0.28	0.37	0.31	0.358
Maintain Habitat for Shorebirds	0.42	0.70	0.53	0.39	0.49	0.40	0.36	0.42	0.40	0.42	0.453
Maintain Habitat for Native Landbirds, Small Mammals, & Their Predators	0.53	0.42	0.49	0.52	0.55	0.37	0.37	0.53	0.41	0.29	0.448
Maintain Natural Botanical Conditions	0.75	N/A	0.70	0.95	1.00	0.85	0.85	0.85	0.80	1.00	0.861111
Average	0.385	0.385	0.36	0.36	0.48	0.42	0.29	0.35	0.40	0.37	

Wetland Function Scores, HGM Rapid Assessment Method											
Function	New River				Sixes River				Elk River	Euchre Creek	
	Hansen Slough	New Lake Outlet	Fourmile Creek	Clay Island Breach	Orchard Hole	Sweet Ranch	Sullivan Gulch	Mouth	Mouth of Swamp Creek	Mouth	
	Function capacity compared to best reference tidal wetland										
Produce Aboveground Organic Matter	0.54	0.47	0.00	0.69	0.81	0.56	0.34	0.33	0.60	0.63	0.554
Export Aboveground Plant & Animal Production	0.38	0.33	0.26	0.49	0.60	0.38	0.20	0.17	0.44	0.44	0.369
Maintain Element Cycling Rates & Pollutant Processing; Stabilize Sediment	0.32	0.55	0.66	0.31	0.71	0.64	0.02	0.23	0.64	0.33	0.441
Maintain Habitat for Native Invertebrates	0.35	0.28	0.34	0.21	0.74	0.15	0.20	0.48	0.32	0.37	0.344
Maintain Habitat for Anadromous Fish	0.37	0.37	0.01	0.09	0.43	0.39	N/A	0.34	0.23	0.21	0.271111
Maintain Habitat for Visiting Marine Fish	0.24	N/A	N/A	N/A	0.13	0.21	N/A	0.17	0.10	N/A	0.17
Maintain Habitat for Other Visiting & Resident Fish	0.24	0.21	0.03	0.10	0.43	0.30	N/A	0.00	0.37	0.14	0.202222
Maintain Habitat for Nekton-feeding Wildlife	0.12	N/A	N/A	N/A	0.13	0.24	N/A	0.12	0.13	N/A	0.148
Maintain Habitat for Ducks and Geese	0.40	0.58	0.46	0.13	0.43	0.66	0.53	0.31	0.45	0.36	0.431
Maintain Habitat for Shorebirds	0.22	0.69	0.41	0.17	0.33	0.20	0.13	0.22	0.19	0.22	0.278
Maintain Habitat for Native Landbirds, Small Mammals, & Their Predators	0.58	0.37	0.52	0.58	0.62	0.29	0.28	0.59	0.35	0.14	0.432
Maintain Natural Botanical Conditions	0.25	0.55	0.20	0.45	0.50	0.35	0.35	0.35	0.30	0.50	0.38
	0.33	0.44	0.29	0.32	0.49	0.36	0.26	0.28	0.34	0.33	

Figure 29: The Risk Assessment to Wetland Integrity compares how each function identified for every wetland compares to a theoretical maximum score, and a best available reference wetland. Green indicated higher stability in that function and red indicates higher risk to function alteration or degredation.

Project Name	Rogue River Estuary Tidal Wetlands Assessment
Year(s) Monitored	2013
Watershed(s) Investigated (HUC12)	Gold Beach – Rogue River (171003100803)
Parameter(s) Measured	Variety of parameters related to wetland functions, values, alterations, and restoration potential associated with the Ecological Prioritization Criteria (Brophy 2007) and Hydrogeomorphic Rapid Assessment Method (HGM RAM) (Adamus 2006) protocols.

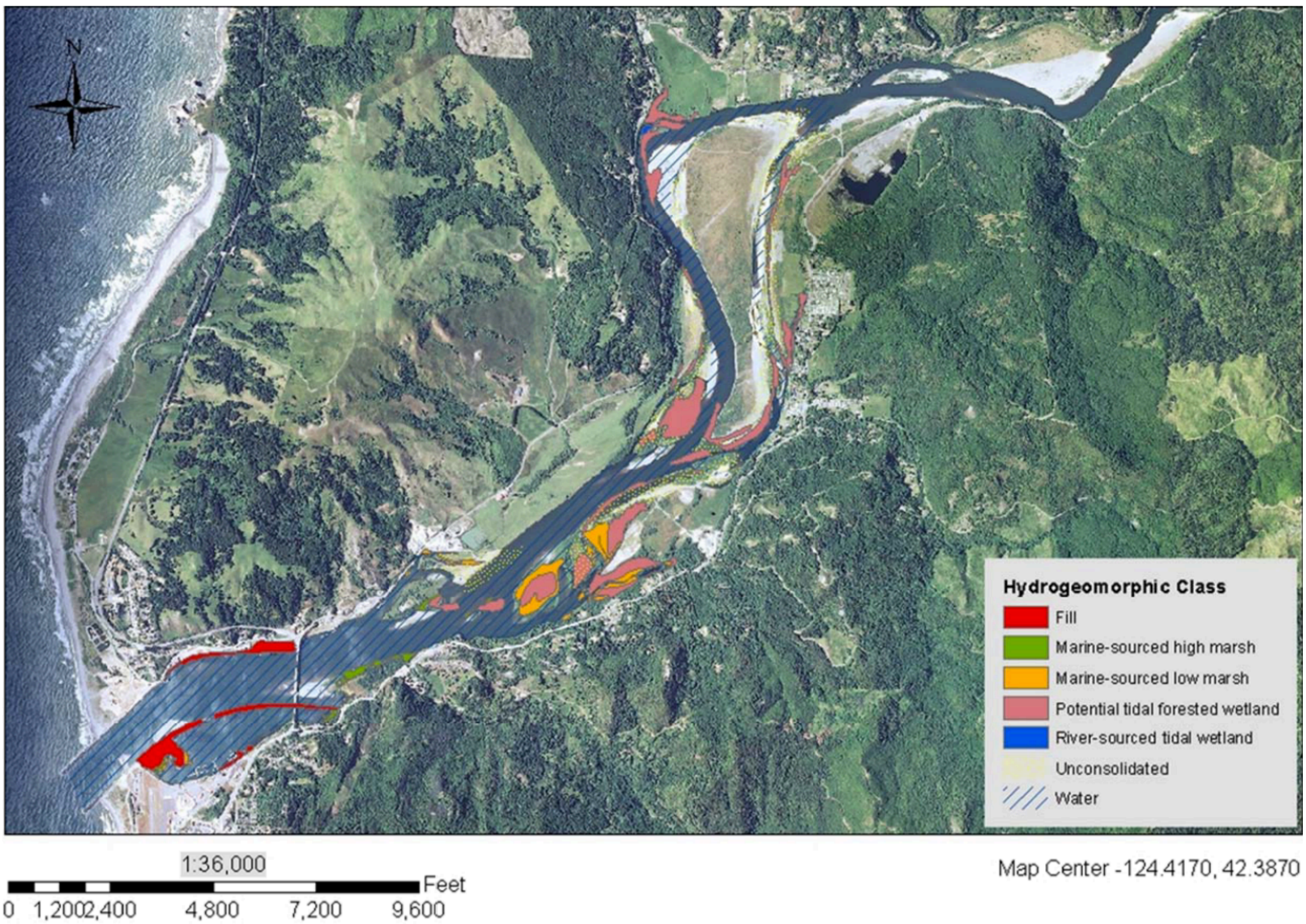


Figure 30: Map of Rogue River estuary extent with identified wetlands mapped according to their HGM class

Project Overview

This assessment combines the Brophy (2007) and Adamus (2005) approaches to quantify the extent and causes of habitat loss and hydrogeomorphic changes in tidal wetlands in the Rogue River. The potential for restoring critical habitat and wetland functions is ranked using Ecological Prioritization Criteria (Brophy, 2007), while indicators of function, risk, and integrity are evaluated using scoring models from the Adamus (2005) Hydrogeomorphic (HGM) Rapid Assessment Method (RAM).

<u>Ecological Priority Criteria:</u> The extent of inundation (head of tide) during King Tide conditions was observed and documented by staff and volunteers. Field measurements of salinity concentrations and stratification during high and low flow were tabulated. The historic aerial photo record was examined to detect channel migration, floodplain re-vegetation, and human-caused alterations. Related studies were combined with these observations to provide a summary of estuary hydrology, sedimentation, and channel stability related to wetland establishment and loss in each of the four estuaries. Ecological priority scores (Brophy, 2007) varied with wetland size, tidal channel condition, connectivity, and diversity of vegetation classes. Wetlands were categorized as restoration or conservation types, and priority ranks for wetlands were depicted on orthophoto base maps.

<u>Hydrogeomorphic (HGM) Rapid Assessment Method</u>: Six tidal wetlands and nearby floodplain wetlands in a variety of geomorphic settings were surveyed using the HGM protocol, including one "reference" and one restoration site . The HGM survey scores 55 indicators, including botanical transects, used to rank wetland functions (calculated by indicator scoring models). Risks to wetlands include human disturbances in close proximity to the wetlands and floodplains, resulting from the narrow valley floors in this tectonically active region. Wetland integrity is threatened by a surprising large proportion of non-native species in the botanical transects, 40%. Wetland indicators that scored low, and could be restored or enhanced, are discussed in a restoration considerations narrative. Wetland descriptions include lists of plant species, grouped by wetland status, native/non-native, and perennial/annual persistence. In addition to the HGM scores, an analysis of cover and diversity of all plant species in plots, off-transect species diversity, and waterfowl food distribution was completed using a wetland vegetation database developed for the Oregon South Coast.

Results and Discussion

This project report was divided up into three primary sections, the results of which are summarized below:

1. Estuary Hydrology, Sedimentation, and Channel Stability
    - Flood frequency and sediment deposition has decreased since dams on the Rogue and Applegate Rivers were installed in 1977 and 1980
    - The Lobster Creek and the tidal reaches of the river contain some of the most extensive bar deposits on the mainstem Rogue.
        i. Many of those bars have become increasingly vegetated over the years, likely due to reduced flood frequency due to the dams upriver. This increased vegetation stabilized the bars and increases the chances of riverine wetland development.
    - Confined channels and valleys limit lateral channel movement, except from river mile 4.2 to 1.2 where substantial lateral change has been documented from 1967/69 to 2009.
    - Salinity intrusion into the estuary is limited by the river's steep gradient and high volume of discharge
        i. On average, when monitored, the saltwater wedge's upper limit has been at river mile 2.7
        ii. Summer flows (augmented by dam releases) are nearly as large as the tidal prism, which is unusual compared to most estuaries in Oregon
2. OWEB Estuary Assessment (Ecological Prioritization Criteria)
    - Tidal wetland extent is difficult to determine due to limited direct measurements of flow and river height
    - 16 total wetland sites were identified. Eight in the conservation group (155 acres total) and eight in the restoration group (133 acres total)
        i. See Table 1 in Summary Statistics section for Ecological Criteria scores for all 16 wetlands

- Repeat disturbances have limited the development of complex wetlands
    i. It's uncertain if these disturbances were anthropogenic, natural, or a combination of both
    ii. See final report for a detailed explanation of these disturbances and their potential sources

3. HGM Tidal Wetlands Rapid Assessment Method
    - Six wetlands were assessed: Boast Basin West – South, Boat Basin West – North, Indian Creek, Elephant Bar Slough, Lower Saunders Slough, Snag Patch / Edson Creek. Two additional surveys were done in 2014 but the results of those surveys were not included in this report (Elephant Bar Downstream and Indian Creek East)
    - All six wetlands were ranked on a scale of 0-1 (1 = high risk) in three main categories: Wetland Integrity, Risk Assessment, and Wetland Function
        i. See Summary Statistics section for full table of results
    - Full results of the HGM and botanical surveys of each of the six wetlands are summarized in a consistent reporting format and are included in the final report. See the HGM section for these individual wetland reports.

All three of the primary sections in this report have a lot of quality information pertaining to the history and current (as of 2013) status of these wetlands. The protocols are effective at examining multiple functions and potential limiting factors of these wetlands such as historic alterations, amount of tidal inundation, vegetation, and local disturbances. Some of these sections lack sufficient explanations as to how these potential limiting factors relate to wetland health, and a more robust explanation of wetland functions would benefit readers who don't already have a good amount of background knowledge in wetland ecology. For example, the section that discusses salinity does a good job of describing how the tidal prism fluctuates throughout the estuary and why, but does not address how that affects wetlands in the area. However, the individual reports of wetlands that received the HGM assessment do a good job of elucidating what specific issues each wetland has and what could potentially be done to address them.

Data Overview (Quality and Future Value)

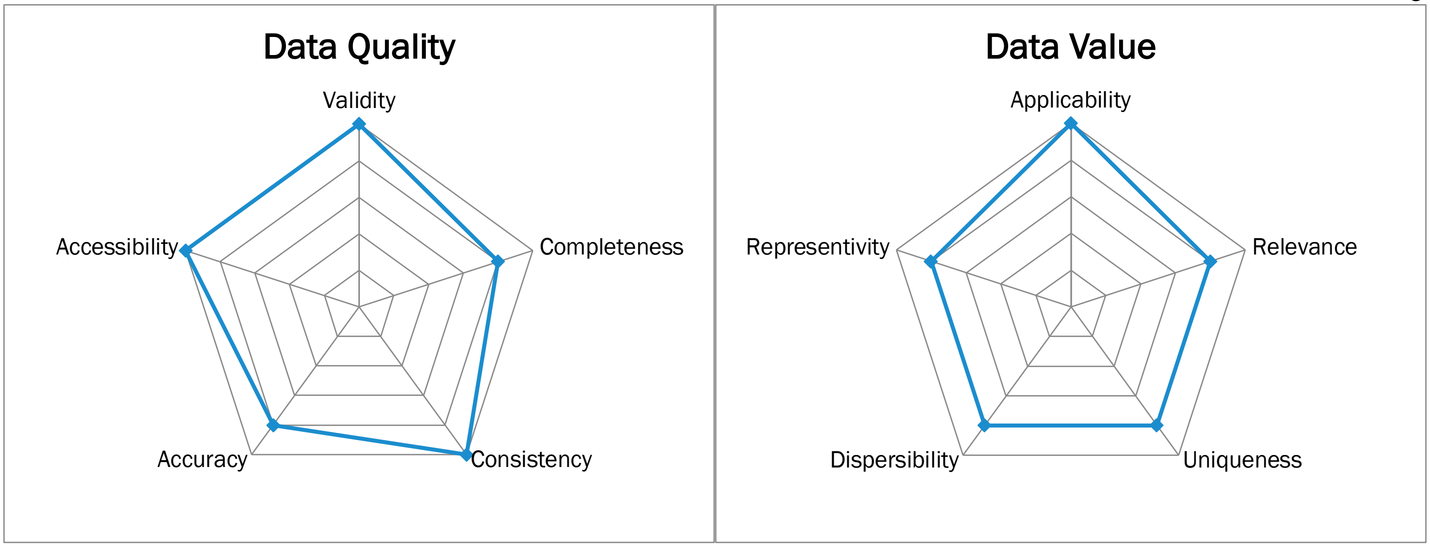


Figure 31: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

- Data Quality
    - Validity: Data collection efforts followed established protocols and there was no indication of invalid data collection.
    - Completeness: There were no complications in the data collection process, and the amount of historic documentation and aerial photos that were collected provided a good extent of information for the historical assessment. However, the extent of tidal inundation was not fully understood and additional monitoring of king tides coupled with direct flow measurements would aid in this understanding.
    - Consistency: All data collection efforts followed the same protocols and did not deviate from them.
    - Accuracy: The assessment of sedimentation and channel stability history using primarily aerial photos and previous reporting gives a decent idea of change over time, but the inability to track yearly change causes one to have to infer a large amount information pertaining to how these wetlands have changed over time. Additional investigations including direct sampling such as soil core samples could help elucidate wetlands histories.
    - Accessibility: All of the HGM RAM data is accounted for. All of the botany transect survey data was assembled into a database that contains a lot of quality botanical information pertaining to species that were surveyed.
- Data Value
    - Relevance: This data were recently collected, and have already informed restoration project efforts. However, the HGM-RAM protocol is now outdated and has been replaced by a new functional assessment method, ORWAP (Oregon Rapid Wetland Assessment Protocol). A comparison between HGM-RAM and ORWAP would need to be done to understand if this project's data could be transferred or if there is a way to compare HGM and ORWAP results.
    - Uniqueness: Others have examined some of the wetlands in these estuaries before, and newer remote sensing technologies have added to our understanding, but other surveys of this extent have not been conducted.

- Applicability: The applicability of the vegetation survey data is quite strong. However, as mentioned before, the HGM-RAM protocol has been replaced by ORWAP which would likely the preferred method to use in future wetland assessments.
- Representability: These protocols look at a number of representative ecological functions. However, many are not direct measurements and are synthesized from a number of parameters that are ranked using best professional judgement.
- Dispersibility: This information may be valuable to multiple partners but does not directly relate to one partner's scope of responsibilities, except possibly the Department of State Lands.

Summary

This project combines multiple assessment protocols over a large area in an attempt to best quantify tidal wetland extent and functions, and determine areas of priority for restoration and conservation actions. It employed a good number of data sources and collection methods (historic aerial photographs, prior reports, in-field functional assessments, vegetation surveys) that, when combined, help to tell the overall story of each wetland; how it likely formed, how it's currently functioning, what limiting factors are effecting it, and what potential restoration actions could be taken to enhance it. The individual wetland reports do a good job of synthesizing a lot of this information and would be a great tool to assess any of these wetlands in the future for potential restoration actions.

The applicability of utilizing the protocols carried out in this project for future monitoring efforts is mixed. The vegetation transect surveys, and the additional information in the accompanying database, are quality monitoring tools that could be used to track change over time in the vegetation communities in these wetlands. The HGM-RAM protocol could also potentially be used to assess changes to wetland functions as well, since multiple parameters are assigned scores that can be reassessed and compared to past scores. However, many of these parameters don't rely on direct measurements. They instead rely on the person carrying out the assessment to use their best professional judgement to assign a score to each parameter. This method introduces the potential for bias, and the uncertainty that can result in two different scores from two individuals using their unique backgrounds and knowledge bases to inform their best professional judgement. As a monitoring tool to track change over time, this assessment method would likely not be able to measure short-term changes and would best be used after a significant period of time (5+ years) in order to assess broad-scale changes that have occurred in the wetland. Additionally, the HGRAM protocol is no longer the standardized wetland functional assessment protocol used by the state of Oregon; it has been replaced by the Oregon Rapid Wetland Assessment Protocol (ORWAP). Additional investigation into how ORWAP compares to HGM-RAM, if their scores could be compared, and which protocol to use in the future to either carry out additional rounds of assessments to track changes over time or to assess other wetlands in the area would need to be carried out before conducting future assessments. Paul Adamus is the creator of both protocols and would be a great resource to reach out.

Summary Tables and Statistics

Ecological Prioritization Results

Proj ID	Site Name	REST_ CON	Acres	Size Score	Tidal Ch Cond Sum	Tidal Ch Cond Score	Connect NWIArea	Connect Score	Salmon Stocks	Salmon Div Score	Swamp Size	Swamp Pct	Swamp Score	NWI Veg *	# Veg Classes	Diversity Score	Total Score	Con Rank	Rest Rank
1	Boat Basin West	CON	2.6	1.1	16.0	4.0	10.9	1.0	4	5.0	0.0	0.00	1.0	EM	1	1	17.1	8	
2	Boat Basin East	CON	1.0	1.0	16.0	4.0	33.6	1.6	4	5.0	0.0	0.00	1.0	EM	1	1	17.6	7	
3	Indian Creek	REST	12.8	1.9	16.0	4.0	61.3	2.3	4	5.0	0.0	0.00	1.0	EM, SS, FO	3	5	23.2		6
4	Elephant Bar Slough	CON	53.1	5.0	20.0	5.0	104.1	3.3	4	5.0	0.0	0.00	1.0	EM, SS, FO	3	5	29.3	2	
5	Elephant Bar Islands	REST	25.9	2.9	20.0	5.0	109.7	3.5	4	5.0	0.0	0.00	1.0	EM, SS	2	3	25.4		2
6	Elephant Bar Fringe	REST	9.4	1.6	16.0	4.0	131.9	4.0	4	5.0	4.7	0.50	3.0	EM, SS	2	3	24.6		5
7	Lower Saunders	REST	6.6	1.4	18.0	4.5	132.9	4.0	4	5.0	4.0	0.61	3.4	EM, SS	2	3	25.9		1
8	Saunders Slough	CON	34.5	3.6	16.0	4.0	160.8	4.7	4	5.0	30.2	0.88	4.5	EM, SS, FO	3	5	30.8	1	
9	Jerry's Flat	REST	25.3	2.9	12.0	3.0	106.5	3.4	4	5.0	13.3	0.53	3.1	SS, FO, NT (EM)	3	5	25.3		3
10	Ferry Hole Bar Fringe	CON	5.7	1.3	16.0	4.0	130.1	4.0	4	5.0	3.3	0.58	3.3	SS	1	1	22.6	6	
11	Snag Patch Island	CON	4.9	1.3	16.0	4.0	79.1	2.7	4	5.0	4.9	1.00	5.0	EM, SS	2	3	25.0	4	
12	Edson Creek	REST	45.7	4.4	14.0	3.5	33.9	1.6	4	5.0	30.4	0.67	3.7	EM, FO	2	3	24.7		4
13	Elephant Rock	CON	43.2	4.2	18.0	4.5	171.1	5.0	4	5.0	6.4	0.15	1.6	EM, SS	2	3	27.8	3	
14	Tidewater	REST	6.1	1.4	14.0	3.5	92.3	3.0	3	1.0	2.3	0.38	2.5	EM	1	1	15.9		8
15	Mailboat Slough	CON	10.2	1.7	18.0	4.5	80.2	2.7	4	5.0	3.1	0.31	2.2	EM, SS	2	3	23.7	5	
16	Industrial fringe	REST	1.2	1.0	16.0	4.0	50.2	2.0	4	5.0	0.7	0.60	3.4	EM	1	1	20.4		7

* Excl. Cowardin veg classes on <10% of the site

Table 1: Ecological prioritization of all 16 wetlands identified using the OWEB Estuary Assessment Protocol. Con Rank is the ranking of all wetlands identified for conservation and Rest Rank is the ranking of all wetlands identified for restoration actions. NWI scores refer to scores made using the National Wetland Inventory (NWI).

Table _: Rogue Wetland Function Scores, HGM Rapid Assessment Method

Function	Boat Basin West- South	Boat Basin West- North	Indian Creek	Elephant Bar Slough	L Saunders Slough	Edson/ Snag Patch
	Function Capacity compared to theoretical high score for function					
Produce Aboveground Organic Matter	0.40	0.40	0.28	0.34	0.27	0.24
Export Aboveground Plant & Animal Production	0.40	0.40	0.21	0.45	0.31	0.34
Maintain Element Cycling Rates & Pollutant Processing; Stabilize Sediment	0.43	0.33	0.42	0.36	0.38	0.46
Maintain Habitat for Native Invertebrates	0.39	0.41	0.49	0.49	0.34	0.43
Maintain Habitat for Anadromous Fish	0.11	0.11	0.59	0.20	0.30	0.54
Maintain Habitat for Visiting Marine Fish	0.16	0.17	0.21	0.33	0.17	0.32
Maintain Habitat for Other Visiting & Resident Fish	0.00	0.00	0.04	0.08	0.05	0.26
Maintain Habitat for Nekton-feeding Wildlife	0.21	0.22	0.36	0.35	0.37	0.38
Maintain Habitat for Ducks and Geese	0.28	0.23	0.28	0.36	0.45	0.40
Maintain Habitat for Shorebirds	0.45	0.46	0.32	0.56	0.32	0.42
Maintain Habitat for Native Landbirds, Small Mammals, & Their Predators	0.39	0.42	0.41	0.28	0.37	0.36
Maintain Natural Botanical Conditions	0.55	0.70	0.15	0.30	0.50	0.35
Risk Assessment - Existing Risks to Wetland Integrity	0.44	0.44	0.43	0.27	0.36	0.38
Wetland Integrity (average botanical indicators, diff from predicted)	0.72	0.89	0.54	0.68	0.68	0.68

Table 2: The results of the HGM-RAM scores for all six wetlands that were surveyed. The bottom two scores are the results of the risk assessment and integrity portions of the HGM-RAM, and the rest of the scores are how well each wetland performs a variety of wetland functions.

Alteration Types in Rogue Tidal Wetland Sites, Detected by Historic Aerial Photographs, Sorted Upstream to Downstream

(types identified with question marks are suspected, but uncertain)

Wetland Site Name	River Miles	Dike	Ditch	Exca-vation	Restrictive Culvert	Road crossing	Channel armor/ riprap	Dredged material disposal	Logging	Grazing	Fill	Cons Rest
Jerry's Flat	3.8-5.0	?	x	x	?	x		x		x		REST
Ferry Hole Bar Fringe	4.0-4.7											CON
Edson Creek	4.4-4.6	?	x	?	x		?	?		x		REST
Snag Patch Island	4.3-4.5											CON
Saunders Slough	2.8-4.2		?		?		?					CON
Elephant Rock	2.9-4.0					x				?		CON
Lower Saunders	3.0-3.3			x		x						REST
Elephant Bar Fringe	2.7-3.1			x		x						REST
Elephant Bar Islands	2.2-2.7					x						REST
Elephant Bar Slough	2.3-2.6									?		CON
Tidewater	1.8-2.0			x	x	x	x					REST
Mailboat Slough	1.4-1.7											CON
Indian Creek	1.0-1.5			x	x	x	x	x		?	?	REST
Industrial fringe	0.0-1.3			x	x	x	?	x	x		x	REST
Boat Basin East	1.0						x					CON
Boat Basin West	0.1-0.2						x	x				CON

Table 3: Alterations that have been done to all wetlands identified via historical photo analysis.

Project Name	Oregon South Coast Estuaries: Hunter Creek, Pistol River, Chetco River, & Winchuck River Tidal Wetlands Assessment
Year(s) Monitored	2013
Watershed(s) Investigated (HUC12)	Lower Hunter Creek (171003120502), Crook Creek – Pistol River (171003120404), Jack Creek – Chetco River (141003120111), South Fork Winchuck River – Winchuck River (141003120202)
Parameter(s) Measured	Variety of parameters related to wetland functions, values, alterations, and restoration potential associated with the Ecological Prioritization Criteria (Brophy 2007) and Hydrogeomorphic Rapid Assessment Method (HGM RAM) (Adamus 2006) protocols.

Project Overview

This assessment combines the Brophy (2007) and Adamus (2005) approaches to quantify the extent and causes of habitat loss and hydrogeomorphic changes in tidal wetlands of four Oregon South Coast Estuaries. The potential for restoring critical habitat and wetland functions is ranked using Ecological Prioritization Criteria (Brophy, 2007), while indicators of function, risk, and integrity are evaluated using scoring models from the Adamus (2005) Hydrogeomorphic (HGM) Rapid Assessment Method.

<u>Ecological Priority Criteria:</u> The extent of inundation (head of tide) during King Tide conditions was observed and documented by staff and volunteers. Field measurements of salinity concentrations and stratification during high and low flow were tabulated. The historic aerial photo record was examined to detect channel migration, floodplain re-vegetation, and human-caused alterations. Related studies were combined with these observations to provide a summary of estuary hydrology, sedimentation, and channel stability related to wetland establishment and loss in each of the four estuaries. Ecological priority scores (Brophy, 2007) varied with wetland size, tidal channel condition, connectivity, and diversity of vegetation classes. Wetlands were categorized as restoration or conservation types, and priority ranks for wetlands were depicted on orthophoto base maps.

<u>Hydrogeomorphic (HGM) Rapid Assessment Method</u>: Six tidal wetlands and nearby floodplain wetlands in a variety of geomorphic settings were surveyed using the HGM protocol, including one “reference” and one restoration site . The HGM survey scores 55 indicators, including botanical transects, used to rank wetland functions (calculated by indicator scoring models). Risks to wetlands include human disturbances in close proximity to the wetlands and floodplains, resulting from the narrow valley floors in this tectonically active region. Wetland integrity is threatened by a surprising large proportion of non-native species in the botanical transects, 40%. Wetland indicators that scored low, and could be restored or enhanced, are discussed in a restoration considerations narrative. Wetland descriptions include lists of plant species, grouped by wetland status, native/non-native, and perennial/annual persistence. In addition to the HGM scores, an analysis of cover and diversity of all plant species in plots, off-transect species diversity, and waterfowl food distribution was completed using a wetland vegetation database developed for the Oregon South Coast.

Results and Discussion

This project report was divided up into three primary sections, the results of which are summarized below:

4. Estuary Hydrology, Sedimentation, and Channel Stability

- Hunter Creek
    i. Transport capacity and sediment supply and relatively balanced
    ii. Upper bar surfaces re-vegetated from 1940-2009 (as seen in aerial photographs) resulting in 52% reduction in area of bed-material sediment, possibly due to reduction in frequency of peak flows
    iii. For more detail see USGS report, "Preliminary assessment of channel stability and bed-material transport along Hunter Creek, southwestern Oregon" (2011)
- Pistol River
    i. High rates of erosion resulting in high sedimentation rates affecting low gradient reaches since the 1950s due to road construction, timber harvest, and peak floods in 1955, 1964, and 1971 leading to bar development, lateral migration, and localized deposition and aggradation.
- Chetco River
    i. Watershed-scale disturbances such as floods, road construction and timber harvest, forest fires; and local activities including dredging for navigation, bank protection, and gravel extraction, are likely to have the greatest effect on sediment transport and channel stability
    ii. 2002 Biscuit Fire burned over 57% of the watershed with varying severity, which has increased recent erosion and sedimentation rates
    iii. Dredging, jetty construction, and bank armoring in the estuary has straightened and deepened the mainstem channel and prevents lateral migration
    iv. From 1939-2008, upper bar surfaces have revegetated (34% reduction in the area of bed-material sediment), possibly from reduced supply upstream or a reduced frequency of peak flows
    v. Most net sediment influx likely deposits upstream of North Fork confluence. A small amount of fine gravel is transported into the estuary reach
- Winchuck River
    i. Bedload and channel stability studies are lacking
    ii. Historic accounts support idea that vertical adjustments due to sedimentation are common, but lateral channel migration has generally not been observed

5. OWEB Estuary Assessment (Ecological Prioritization Criteria)
    - See report for detailed examination of wetland acreage change over time for each estuary via historic and aerial photograph analysis
    - 15 total wetland sites were identified. Five in the conservation group (36 acres total) and 10 in the restoration group (124 acres total) due to alterations of flow restrictions, fill, ditching, bank stabilization, excavation, gravel extraction, grazing, and invasive species
        i. See Table 1 in Summary Tables and Statistics section for Ecological Criteria scores for all 15 wetlands
6. HGM Tidal Wetlands Rapid Assessment Method
    - 6 wetlands were assessed (Sixes Sullivan Gulch, Hunter North Slough and Flat, Pistol Overflow (ODOT Pond), Pistol Former Channel, Winchuck Ranch South, Winchuck Reference, Winchuck Wayside)
    - Wetland Integrity: Winchuck Ranch South and Sixes Sullivan Gulch tied for highest integrity score, lowest was Winchuck Wayside (recent restoration site where vegetation is still in recovery) (See Summary Statistics section for full table of results)
    - Risk Assessment: Summary of potential stressors on a 0 to 1 scale (1 = high risk). Winchuck Reference had lowest score (least at risk from potential stressors) and Winchuck Wayside had highest score (0.43, still relatively low). (See Summary Statistics section for full table of results)

- Wetland Functions: Wetlands were ranked on a variety of different functions, this ranking was too detailed to include in this summary. See report for results.
- See final report for individual reports on all six wetlands

These results summarize the main takeaways from the primary sections of this report. The full extent of the results of this project could not be distilled into this summary report. If you have questions or are looking for information pertaining to a particular wetland or estuary included in this report, it's advised that you seek that information in the full report.

All three of the primary sections in this report have a lot of quality information pertaining to the history and current (as of 2013) status of these wetlands. The protocols are effective at examining multiple functions and potential limiting factors of these wetlands such as historic alterations, amount of tidal inundation, vegetation, and local disturbances. Some of these sections lack sufficient explanations as to how these potential limiting factors relate to wetland health, and a more robust explanation of wetland functions would benefit readers who don't already have a good amount of background knowledge in wetland ecology. However, the individual reports of wetlands that received the HGM assessment do a good job of elucidating what specific issues each wetland has and what could potentially be done to address them.

Data Overview (Quality and Future Value)

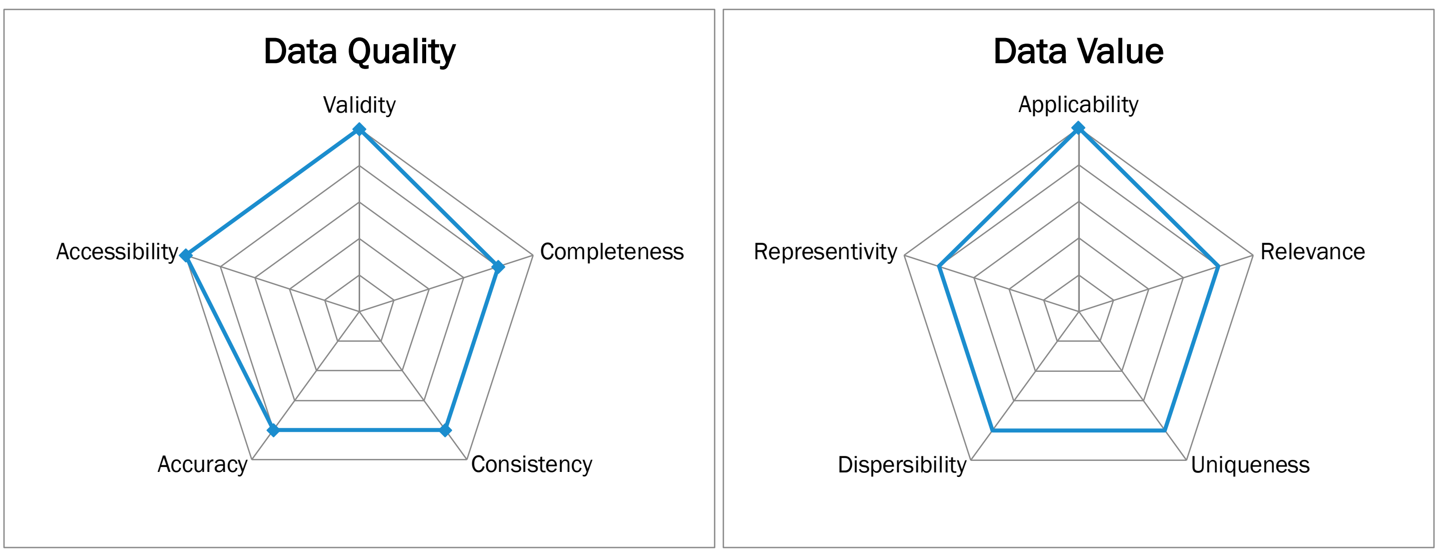


Figure 32: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

- Data Quality

  - Validity: Data collection efforts followed established protocols and there was no indication of invalid data collection.
  - Completeness: There were no complications in the data collection process, and the amount of historic documentation and aerial photos that were collected provided a good extent of information for the historical assessment. However, the extent of tidal inundation was not fully understood and additional monitoring of king tides coupled with direct flow measurements would aid in this understanding.
  - Consistency: All data collection efforts followed the same protocols and did not deviate from them.
  - Accuracy: The assessment of sedimentation and channel stability history using primarily aerial photos and previous reporting gives a decent idea of change over time, but the inability to track yearly change causes one to have to infer a large amount information pertaining to how these wetlands have changed over time. Additional investigations including direct sampling such as soil core samples could help elucidate wetlands histories. Some of the vegetation transects that could not be established following the protocol were established to maximize diversity, which introduces bias to the results and is not representative of the larger area.
  - Accessibility: All of the HGM-RAM data is accounted for. All of the botany transect survey data was assembled into a database that contains a lot of quality botanical information pertaining to species that were surveyed.
- Data Value
  - Relevance: This data was recently collected, and has already informed restoration project efforts. However, the HGM-RAM protocol is now outdated and has been replaced by a new functional assessment method, ORWAP (Oregon Rapid Wetland Assessment Protocol). A comparison between HGM-RAM and ORWAP would need to be done to understand if this project's data could be transferred or if there is a way to compare HGM and ORWAP results.
  - Uniqueness: Others have examined some of the wetlands in these estuaries before, and newer remote sensing technologies have added to our understanding, but other surveys of this extent have not been conducted.
  - Applicability: The applicability of the vegetation survey data is quite strong. However, as mentioned before, the HGM-RAM protocol has been replaced by ORWAP which would likely the preferred method to use in future wetland assessments.
  - Representability: These protocols look at a number of representative ecological functions. However, many are not direct measurements and are synthesized from a number of parameters that are ranked using best professional judgement.
  - Dispersibility: This information may be valuable to multiple partners but does not directly relate to one partner's scope of responsibilities, except possibly the Department of State Lands.

Summary

This project combines multiple assessment protocols over a large area in an attempt to best quantify tidal wetland extent and functions, and determine areas of priority for restoration and conservation actions. It employed a good number of data sources and collection methods (historic aerial photographs, prior reports, in-field functional assessments, vegetation surveys) that, when combined, help to tell the overall story of each wetland; how it likely formed, how it's currently functioning, what limiting factors are effecting it, and what potential restoration actions could be taken to enhance it. The individual wetland reports do a good job of synthesizing a lot of this information and would be a great tool to assess any of these wetlands in the future for potential restoration actions.

The applicability of utilizing the protocols carried out in this project for future monitoring efforts is mixed. The vegetation transect surveys, and the additional information in the accompanying database, are quality monitoring tools that could be used to track change over time in the vegetation communities in these wetlands. The HGM-RAM protocol could also potentially be used to assess changes to wetland functions as well, since multiple parameters are assigned scores that can be reassessed and compared to past scores. However, many of these parameters don't rely on direct measurements. They instead rely on the person carrying out the assessment to use their best professional judgement to assign a score to each parameter. This method introduces the potential for bias, and the uncertainty that can result in two different scores from two individuals using their unique backgrounds and knowledge bases to inform their best professional judgement. As a monitoring tool to track change over time, this assessment method would likely not be able to measure short-term changes and would best be used after a significant period of time (5+ years) in order to assess broad-scale changes that have occurred in the wetland. Additionally, the HGRAM protocol is no longer the standardized wetland functional assessment protocol used by the state of Oregon; it has been replaced by the Oregon Rapid Wetland Assessment Protocol (ORWAP). Additional investigation into how ORWAP compares to HGM-RAM, if their scores could be compared, and which protocol to use in the future to either carry out additional rounds of assessments to track changes over time or to assess other wetlands in the area would need to be carried out before conducting future assessments. Paul Adamus is the creator of both protocols and would be a great resource to reach out.

Summary Tables and Statistics

Table 1: South Coast Tidal Wetland Ecological Prioritization

Wetland Sites	Size, acres	Size Score	Tidal Ch Condition	Connect NWI Ac	Connect Score	Salmon Stocks	Salmon Score	Swamp Score	NWI Veg Types	Veg Div Score	Total Score	Ecol Priority	Rest Rank	Cons Rank
Pistol Pasture channel and swamp	25.5	5.0	3.0	1581	5.0	4	5.0	1.0	EM FO	3	25.0	High	1	
Pistol marsh and swamp	12.5	2.9	4.3	663	2.7	4	5.0	1.0	EM SS	3	23.2	High		1
Winchuck Reference	0.9	1.0	5.0	9	1.0	4	5.0	1.0	EM	1	19.0	High		2
Pistol ODOT overflow	6.8	2.0	3.7	333	1.8	4	5.0	1.0	SS	1	18.1	Mod-High		3
Chetco at Ferry Creek	12.8	2.9	2.3	141	1.3	4	5.0	1.0	EM FO	3	17.9	Mod-High	2	
Chetco at Joe Hall	9.4	2.4	3.7	75	1.2	4	5.0	1.0	SS	1	17.9	Mod-High	3	
Winchuck Johnson South (W)	11.2	2.7	2.3	179	1.4	4	5.0	1.0	EM SS	3	17.8	Mod-High		4
Chetco upstream of 101, east bank	4.5	1.6	3.0	50	1.1	4	5.0	1.0	EM SS	3	17.7	Mod		5
Hunter North	14.6	3.2	3.0	131	1.3	4	5.0	1.0	EM	1	17.5	Mod	4	
Hunter Turner pasture	25.5	5.0	1.7	459	2.1	4	5.0	1.0	EM	1	17.5	Mod	5	
Winchuck Johnson North (E)	7.2	2.0	3.0	108	1.3	4	5.0	1.0	EM	1	16.3	Low-Mod	6	
Chetco at Chetco RV	10.9	2.6	2.3	131	1.3	4	5.0	1.0	EM	1	15.6	Low-Mod	7	
Winchuck Wayside	0.9	1.0	3.0	8	1.0	4	5.0	1.0	EM	1	15.0	Low-Mod	8	
Hunter Turtle Rock	3.0	1.3	2.3	48	1.1	4	5.0	1.0	SS	1	14.1	Low	9	
Chetco upstream of 101, west bank	13.7	3.1	1.0	164	1.4	4	5.0	1.0	EM	1	13.5	Low	10	

Figure 33: Ecological prioritization of all 15 wetlands identified using the OWEB Estuary Assessment Protocol. Con Rank is the ranking of all wetlands identified for conservation and Rest Rank is the ranking of all wetlands identified for restoration actions. NWI scores refer to scores made using the National Wetland Inventory (NWI).

Table 2: Wetland Function Scores, HGM Rapid Assessment Method	Hunter North	Pistol ODOT	Winchuck Wayside	Winchuck Reference	Winchuck Ranch S
Risk Assessment - Existing Risks to Wetland Integrity	0.36	0.33	0.43	0.27	0.28
Wetland Integrity (average botanical indicators, diff from predicted)	0.50	0.72	0.40	0.47	0.72

	Function Capacity compared to theoretical high score for function				
Function	**Hunter North**	**Pistol ODOT**	**Winchuck Wayside**	**Winchuck Reference**	**Winchuck Ranch S**
Produce Aboveground Organic Matter	0.41	0.34	0.41	0.34	0.31
Export Aboveground Plant & Animal Production	0.49	0.30	0.42	0.42	0.26
Maintain Element Cycling Rates & Pollutant Processing; Stabilize Sediment	0.62	0.38	0.41	0.55	0.21
Maintain Habitat for Native Invertebrates	0.50	0.48	0.54	0.56	0.50
Maintain Habitat for Anadromous Fish	0.17	0.16	0.17	0.53	0.22
Maintain Habitat for Visiting Marine Fish	0.18	0.16	0.19	0.31	0.23
Maintain Habitat for Other Visiting & Resident Fish	0.10	0.08	0.05	0.35	0.25
Maintain Habitat for Nekton-feeding Wildlife	0.27	0.31	0.15	0.37	0.21
Maintain Habitat for Ducks and Geese	0.36	0.38	0.22	0.41	0.27
Maintain Habitat for Shorebirds	0.51	0.50	0.39	0.51	0.41
Maintain Habitat for Native Landbirds, Small Mammals, & Their Predators	0.44	0.46	0.54	0.39	0.37
Maintain Natural Botanical Conditions	0.85	0.90	0.85	0.75	0.90

	Function Capacity compared to best reference tidal wetland				
Function	**Hunter North**	**Pistol ODOT**	**Winchuck Wayside**	**Winchuck Reference**	**Winchuck Ranch S**
Produce Aboveground Organic Matter	0.61	0.37	0.59	0.36	0.27
Export Aboveground Plant & Animal Production	0.55	0.27	0.44	0.45	0.21
Maintain Element Cycling Rates & Pollutant Processing; Stabilize Sediment	0.61	0.27	0.31	0.51	0.01
Maintain Habitat for Native Invertebrates	0.44	0.38	0.53	0.59	0.44
Maintain Habitat for Anadromous Fish	0.22	0.21	0.21	0.72	0.28
Maintain Habitat for Visiting Marine Fish	0.17	0.14	0.19	0.35	0.24
Maintain Habitat for Other Visiting & Resident Fish	0.11	0.09	0.05	0.38	0.27
Maintain Habitat for Nekton-feeding Wildlife	0.20	0.25	0.03	0.35	0.12
Maintain Habitat for Ducks and Geese	0.43	0.46	0.22	0.51	0.28
Maintain Habitat for Shorebirds	0.38	0.36	0.17	0.38	0.22
Maintain Habitat for Native Landbirds, Small Mammals, & Their Predators	0.42	0.46	0.60	0.33	0.28
Maintain Natural Botanical Conditions	0.35	0.40	0.35	0.25	0.40

Figure 34: The results of the HGM-RAM scores for all five wetlands that were surveyed. The bottom two scores are the results of the risk assessment and integrity portions of the HGM-RAM, and the rest of the scores are how well each wetland performs a variety of wetland functions.

Project Name	Walker Ranch Water Quality Restoration Monitoring
Year(s) Monitored	2009, 2010, 2011
Watershed(s) Investigated (HUC12)	Crook Creek – Pistol River
Parameter(s) Measured	Turbidity, Specific Conductivity

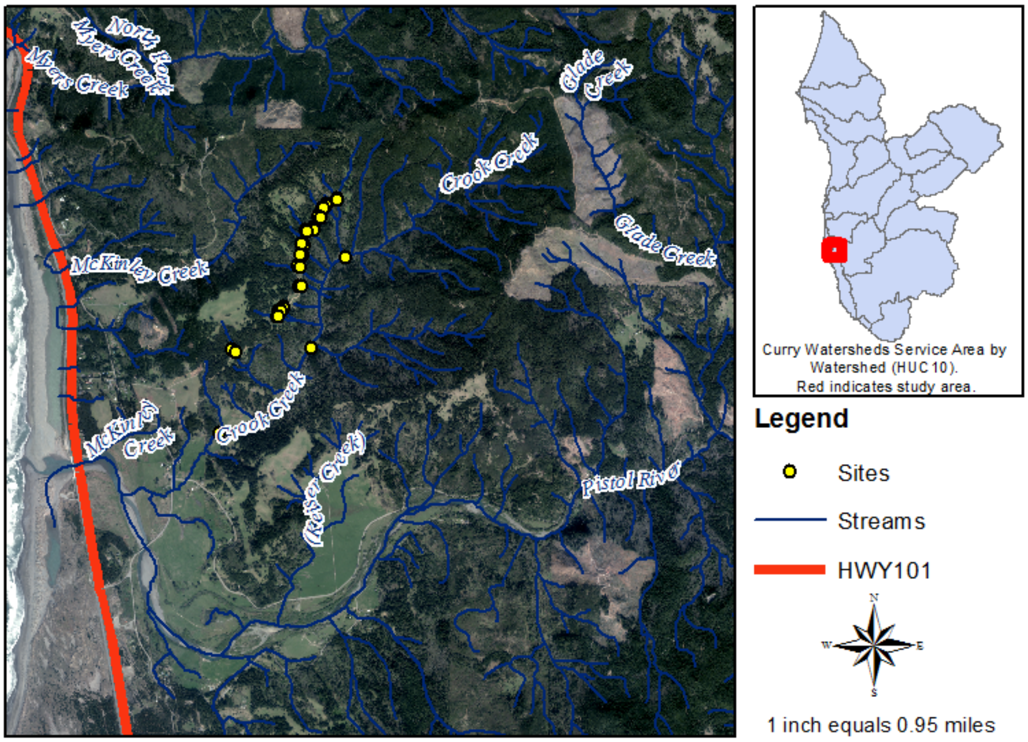


Figure 35: Map of study area with sample site locations

Project Overview

This monitoring project is the project effectiveness portion of the Walker Ranch Water Quality Restoration project, which implemented road sediment abatement and pasture management projects on Walker Ranch. The ranch is located along an upper portion of Crook Creek that drains into the Pistol River. This project aimed to document changes in water quality related to these restoration actions, and did so by measuring turbidity and specific conductivity during storm events upstream and downstream of 12 road-stream crossings and at two seeps throughout the property for three years: one pre-implementation year (2009) and two post-implementation years (2010 & 2011).

Precision was checked using field duplicates for 10% of samples and accuracy was maintained by calibration of meters with standards as discussed in Standard Operating Procedures for Water Quality Monitoring, South Coast and Lower Rogue Watershed Councils (March, 2011 revision).

Precipitation data from the Flynn Prairie remote access weather station was used to measure relative storm intensity in order to compare between sampling events.

Control – Treatment comparisons were calculated by Relative Percent Difference =

100 x [(Treatment – Control) / ((Treatment + Control)/2)]

Results and Discussion

- Pre-implementation mean turbidity downstream of road crossings was over 6x greater than turbidity on upstream, control reaches (39.7 NTUs -> 257 NTUs)
    - The difference between downstream and upstream turbidity measurements for all post-implementation storm events was negligible compared to the aforementioned pre-implementation storm, indicating likely success of implemented projects at reducing in-stream turbidity
- Relative percent difference (RPD) between upstream (control) and downstream (treatment) showed that the largest differences were seen in pre-implementation storms (except for one post-implementation outlier that was sampled much earlier in the season = likely more sediment mobilization due to dry-season sediment accumulation).
- Mean turbidity of control samples was used as a measure of storm intensity in order to examine RPD in relation to that.
    - Comparison of RPD of only the 3 most intense storms (highest mean control turbidity, 1 from each year monitored) showed evidence of substantial turbidity reductions post-implementation.
- RPD of specific conductivity showed similar results to turbidity (lower difference in post-implementation years)

Data Overview (Quality and Future Value)

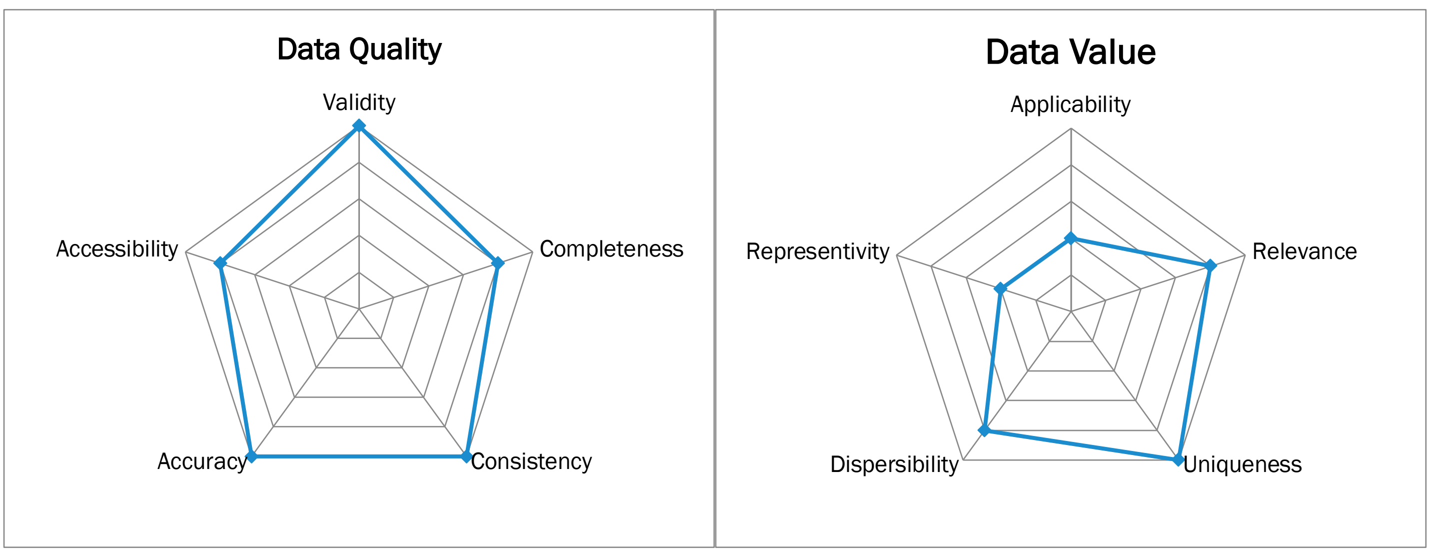


Figure 36: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

The overall quality of the data collected is quite high (Figure 1). This project followed a standardized protocol and had good quality QAQC measures applied throughout the data collection and initial analysis processes. All of the samples are assumed to have been collected in a uniform manner, and all samples were collected by the same person. However, one sample leaked post-collection and was unusable for analysis. All of the raw data is available in the CWP Water Quality Database, but none of the products of the analysis could be found except for what is included in the final report.

This data are of moderate to low value for future use by the CWP or other partners (Figure 1). The greatest likely value these data have are that they are the only turbidity measurements that have been collected by the CWP in this upper subwatershed. The results of this study were relevant and valuable to assessing the initial project, but they would likely not be relevant to future work unless there is a want to conduct a second round of monitoring for this individual project to assess long term conditions. The primary reason these data aren't highly valuable is due to the nature of turbidity measurements being an indirect measure of the desired parameter, which is sedimentation in the water column, which is highly correlated with in-stream flow. It would therefore be improbable to determine the relationship between these data and future data due to the absence of any flow data. Precipitation could potentially be used as a surrogate for flow, but the nearest weather station is too far away to provide accurate enough precipitation data of the study area. This fact that turbidity is so highly correlated with other parameters is why it is also difficult to use turbidity as a representative parameter of overall condition of a study area or watershed.

Summary

This project measured a high number of sites relative to the study area, making the results highly representative of the entire area. The study design was sound, and resulted in good quality data. The final report also does a good job of addressing anomalies and outliers and hypothesizing why these results are the way they are (not caused by error, rather they're likely representative of physical processes, although this cannot be proven given the limited available data).

Many factors that may influence storm event grab sample turbidity measurements make this survey design ineffective at determining causation and allowing for implementation in future monitoring. For example, storm severity and seasonal timing of sampling can have a large effect on the amount of turbidity and runoff entering the stream (early season storms flush more sediment, sampling at different times during storm event could pick up more or less sediment depending on how long sediment has had to mobilize, etc).

This project used mean control turbidity as a measure of storm intensity. The use of mean control turbidity or sp. conductivity as an estimate of storm intensity is arguably a weak metric to represent actual storm intensity because of the number of influential factors not addressed in this metric as mentioned above.

Summary Tables and Statistics

Table 24: Summary Statstics of Data by Parameter and Date

Parameter:Date	n	mean	sd	median	min	max	range	skew	kurtosis	se
Specific Conductance:2/26/2009	31	63.16	12.21	60	40	86	46	0.28	-0.81	2.19
Specific Conductance:3/15/2009	33	53.88	13.93	53	21	81	60	-0.35	-0.35	2.43
Specific Conductance:11/30/2010	32	66.75	12.80	64	43	94	51	0.37	-0.85	2.26
Specific Conductance:1/12/2010	33	69.79	15.77	65	47	109	62	0.82	0.03	2.74
Specific Conductance:2/12/2010	33	64.79	10.67	64	45	84	39	0.21	-0.88	1.86
Specific Conductance:3/12/2010	33	65.03	12.45	61	40	94	54	0.43	0.16	2.17
Specific Conductance:3/8/2011	35	56.57	8.63	57	40	72	32	0.02	-1.07	1.46
Specific Conductance:4/13/2011	35	60.49	12.32	58	41	87	46	0.41	-0.78	2.08
Turbidity:2/26/2009	31	15.32	16.22	11.2	1.18	75.8	74.62	1.90	3.96	2.91
Turbidity:3/15/2009	33	374.40	637.79	77.7	1.06	2156	2154.94	1.91	2.15	111.02
Turbidity:11/30/2010	32	30.47	29.95	17.6	2.12	104	101.88	1.14	-0.03	5.29
Turbidity:1/12/2010	33	10.90	5.66	10.2	2.31	20.2	17.89	0.11	-1.55	0.99
Turbidity:2/12/2010	33	110.25	95.60	75.9	6.8	403	396.2	1.40	1.45	16.64
Turbidity:3/12/2010	33	28.11	17.34	23.7	9.1	89	79.9	1.52	2.51	3.02
Turbidity:3/8/2011	35	73.69	107.37	39.9	6.61	522	515.39	3.12	9.39	18.15
Turbidity:4/13/2011	35	18.48	21.79	11.8	2.35	83.8	81.45	2.08	3.30	3.68

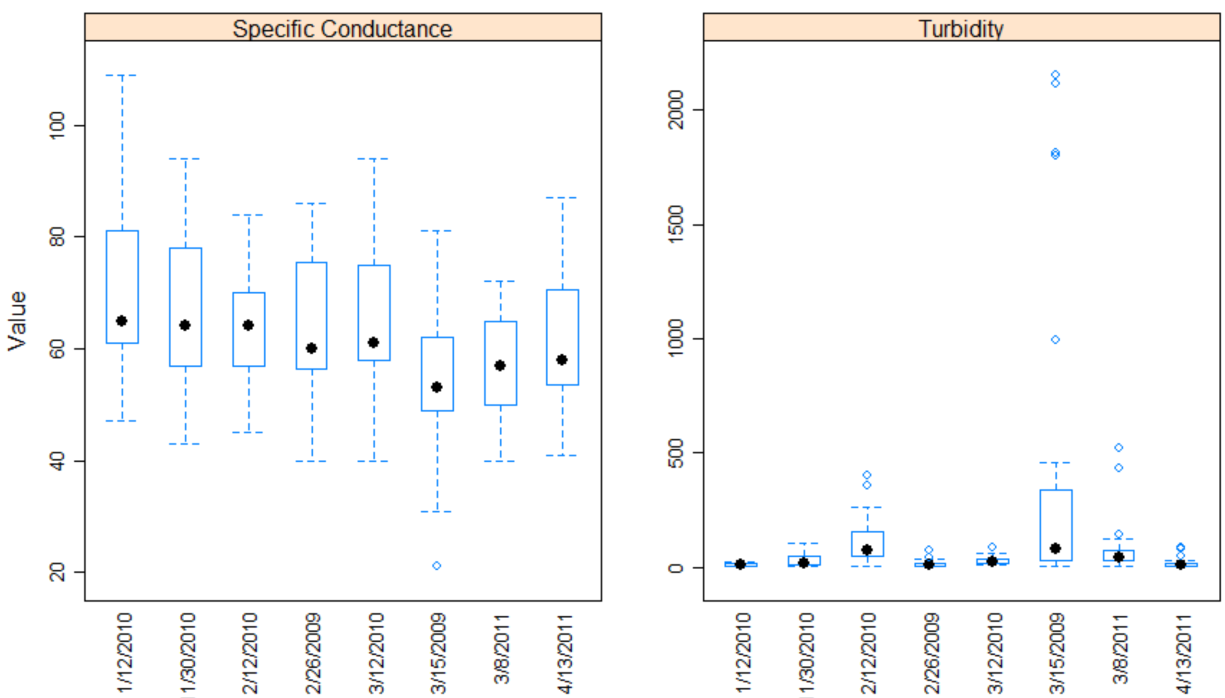


Figure 37: Boxplots of Data by Parameter and Sample Date.

Units of measurement: Specific Conductance (μS), Turbidity (NTU)

Project Name	Winchuck Estuary Nitrate Source Search
Year(s) Monitored	2007
Watershed(s) Investigated (HUC12)	South Fork Winchuck River-Winchuck River (171003120202)
Parameter(s) Measured	Nitrate+nitrite, Specific Conductivity, Turbidity

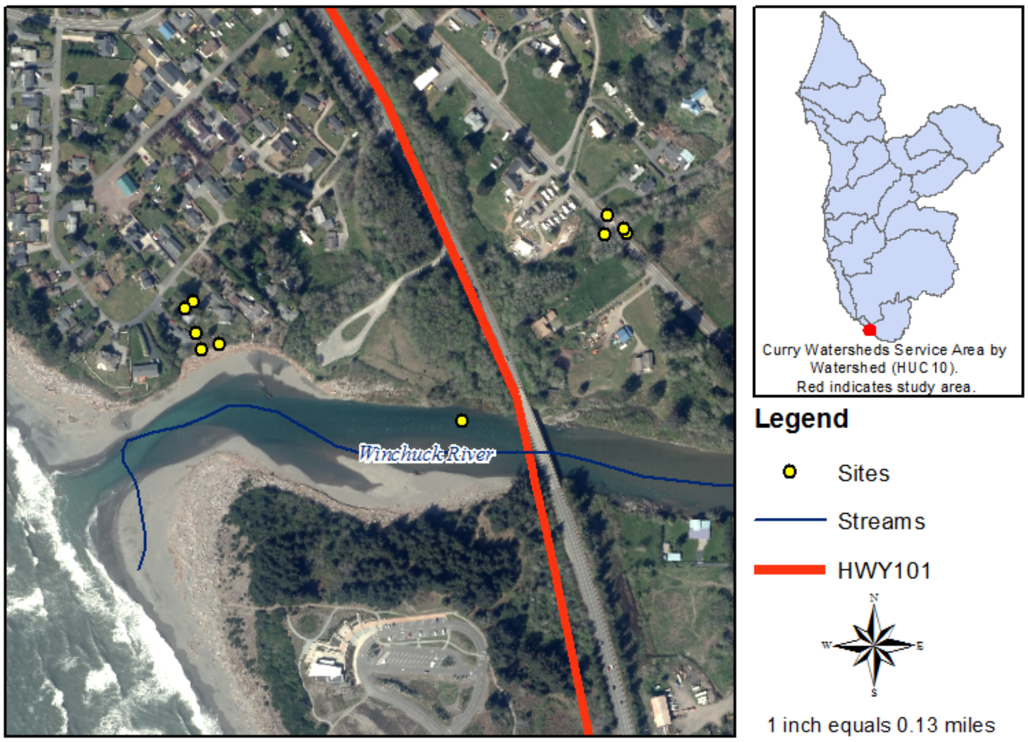


Figure 38: Map of study area with sample site locations

Project Overview

The impetus for this project came from multiple previous water quality sampling efforts in the Winchuck estuary (2004 diurnals and stormchasers projects) that detected relatively high nitrate levels entering the system. The three potential sources that were investigated were: 1) a tributary on the north bank of the estuary near its mouth, 2) a white pipe on the north bank of the estuary near its mouth, and 3) a black pipe on the north bank of the estuary near its mouth. This project's goal was to attempt to identify the sources of nitrate upstream of these outlets to the estuary that had been sampled previously. Red tracer dye was used to identify many of these upstream sources for sites that entered the estuary via a culvert or pipe. A total of 11 sites were sampled via grab samples for nitrate+nitrite, specific conductivity, and turbidity on three separate dates in 2007 (1/3, 2/12, 4/22).

Results and Discussion

The highest concentration of nitrate+nitrite for all three sampling events (1.4-2.2 mg/L) came from water flowing out of a seep that drains into a grate upstream of the black pipe sample site. This could be an indication of a failing septic system leaking into the groundwater source, but further analysis and testing would have to be done to indicate if that is in fact the source.

Most of the sample sites did not, for the most part, indicate excessively high levels of nitrate+nitrite entering the estuary. However, it should be noted that these samples were taken during storm events in the middle of the wet season, so concentrations could be quite diluted and sources from overland flow may have already entered the system. For instance, a Stormchasers sample at the tributary on the north bank site from a storm event on 11/6/2005 resulted in the highest nitrate+nitrate reading of any sample taken at any of these locations (2.9mg/L). This may indicate high concentrations of nitrate+nitrite during the “first flush” from the first substantial storm after months of dry conditions. Additional sampling at different times throughout the year would be needed to better understand these nitrate+nitrite input dynamics.

There were also multiple sites that indicated potential influences from other, non-sampled sources, or intermixing between sources further upstream. Additional sample sites would be needed to better understand these dynamics and isolate potential nitrate+nitrite sources.

Data Overview (Quality and Future Value)

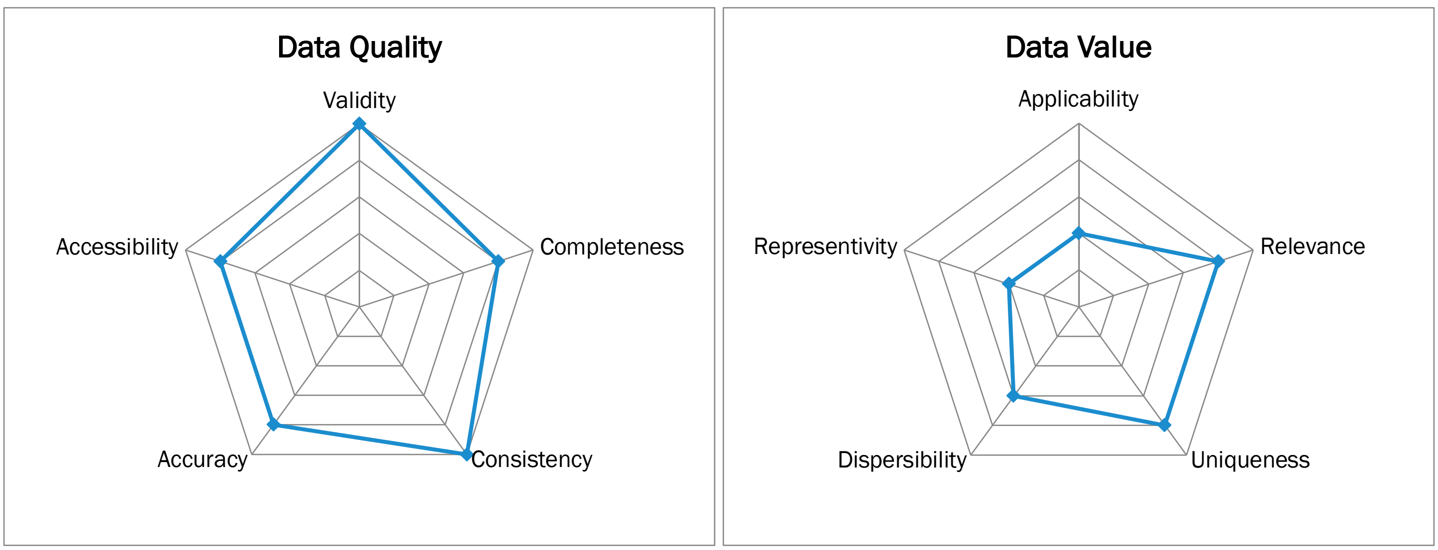


Figure 39: Data Quality and Value Assessment Results.

Data quality represents the overall quality of the data collected, and value represents how valuable the data are in relation to associated projects as well as for use in future monitoring efforts. All parameters were ranked on a 5 point scale with 5 (outer edge of chart) being highest and 0 (center of chart) being lowest.

The overall quality of the data that was collected for this project was quite high. The sample collection methods were sound, using DEQ approved protocols laid out in a Sampling and Analysis Plan, which resulted in valid data acquisition. However, a majority of the nitrate data as graded for quality by DEQ received a ‘B’ level grade, indicating some potential inaccuracy in the data. Four of the 11 sample sites were not sampled during the first storm, and the samples that were collected during that first storm were not sampled for turbidity, otherwise all sample sites and parameters were accounted for in the data. All of the raw data is available in the CWP’s WQDB, but a majority of the analysis and results from said analysis were unaccounted for aside from what was included in the final report.

The overall value of this data as it pertains to future use and applicability is somewhat low. The age of the data at the time of this review (>10 years old), relatively low number of sampling events, and confounding results that indicated the necessity for additional sampling sites and periodicity disqualify this dataset from being applicable to any current or future trend analysis barring additional data and extensive analytical techniques. However, this data do provide some qualitative information pertaining to the history of the water quality of the Winchuck estuary and could be informative for the design of future water quality investigations. It is also data that could be useful for DEQ, and has been shared with them already.

Summary

The intent of this project, to isolate and identify upstream sources of nitrate entering the Winchuck estuary, was only partially accomplished through the implementation of the project due in large part to; confounding results from multiple sample sites indicating potential mixing upstream and additional inputs not identified or sampled, and the relatively low number of sampling events during only one season with no follow up investigations being conducted. This project did succeed in identifying at least one potentially significant source of nitrate from a seep upstream of the black pipe that drains into the estuary. It is also the only source of data of upstream nutrient sources that could be affecting the estuary. This information could be useful for informing the development of future investigations of the Winchuck estuary's water quality, but cannot likely be utilized for quantitative analysis of current or future conditions.

Summary Tables and Statistics

Table 25: Summary Statistics of Data by Parameter and Date

Paratemer:Date	n	mean	sd	median	min	max	range	skew	kurtosis	se
Nitrate-Nitrite:03-Jan-07	7	1.61	0.30	1.59	1.27	2.2	0.93	0.88	-0.42	0.11
Nitrate-Nitrite:12-Feb-07	11	1.15	0.44	1.05	0.324	1.85	1.526	-0.11	-0.99	0.13
Nitrate-Nitrite:22-Apr-07	11	0.81	0.40	0.765	0.033	1.44	1.407	-0.09	-0.65	0.12
Specific Conductance:03-Jan-07	7	126.43	22.37	121	104	164	60	0.46	-1.52	8.45
Specific Conductance:12-Feb-07	11	107.27	16.72	113	62	119	57	-1.70	1.98	5.04
Specific Conductance:22-Apr-07	11	103.45	14.79	108	64	116	52	-1.61	1.73	4.46
Turbidity:03-Jan-07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Turbidity:12-Feb-07	11	5.44	4.82	4.82	0.31	15.3	14.99	0.69	-0.76	1.45
Turbidity:22-Apr-07	11	9.22	7.07	8.41	0.22	22	21.78	0.13	-1.23	2.13

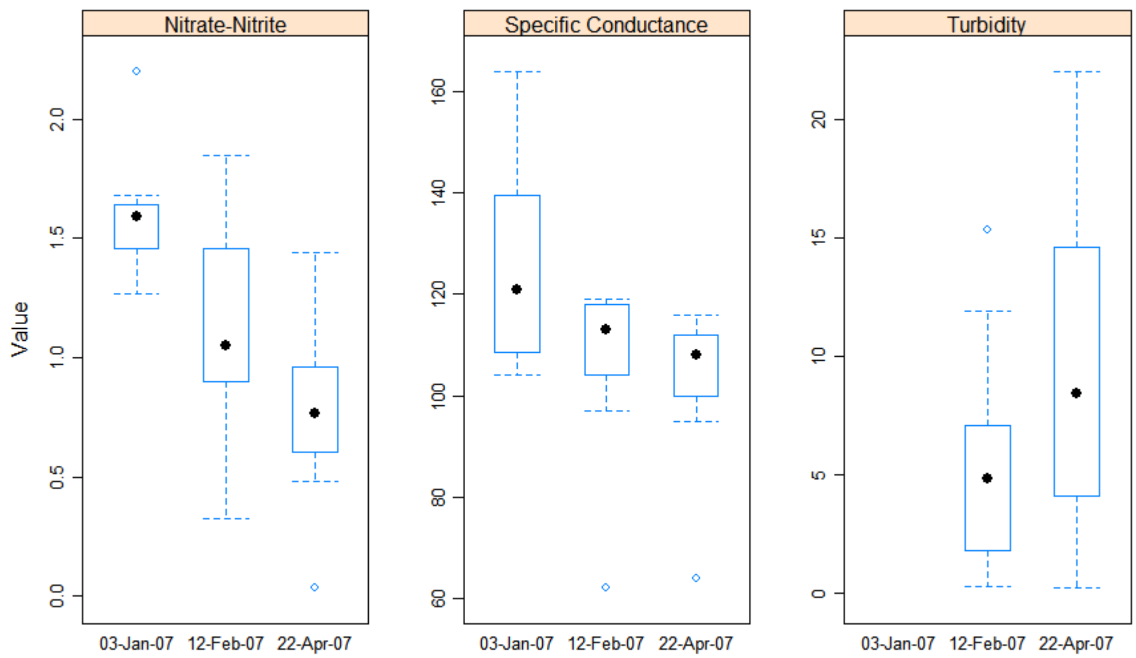


Figure 40: Boxplots of Data by Parameter and Sample Date.

Units of measurement: Nitrate-nitrite (mg/L), Specific Conductance (µS), Turbidity (NTU)