ROGUE RIVER ESTUARY

Strategic Plan 2015

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Coordinator | Lower Rogue Watershed Council

Lower Rogue Watershed Council

The Lower Rogue Watershed Council (LRWC) was formally chartered and recognized by the Curry County Commissioners and the Governor's Watershed Enhancement Board on May 16th, 1994. The Lower Rogue Watershed includes all lands and waters of these lands that drain into the Rogue and Illinois Rivers within Curry County, Oregon, and is the western extent of the Rogue River Basin.

Our Purpose is *to protect, enhance, and restore long-term natural resources and economic stability of the Lower Rogue Watershed and the near shore environment.*

Our Mission is *to represent the broad and diverse geographic areas and community interests in the watershed and work collaboratively with these interests and landowners to develop and carry out voluntary watershed protection, restoration, enhancement, and community engagement activities.*

ACKNOWLEDGMENTS

This document has been a long process for the LRWC, and we could not have done it without the assistance of past and present watershed council members, staff, and our partners.
Thank you to Aaron Fitch, who was instrumental to the field work for the Tidal Wetland Assessment and identification of wetland plant species. Finally, thank you to the Technical Team, the Education Team, and the Strategic Planning Team – we couldn't have pulled this together without their participation and thoughtful review.

THANK YOU TO THE REVIEWERS

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For more information or copies of this plan, please visit our website at www.currywatersheds.org, or contact the Lower Rogue Watershed Council at 541-247-2755 (4#) (email: info@currywatersheds.org).

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INTRODUCTION

The City of Gold Beach and much of Curry County are economically dependent on the health and viability of the lower Rogue River and its estuary, and the fish, wildlife, recreation, and aesthetic values they impart. The estuary is the vital interface between ocean and fresh water that is critical to the health and survival of numerous threatened anadromous species such as Southern Oregon Northern California Coast coho salmon and Chinook salmon, green and white sturgeon, steelhead trout, and Pacific lamprey. Specifically, the estuary provides a nursery and transition area for juvenile salmonids. The Rogue Basin Coordinating Council determined that the estuary is a limiting factor to salmonid health based on the extensive physical and hydrologic modifications that have occurred in the past and the subsequent impacts to available aquatic habitat and water quality[1]. The loss of wetlands, off-channel habitat, and decreased estuary size and functionality may also be tied to smaller size and survival rates noted for salmonid smolts[2].

Purpose

Neither formal research nor a scientific assessment had been done for the Rogue Estuary to quantitatively identify the extent or location of habitat loss, alterations and water quality concerns, or to qualitatively assess restoration potential. Few opportunities existed for citizens to learn about these estuary environments or to be trained in meaningful monitoring and data collection. To this end, the Lower Rogue Watershed Council was awarded an EPA Urban Waters grant in 2012 to accomplish four goals:

A. produce a scientifically-based assessment of the Rogue estuary that includes historic and current conditions, an analysis of limiting factors, areas for restoration, enhancement, and conservation, and recommendations for projects
B. educate and engage the local community in a continuing education class at the local community college, with a sub-set of students trained to collect water quality and wetland data appropriate for volunteer sampling
C. monitor water and environmental quality including
    i. storm runoff source search (volunteer sampling of turbidity & *Escherichia coli (E.coli)* sources
    ii. estuary *E.coli* concentrations
    iii. shellfish habitat evaluation to inform appropriate *E.coli* criteria
    iv. concentration of indicator metals (Copper-Cu, Zinc-Zn, Lead-Pb) in storm runoff and substrate
D. convene a community/agency Estuary Team to use the assessments in developing a community-driven restoration plan for the Rogue Estuary

The overall goal of the Rogue River Estuary Strategic Plan is to guide restoration, enhancement, and conservation efforts in the estuary and its tributaries; emphasizing wetlands, floodplain connectivity, off-channel habitat, and water quality.

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[1] Rogue Basin Coordinating Council (RBCC). 2006. *Rogue Basin Watershed Health Factors Assessment*.
[2] Reimers. P.E. 1973. *The length of residence of juvenile fall Chinook salmon in Sixes River, Oregon*. Oreg. Fish Comm. Res. Rep. 4(2), Oregon Dept. Fish & Wildlife, Portland, OR 97201, 43 p

WATERSHED RESTORATION OBJECTIVES AND STRATEGIES

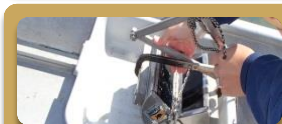
A. Increase conservation opportunities in the Rogue River Estuary
   i. Protect existing high quality resources (i.e.. habitat, water quality/quantity)
   ii. Outreach to landowners to discuss the opportunities and benefits of land acquisitions and conservation easements
   iii. Protect intertidal and shallow subtidal habitats, and buffers between uplands and tidal wetlands (and their adjacent riparian floodplains)
B. Protect and enhance tributary contributions to off-channel habitat
   i. Prioritize projects that result in maximum ecological benefit for the most species, and that address wetland functions and high ecological values
   ii. Remove noxious weeds that may be limiting off-channel habitat (including tidal wetlands and sloughs) and replace with native species
   iii. Target habitat improvements in area tributaries to increase sinuosity and complexity of off-channel tributary habitat
C. Stabilize and connect floodplain areas to aid in wetland establishment
   i. Promote stability in wetlands and adjacent floodplain riparian areas by trapping fine sediments and organic matter to reestablish process and function
   ii. Target habitat improvements in areas where tributaries run along, and are adjacent to, the floodplain and where there is wetland and ground water exchange
   iii. Restore degraded riparian areas, and assess and remove noxious upland, wetland and aquatic plants
   iv. Educate the public on the functions and resources of floodplains, discourage new floodplain developments, and work with gravel operators to determine suitability of estuary enhancements on their properties
D. Expand community participation in improving watershed health
   i. Organize watershed tours, special presentations, classes and outreach materials about estuary science, and the importance of natural resources to our economy
   ii. Engage landowners to maintain and enhance healthy riparian areas, and promote the Curry County Riparian Protection Ordinance
   iii. Solicit local financial support of LRWC projects and activities
E. Promote sustainable ecological practices and methods
   i. Address the key limiting factors in the watershed: off-channel habitat, sediment supply, water quality, channel modification, and early seral conditions[1]
   ii. Promote landowner participation in projects and programs to address limiting factors
   iii. Partner with community stakeholders to encourage tourism in a way that is ecologically sustainable, benefits the local communities, strengthens the local economy and employs the local workforce, and where possible uses local materials and local agricultural products

[1] Rogue Basin Coordinating Council (RBCC). 2006. *Rogue Basin Watershed Health Factors Assessment*.

Restoration & Monitoring Concepts

Prioritize tributaries, stream reaches and processes – using watershed assessments, GIS data, agency priorities and documents (e.g. TMDL plan), and technical advisor input.

Focus on estuary areas first and then move upland - to provide a landscape treatment that addresses entire watershed ecosystem.



Collect additional data to identify specific project locations and recruit landowners – to promote strategic and contiguous restored areas.

Provide connectivity – reconnecting waterways, streams with floodplains, restored habitats and restored processes to increase effectiveness in addressing causes of watershed processes degradation.

Long-term maintenance and stewardship to protect investment – by supporting landowners and assisting with resources necessary to maintain project sites.

Monitor to evaluate effectiveness and adapt strategies as needed – to inform and improve restoration strategies while providing accountability to watershed communities.

STRATEGIC PLAN DEVELOPMENT:

Prioritization Process

An initial Estuary Team was convened in 2011, with a formal Strategic Planning Team assembled in May, 2013 can be found in Table 1 below. This Team consisted of 15 experts in watershed and fisheries management, as well as local stakeholder members operating businesses within the Rogue River Estuary. The immediate task of the team was to draft a Strategic Plan for the estuary; with goals, objectives, and project recommendations. Importantly, the Team also began to develop collaborative working relationships between groups with often conflicting interests and positions.

Table 1: Rogue River Estuary Strategic Planning Team

Strategic Action Plan Team		
Individual/Organization	**Interest**	**Contribution**
USDA Forest Service	Natural Resource Agency, Fisheries	In-kind; team participation, technical support, project coordination
Port of Gold Beach	Port Authority/landowner	In-kind, team participation willing landowner
OR State University Extension, Curry County	Watershed Education	In-kind; team participation, course instruction, funding opportunities, LID support
Curry County	County Government	In-kind; land use planning, GIS support, economic development, TMDL implementation
City of Gold Beach	City Government	In-kind; land use planning, economic development, TMDL implementation
US Fish & Wildlife Service	Coastal Program	Cash; In-kind: technical advice, funding opportunities, team participation
Southwestern Oregon Community College	Continuing and Community Education	In-kind: community education outreach, class host
Gold Beach High School	Education	In-kind; classroom instruction, student recruitment, volunteer coordination
Jerry's Rogue Jets	Recreation Industry	In-kind: team participation, economic development
South Slough National Estuarine Research Reserve	Natural Resources Agency	In-kind: team participation, classroom instruction, technical review & support
Curry Anadromous Fishermen	Salmon Trout Enhancement Program (ODFW)	In-kind: team participation, volunteer recruitment and activities
OR Dept. of Fish & Wildlife	Natural Resources Agency	In-kind: team participation, technical support, surveys and monitoring
Freeman Rock	Gravel Industry	In-kind; team participation, landowner
Tidewater	Gravel Industry	In-kind; team participation, landowner
Curry Sportfishing Assoc	Fishing Guide Industry	In-kind; team participation, economic interest, boat pilot coordination

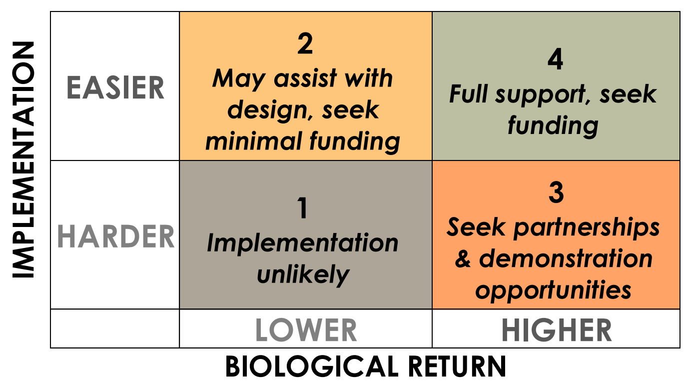
There were six public sessions with the Team focusing on the following topics: 1) Ecological Function and Strategic Plan Process; 2) Historic Estuary Maps (used to examine the extent of estuarine alterations and solicit takeholder input); 3) Results of Hydrogeomorphic (HGM) & Botany Assessments; 4) Ecological Prioritization Process (OWEB) and Results of Rogue Prioritization; 5) Identification of critical data gaps; and 6) Strategic Plan review and approval.

Floodplain connectivity and wetland functions were discussed regularly throughout the first several meetings, as well as ecological and social targets identified by the Strategic Planning Team. Targets identified were:

- Water quality and quantity
- Native fish and wildlife populations
- Nursery habitat
- Habitat complexity
- Sustainable harvest of fish
- Economic viability
- Recreational opportunities

To help interpret the results of the HGM Assessment location maps of the wetlands, showing the botanical transects, were shared with the team. The HGM assessment involved an extensive guide to evaluate 55 indicators of wetland function. Team members received a list of the indicators, showing which ones affect each of the wetland functions. It was noted that it is appropriate to compare scores among wetlands for each function, but functions are not intended to be compared among each other.

The Lower Rogue Watershed Council prioritization process and approach were loosely modeled after the Coos Watershed Association watershed restoration planning[1]. Restoration and enhancement projects were assigned scores (0-4) according to biological effectiveness and socio-economic feasibility. The threshold was set at <2 and >2, which was then used to assess potential restoration and conservation opportunities.



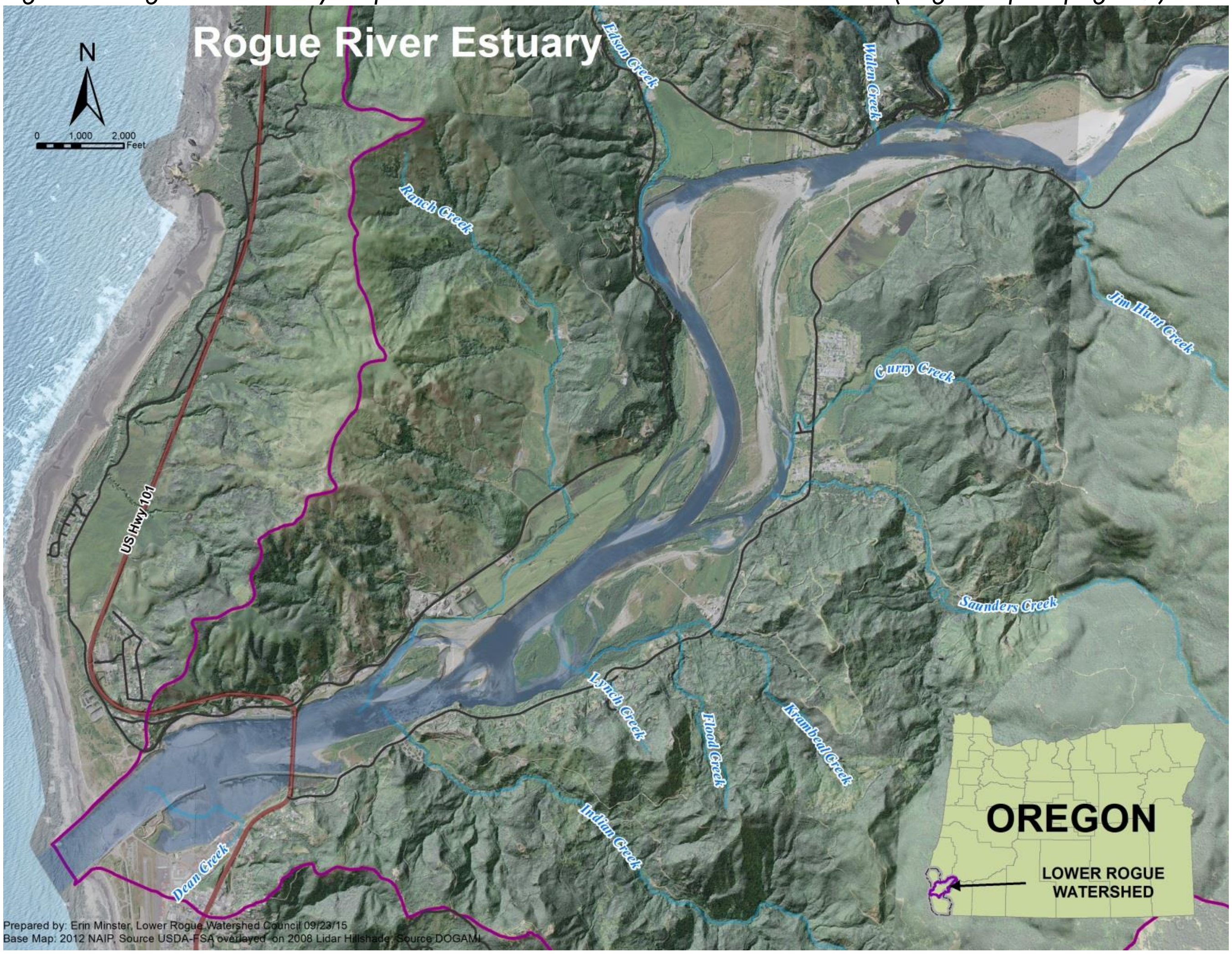
*Scoring approach modeled after the Coos WA method. www.cooswatershed.org

Public engagement

The Lower Rogue Watershed Council sponsored a Community Environmental Education Course at the Southwest Oregon Community College, titled *Estuarine Environments*. *Figure 1*, on the following page, was developed for and used extensively throughout the course as we engaged the students in discussions around the estuary and its tributaries. It was key to our discussions of the wetland and water quality assessments, and for conservation, restoration, and enhancement opportunities in the Rogue River Estuary.

[1] Coos Watershed Association. 2006. *Coos Bay Lowland Assessment and Restoration Plan*, Charleston, OR: Coos Watershed Association.

Figure 1: Rogue River Estuary Map used for SWOCC Estuarine Education Course (larger map on page 37)



Twenty four students signed up for the eight week course, which hosted six dynamic speakers and four field trips within the Rogue Estuary. The objectives for the class were as follows:

Knowledge:

- Understand basic components of estuarine ecology
- Understand estuarine function and value
- Develop basic understanding of water quality and habitat components important to estuary function, including terminology and baseline conditions

Skills:

- Use scientific terminology relevant to class topics
- Understand basic water quality components, standards, and sampling protocols
- Recognize basic habitat types and mapping protocols
- Perform mapping and sampling procedures in the estuary

Attitudes and Values

- An appreciation of the complexities and importance of estuarine functions and habitat
- An awareness of issues surrounding river and estuary management for different objectives such as fisheries, recreation, residential and industrial development

(Field trip to Indian Creek on the Rogue River with SWOCC class participants. *Photo credit: Kelly Timchak, 2013*)

The Lower Rogue Watershed Council also employed a variety of mechanisms and media to inform partners, stakeholders, other agencies and organizations, and the community about project results. Regular briefings during Watershed Council meetings were supplemented by presentations of results at meetings of the watershed council, fishing groups, and other community organizations.

In addition to personal communication of results, the Rogue River Estuary Tidal Wetland Assessment, the 2012-2013 Investigation of Storm Runoff Sources of Turbidity, E.coli bacteria & Indicator Metals (Cu, Pb, Zn): Rogue River Estuary and Urban Area, Oregon, and the Rogue River Estuary Strategic Plan are available on our website at www.currywatersheds.org.

Funding strategy

We want to ensure that priority programs and projects are supported through regular state and federal grant dollars, but also through a diverse financial portfolio; including foundation support, endowments, donations, and fundraising events.

A portion of our funding should be also dedicated to capacity in order to capture existing institutional knowledge and to maintain relationships, ensuring that current programs and projects are not interrupted or significantly delayed if key employees should leave the organization. *Table 2* below gives only a small glimpse into the ever-changing and evolving world of available funds. This list should be maintained and updated with the review of the Strategic Plan.

Table 2: Funding Sources for Restoration, Conservation, and Enhancement Work

Funding Sources				
Granting Agency	**Grant Cycles**	**Focus**	**Availability**	**Reference**
Oregon Watershed Enhancement Board	April, October	Technical Assistance, Education, Monitoring,	Individual landowner, tribe, watershed council, soil & water conservation district, nonprofits, schools	http://www.oregon.gov/OWEB/GRANTS/pages/grant_faq.aspx
United States Fish & Wildlife Service	recurring	Coastal wetlands, fish & wildlife restoration, conservation, endangered species	State & local government, nonprofits, individuals, educational institutions	http://www.fws.gov/grants/
National Fish & Wildlife Program	recurring; can apply twice annually	More than 70 different grant programs	Federal, state, and local governments, educational institutions, and nonprofit organizations	http://www.nfwf.org/whatwedo/grants/Pages/home.aspx#.VN6cNS7rajs
Department of Environmental Quality	Nonpoint Source Pollution 319 Grants	Nonpoint source water quality and watershed enhancement projects that address the short and long term NPS priorities.	Watershed Councils, Soil and Water Conservation Districts and other Natural Resources and Water Quality related agencies; colleges and universities, and nonprofit organizations	http://www.deq.state.or.us/wq/grants/grants.htm
Environmental Protection Agency	several ongoing grant programs	Pollution, monitoring, healthy communities, coastal wetlands, estuaries, water quality, etc.	state/local government, tribe, territory, public, private profit, nonprofit organizations, institutions, specialized groups, and individuals	http://www.epa.gov/ogd/competition/open_awards.htm
Oregon Department of Fish & Wildlife	quarterly or annually; depending on grant program	Access, habitat, restoration, education, bird conservation	Individual landowner, conservation organization, hunting group, watershed council, state & federal agency, school	http://www.dfw.state.or.us/fish/docs/grant_application_chart.pdf
Wild Rivers Coast Alliance	funds 1-2 year grants, ranging from $10,000 - $100,000 per year	Support and promote healthy fish and species habitats, working landscapes, seasscapes, ans sustainable tourism	individuals and organizations	http://wildriverscoastalliance.com/SectionIndex.asp?SectionID=3

Plan updates & revisions

This plan will be assessed every five years by the Lower Rogue Watershed Council and revised if needed. An amended date will be included in the document, and signed by the Lower Rogue Watershed Council Chair and Coordinator.

ENVIRONMENTAL AND SOCIAL SETTING

The Rogue River has a drainage area of 5,156 square miles, yet the estuary of the Rogue River is one of the smallest in Oregon, measuring approximately 1,880 acres during winter flows, and less during summer flows[1].

Estuary Hydrology, Sedimentation, and Channel Stability

Sea-level rise over the last 12,000 years created long tidal reaches in most Oregon estuaries, but on southern half of the Oregon coast, recent uplift (associated with subduction along the tectonic plate margin) has been more rapid than the global rate of sea level rise[2]. Not only is the tidal reach shorter due to uplift, but Jones et al.[3] cite evidence that the Rogue River has transported gravel to the Pacific Ocean at a rate that has filled the depositional area created by Holocene sea-level rise.

Since major dams were completed on the Rogue and Applegate Rivers in 1977 and 1980, the frequency of floods has decreased[3]. Both dams trap sediment, detaining 13 percent of the area of the Rogue Basin, and 29 percent of the Applegate Basin. From 2008-2010, three minor dams were removed, but they probably didn't substantially affect peak flows or sediment transport. Jones et al.[3] did not assess the effects of dam removal on downstream sediment transport, but cited estimates of release of 6-years' worth of sand and gravel (based on annual transport rates at Savage Rapids Dam).

The U.S. Geological Survey (USGS) recently completed a reconnaissance-level assessment of channel stability and bed-material transport on the Rogue River and its largest tributaries, the Applegate and Illinois Rivers[3]. The Rogue Estuary is located within the Tidal Reach (river mile (RM) 0-4.2) and the downstream section of the Lobster Creek Reach (RM 4.2-27). The tidally-influenced channel is alluvial and unconfined from upstream until RM 1.2, where it becomes confined (lacks a floodplain) as the valley narrows and the channel is bounded on the south bank by a levee. *Figure 1*, on page 12 (and page 41), displays the Rogue River Estuary with the river miles marked for reference throughout this section.

The Lobster Creek and Tidal Reaches contain some of the most extensive bar deposits on the mainstem Rogue River. These large bar areas and the lack of contrast between surface and subsurface sediment sizes (low armoring ratios) indicate that the supply of bed sediment closely balances or even exceeds transport capacity[3].

The Rogue Basin likely has greater over-all bed-material transport than the Umpqua Basin to the north. Wallick et al.[4] estimated that the Umpqua River transports on average of 13,000 to 51,000 cubic yards. Lacking either actual transport measurements or transport capacity calculations, the conclusion of greater bed-material transport in the Rogue River is tentative. However, it is supported by the observations of greater bar area and frequency along most of the Rogue River as well as the much shorter tidal reach on the Rogue (5 miles) compared to that on the Umpqua River (25 miles). Greater bed-material transport in the Rogue River is also supplied by 56 percent of the drainage basin within the Klamath Mountain geologic province. Sediment inputs from tributaries, draining steep portions of the Klamath Mountains into the Illinois and Applegate Rivers,

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[1] Unless otherwise cited, the following information in the Environmental & Social Setting section is referenced directly from Hicks, D. 2005. *Lower Rogue Watershed Assessment*. Lower Rogue Watershed Council.

[2] Komar, P. D. 1997. The Pacific Northwest Coast: Living with the Shores of Oregon and Washington. D.uke University Press. 195 pp.

[3] Jones, K.L., O'Connor, J.E., Keith, M.K., Mangano, J.F., and Wallick, J.R. 2012. Preliminary assessment of channel stability and bed-material transport in the Rogue River basin, southwestern Oregon: U.S. Geological Survey Open-File Report 2011–1280, 96 p.

[4] Wallick, J.R., J.E. O'Connor, S. Anderson, K.K. Mackenzie, C. Cannon, and J.C. Risley. 2011. *Channel change and bed-material transport in the Umpqua River basin, Oregon*. Scientific Investigations Report 2011-5041. *Prepared in cooperation with the US Army Corps of Engineers.*

are probably important to the overall delivery of bed material. Bed material entering the steep and confined Galice Reach (RM 27-82) is likely transported through the reach and deposited in the flatter and wider Lobster Creek and Tidal Reaches downstream[1].

Confined channels and valleys limit lateral channel movement, but in the unconfined section of the Tidal Reach from RM 4.2 to 1.2, channel form changed substantially between 1967/69 and 2009. This indicates that bed-material transport and deposition are important processes maintaining channel form in the more alluvial reaches, and that these dynamic reaches are those most likely to be sensitive to changes in bed-material supply and transport capacity.

Within the Tidal Reach, historic channel changes were summarized by Jones, et al.[1] as follows:

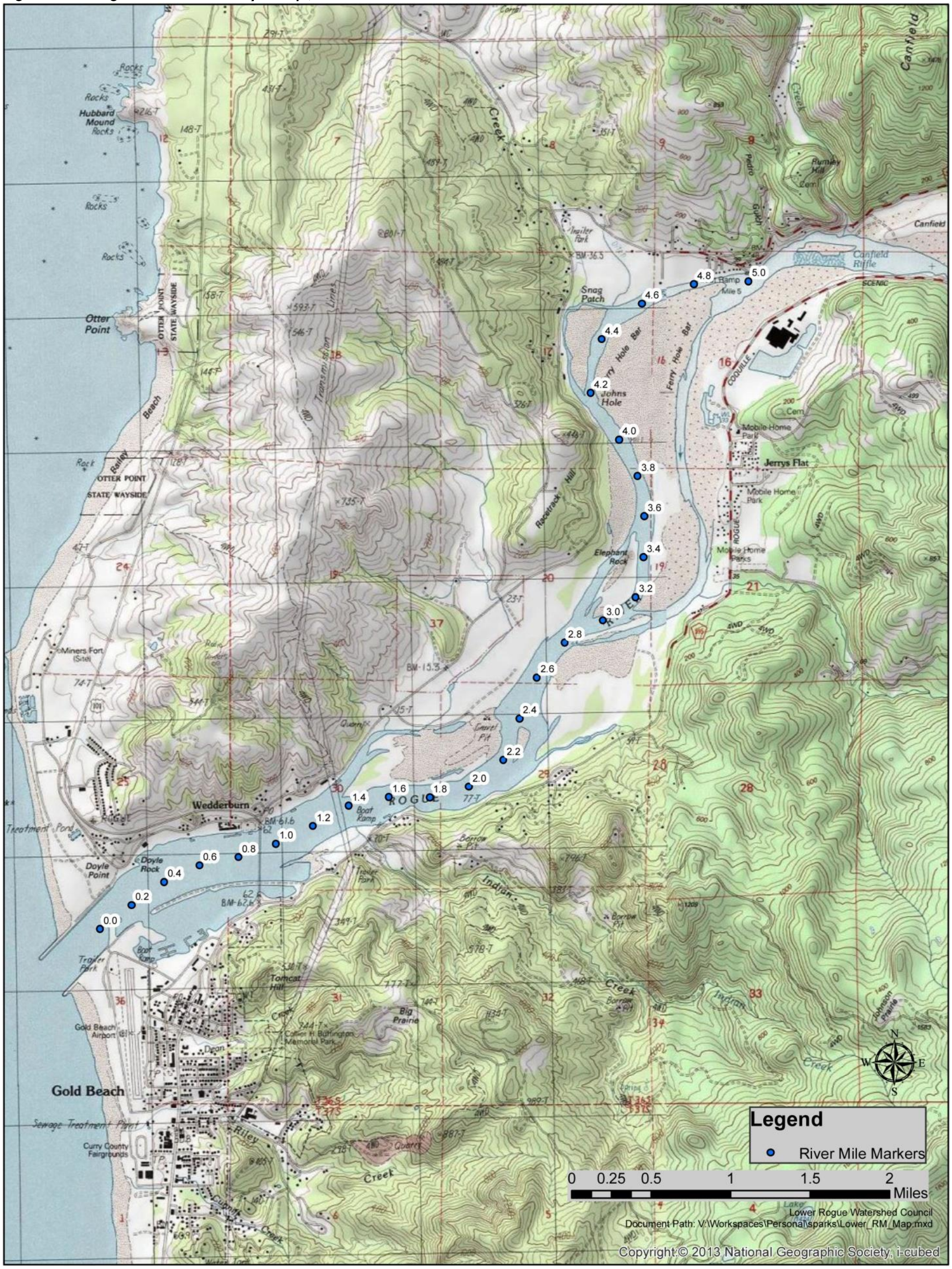
- Channel is dynamic with potential for lateral and vertical adjustments (based on repeat cross sections and delineation of channel margins)
- At the USGS Elephant Rock mapping site, there was an 11 percent net increase in bar area and a 19 percent net decline in wetted channel width. The bar area was increased by migration of the Rogue River channel toward the right bank near RM 2.5-1.6 from 1969 to 2005.
- Elephant and Wedderburn Bars are tentatively 1) dynamic with modest annual deposition and erosion; and 2) rebuilt by deposition after large floods (based on surveys at instream gravel mining sites)
- The December 1996 flood (an event larger than the 100-year flood) deposited up to six feet of sediment on river bars from Agness to the Rogue River mouth
- At the Patterson Bridge at Hwy 101 (RM 0.9), the deepest part of the channel (thalweg) lost about 1.1 meters in depth (aggraded), in 2000–2009 surveyed cross sections

On six of eight USGS mapping sites in the Rogue Basin, bar area decreased between 1967/69 and 2009. Jones et al.[1], suggested that vegetation became established on surfaces formed or eroded by the 1964 flood, and has been maintained by reduced peak flows. These vegetated and stabilized bar features store large volumes of sediment that may be eroded and transported during future floods. Although the supply of sediment to the Lower Rogue may be greater than the transport capacity of the river, the extent and area of bars have also been influenced by historical and ongoing gravel mining. Over the last 40 years, permits for gravel removal have declined from 313,000 cubic yards per year to 40,000 cubic yards per year[2]. Thus, sediment has both increased and decreased within different parts of the Rogue Basin, from a variety of sources, making it difficult to assign a cause to any particular lateral or vertical movement in the channel or river bar location. Taking a long-term view, the reduction in peak flows and stabilization of bars upstream, should allow bars in the Tidal Reach to stabilize and provide opportunities for wetland establishment.

[1] Jones, K.L., O'Connor, J.E., Keith, M.K., Mangano, J.F., and Wallick, J.R. 2012. Preliminary assessment of channel stability and bed-material transport in the Rogue River basin, southwestern Oregon: U.S. Geological Survey Open-File Report 2011–1280, 96 p.

[2] Pratt, D.J.. 2004. Gravel removal operations and fish habitat planning, Curry County, Oregon: Gold Beach, Oregon. Curry County Department of Public Services, 114 p.

Figure 2: Rogue River Estuary Map, with River Mile Markers labeled



Jones et al.[1], recommended further data collection and analysis to refine our understanding of historical and ongoing sediment transport and effects on channel morphology.

- Gaging stations for Illinois River and Lobster Creek
- Light Detection and Ranging (LiDAR) coverage for high-resolution topography on the upstream portion of the Lobster Creek reach and Illinois River Reaches (already available for the downstream Lobster Creek and Tidal Reaches)
- Bar area changes – using LiDAR and sequential photos can be done for area covered by LiDAR
- Use methods employed for the lower Chetco River[2]
- Bed-material transport rates
- Bedload transport equations may be used for capacity-limited reaches
- Bed material sampling
- Sediment yield analyses
- Direct measurements of bedload
- Gravel mining pre- and post-surveys
- Detailed channel morphology assessment

The estuary is river-flow dominated[3]. The mean high tide on the Rogue River is 4.9 feet, and these tides extend approximately 4.2 miles from the mouth to a riffle below Edson Creek. The mean higher high water is 6.7 feet and many summer tides extend to river mile 4.6, upstream of Edson Creek (which drains into Snag Patch Slough).

Salinity intrusion in the estuary is limited due to the steep river gradient and the high volume of river discharge[4]. In 1977 (a year of record low flows on the Rogue), saltwater extended upstream to river mile 3.6, upstream of Elephant Rock. The more typical limit of saltwater was at river mile 2.7. Since 1977, Rogue summer flows have been augmented by releases from dams, limiting the upstream extent of salinity[1]. During profiling at high tide in summer 2010 and 2011, the upstream extent was detected at river mile 2.6[5]. The Rogue estuary is classified as highly stratified during winter flow, and moderately stratified during summer flow[3]. Ratti[4], illustrated the effects of discharge, with monthly bottom salinity remaining below 5 parts per thousand during the winter and most spring months, but exceeding 25 parts per thousand during summer months.

The tidal prism, which describes the volume of water between the mean low water and mean high water, is estimated to be 1.6×10^8 cubic feet[4]. During high river flows, the volume of incoming water during a tidal cycle is several times greater than the tidal prism. Summer flows also produce a volume of water nearly as large as the tidal prism, which is unusual for most estuaries in Oregon.

Habitat

The estuary can be divided into two subsystems: the Marine and the Riverine.

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[1] Jones, K.L., O'Connor, J.E., Keith, M.K., Mangano, J.F., and Wallick, J.R. 2012. Preliminary assessment of channel stability and bed-material transport in the Rogue River basin, southwestern Oregon: U.S. Geological Survey Open-File Report 2011–1280, 96 p.

[2] Wallick, J.R. and J.E. O'Connor. 2010. *Estimation of Bed Material Transport in the lower Chetco River, Oregon, Water Years 2009–2010*. USGS. *Prepared in cooperation with the U.S. Army Corps of Engineers and the Oregon Department of State Lands.*

[3] Adamus, P.R. 2006. Hydrogeomorphic (HGM) *Assessment Guidebook for Tidal Wetlands of the Oregon Coast, Part 1: Rapid Assessment Method*. Produced for the Coos Watershed Association, Oregon Department of State Lands, and U.S.E.P.A.-Region10. Charleston, OR: Coos Watershed Association.

[4] Ratti, F. 1979, Natural resources of Rogue Estuary, an Estuary Inventory Report, Oregon Dept. of Fish and Wildlife, vol 2. no. 8.

[5] Myers, C.R. 2015a (unpublished). Rogue River Estuary Tidal Wetlands Assessment.

Marine

The Marine Subsystem is identified as open ocean overlying the continental shelf and coastline exposed to waves and currents of the open ocean shoreward to 1) extreme high water of spring tides; 2) seaward limit of wetland emergents, trees, or shrubs; or 3) the seaward limit of the Estuarine System, other than vegetation. Salinities exceed 30 parts per thousand[1].

The marine subsystem accounts for 80 percent of the area of the estuary and extends from the mouth to the Highway 101 bridge at river mile 1.0. This system has high salinity during the summer and strong currents throughout the year. The area is highly modified and most of the development in the estuary is located in this subsystem. Approximately 13 acres of intertidal and 14 acres of subtidal land was filled between 1960 and 1972. Fills included the dike (separating the boat basin from the main channel), marina, and the development and riprap along the north shore.

Downstream of the Coast Guard Dock, the main channel has a predominantly sand and sulfide mud substrate[2]. River flow and sand bar formation restrict deposition of ocean sands within the lower estuary. High winter flows carry most river-born suspended sediments beyond the mouth of the Rogue River. During the summer, these sediments are carried upriver and deposited over the gravel bars in the upper estuary. Amphipods, such as *Anisogammarus spp.* and *Corophium spp.*, are important in the diets of salmonids, and were found in the sand and fine gravel substrate measured upstream of the Coast Guard dock[2].

Intertidal areas are found primarily within the boat basin, and although the area is small, there is a high diversity of habitat types that may be significant in the productivity of the estuary. Sand and cobble/gravel shores, mud and mixed sand/mud flats, algal beds, and a low fringing salt marsh all provide shallow habitat for fish rearing, and habitat for a variety of birds. Two intertidal areas outside of the diked area were noted as locations where marine and anadromous fish congregate[3]. The first is a small tideland area along the north shore near the Coast Guard dock. It is the only undiked shoreland remaining in the marine subsystem, and the shore forms a cove protected from swift channel currents. The other area is along the river side of the spit that forms each year inside the jetties (a popular place for surf perch fishing) and is also out of the main current, which flows mostly on the northern side of the river at this time.

Riverine

The Riverine Subsystem includes all wetlands and deepwater habitats contained within a channel, with two exceptions: 1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens; and 2) habitats with water containing ocean-derived salts in excess of 0.5 parts per thousand[1].

The riverine subsystem extends from the Highway 101 bridge to the head of tide. High tides which are lower than mean high water do not extend beyond the second riffle above Elephant Rock, while higher high tides extend to a third riffle located at river mile 4.5.

There is twice as much subtidal area in the riverine subsystem than in the marine subsystem, with most of the substrate being cobble and gravel. Areas away from strong currents, where silt is deposited during the summer and fall and where bottom salinities are sufficiently high, provide suitable habitat for amphipods (crustacea that are shrimp-like in form, which contains mostly marine and freshwater forms). Benthic sampling by the U.S. Forest Service downstream of river mile 2.2 found productive habitat for *Corophium spp.* and

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[1] Cowardin, L.M., V. Carter V., F.C. Golet, E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service Report No. FWS/OBS/-79/31.Washington, D.C.

[2] Ratti, F. 1979, Natural resources of Rogue Estuary, an Estuary Inventory Report, Oregon Dept. of Fish and Wildlife, vol 2. no. 8.

[3] Frick, R. 2005. Fisheries Biologist, United States Forest Service – Rogue/Siskiyou National Forest. Personal communication.

Anisogammarus spp. in the channel and lower intertidal areas. The subtidal habitat is important feeding and rearing areas for fish with juvenile Chinook, coho salmon and cutthroat trout often abundant in this area[1].

More than 50 percent of the area in the riverine subsystem consists of gravel bars and shrub wetlands (primarily willow swamps) that lie above mean high water and only flood during higher tides and high river discharge. The shrub wetlands contribute nutrients and organic matter to the estuary and provide habitat for terrestrial wildlife. The gravel flats are often sparsely vegetated, functioning as a flood way and providing interstitial flow[2].

Summer intertidal areas include a wider variety of habitat types than winter areas. At river mile 1.2 (*Figure* 1), an intertidal island is a remnant of a larger peninsula that existed prior to floods and construction of the dike. Part of the current island is classified as an intertidal gravel marsh characterized by spike rush and scattered forbs growing on a gravel substrate - a marsh type unique to a few south coast estuaries. This is the largest remaining example of intertidal gravel marsh in the Rogue River estuary.

Another major intertidal area is located on the north shore at Mail Boat Point, the tip of a larger island where juvenile salmon and cutthroat congregate. The point has a gravel substrate, but due to its location between the river channel and the mouth of the north slough and associated slowing of the current, has sediment deposition that supports *Corophium* amphipods and productive algal beds.

On the south shore at river mile 1.5, Krambeal Slough (local name - God Wants Ya Slough) is the most densely vegetated marsh in the estuary and provides habitat for juvenile fish, terrestrial wildlife, and waterfowl[1]. Krambeal Creek (local name - God Wants Ya Creek) feeds the slough. Prior to the 1996 flood, Saunders Creek would also empty into God Wants Ya Slough during high winter flows through a channel that cut through the gravel flat currently owned by Freeman Rock, Inc. Now, and during normal flows previously, Saunders Creek enters at river mile 1.9. The gravel bars downstream from Elephant Rock are important estuarine habitats. Most of the remaining summer intertidal habitats are cobble and gravel shores, with freshwater predominating, which are important for secondary production and fish rearing[1].

Fish productivity

Along the Oregon coast, the Rogue River basin is the largest producer of Pacific salmon after the Columbia River basin[3]. Chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*), steelhead (*Oncorhynchus mykiss*), and cutthroat (*Oncorhynchus clarki)* are all native to the Lower Rogue watershed. Historical numbers of coho are thought to have been relatively small in most south coast basins including Lower Rogue tributaries. This is likely due to the relatively steep topography that leads to a high gradient, confined and high-energy system[4].

Juvenile salmon use the estuary to acclimate to saltwater and to gather olfactory information for successful homing[15]. Although their basic requirements are the same, salmonid species differ in the types of habitat they use. For example, juvenile coho prefer pool areas of moderate velocity in the summer, especially those with slack water current near undercut stream banks, root wads, or logs. In winter, they seek slow, deep pools or side channels, utilizing cover under rocks and logs[3].

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[1] Frick, R. 2005. Fisheries Biologist, United States Forest Service – Rogue/Siskiyou National Forest. Personal communication.

[2] Ratti, F. 1979, Natural resources of Rogue Estuary, an Estuary Inventory Report, Oregon Dept. of Fish and Wildlife, vol 2. no. 8.

[3] Middle Rogue Watershed Association. 2001. Middle Rogue watershed action plan: Grants Pass, Oregon, 39 p. Accessed October 19, 2001, at *http://soda.sou.edu/awdata/050104a1.pdf*.

[4] Confer, T. 2001. ODFW Southwest Region Assistant District Fisheries Biologist. Personal communication.

[5] Dittman, A., and T. Quinn. 1996. Homing in Pacific salmon: mechanisms and ecological basis. *Journal of Experimental Biology*, *199*(1), 83-91.

Conversely, juvenile steelhead spend their first summer in relatively shallow, cobble-bottomed areas at the tail-out of a pool or shallow riffle. During winter, they hide under large boulders in riffle areas. In summer, older steelhead juveniles prefer the lead water of pools and riffles where there are large boulders and woody cover[1]. The turbulence created by boulders also serves as cover. During winter, these steelhead juveniles are found in pools, near streamside cover, and under debris, logs or boulders.

Cutthroat trout habitat requirements are similar to those of steelhead with the exception that they spend the summer in pools[1]. Chinook juveniles tend to rear in large tributaries, and their habitat requirements are different than those of coho. For example, estuarine residence and growth are key elements in a chinook life-history pattern. During this transition between freshwater and saltwater, juveniles, especially coho salmon, are dependent upon side channels, off-channel ponds, and slow, backwater estuarine habitat. Forested wetlands also provide protection from predators and increase growth rates due to the high productivity of macroinvertebrates, based on the accumulation of organic matter[2] [3].

Presence and absence of both juvenile and adult salmonids within the Rogue Estuary tributaries are listed on *Table 3*. Please note that documenting a few adults in a reach does not necessarily indicate the presence of a successful spawning population, but does indicate some level of distribution[4].

Many south coast estuaries, including the Rogue River historically, receive on shore transports of sand over the summer, which shallows the mouth and restricts river flow to the ocean. This increases the productivity of the estuary by inundating low shorelands and trapping nutrient-rich ocean water.

A study on the Sixes River to the north found that juvenile fall Chinook that reared in the estuary throughout the summer and fall had the highest adult returns to the river[5]. A comparison of 1945 and 1975 adult fish scales from the Rogue River indicate that juvenile spring and fall Chinook spend much less time rearing in the estuary than they did 20 years ago[2]. These data suggests that physical and hydrologic modifications in the Rogue River estuary discussed previously may have had substantial impacts on Chinook populations in the river.

Both eulachon (commonly called smelt, candlefish, or hooligan) and coho salmon are listed as threatened under the federal Endangered Species Act. Green sturgeon, within the Northern Distinct Population Segment, are listed as a species of concern under the federal Endangered Species Act[6]. Green sturgeon (*Acipenser medirostris)* and white sturgeon (*Acipenser transmontanus*) both use the Rogue River, but not much is known about their historic levels, life cycle characteristics, or habitat requirements. In the Rogue River, green sturgeon far outnumber white sturgeon and the Rogue River is one of only three known spawning rivers in the world for these fish[5].

Temperature is also vital to fish survival, and the standards set by DEQ are meant to protect salmon and trout throughout their life histories: spawning, rearing and migration. At this time, all of the streams in the Rogue River Basin are designated as either core cold-water habitat or salmon and trout rearing and migration

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[1] Provost, M., R. Horton, J. MacLeod, R.M. Davis. 1997. Southwest Oregon Salmon Restoration Initiative. Phase 1: A Plan to Stabilize the Native Coho Population from Further Decline. Rogue Valley Council of Governments.

[2] Soto, T., A. Corum, H. Voight, D. Hillemeier, and L. Lestelle. 2008. The role of the Klamath River mainstem corridor in the life-history and performance of juvenile coho salmon (Oncorhynchus kisutch). Phase I Report 2006-07 Winter. Submitted to U.S. Bureau of Reclamation, Klamath Falls, Oregon. December 2008.

[3] Hillemeier, D., T. Soto, S. Silloway, A. Corum, M. Kleeman, and L. Lestelle. 2009. The Role of the Klamath River mainstem Corridor in the Life-History and Performance of Juvenile Coho Salmon (*Oncorhynchus kisutch*). Period Covered: May 2007–May 2008. Report submitted to the United States Bureau of Reclamation. Klamath Falls, Oregon, 97603.

[4] Mazur, S. 2015. ODFW Southwest Region Assistant District Fisheries Biologist. Personal communication.

[5] Reimers. P.E. 1973. *The length of residence of juvenile fall chinook salmon in Sixes River, Oregon*. Oreg. Fish Comm. Res. Rep. 4(2), Oregon Dept. Fish & Wildlife, Portland, OR 97201, 43 p.

[6] NOAA. Office of Protected Resources. 2015. http://www.nmfs.noaa.gov/pr/species/fish.

habitat. Spawning areas and times have been determined for streams in the basin. Temperature models, where developed, allow for a determination of natural stream temperatures which may then supersede a numeric criterion[1].

Juvenile coho salmon
Photo Credit: Erin Minster, 2014

Table 3: Fish Distribution within the Rogue River Estuary and its Tributaries

Fish Distribution within Rogue River Estuary								
Tributary	Chinook		Steelhead		Cutthroat		Coho	
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult
Rogue (mainstem)	yes	yes	yes	yes	yes	yes	yes	yes
Krambeal Creek (local name - God Wants Ya)	yes	no	yes	no	yes	yes	yes	possible, not documented
Curry Creek	yes	no	yes	no	yes	possible, not documented	yes	possible, not documented
Saunders Creek	yes	yes	yes	yes	yes	yes	yes	yes
Indian Creek	yes	yes	yes	yes	yes	yes	yes	yes, historic
Edson Creek	yes	no	yes	no	yes	yes	yes	yes
Ranch Creek	no	no	yes	no	yes	yes	yes	yes, historic

**Spawning and rearing information derived from CSWCD & ODFW surveys and fish distribution maps*

At this time, little information is available on other fish species using the estuary. Marine fish such as shiner perch, surf smelt, juvenile sturgeon, and starry flounder come into the estuary in the summer to feed, with some perch species spawning or bearing their young in the estuary. Smelt, lamprey, and adult green and white sturgeon migrate through the estuary and spawn in the river systems. Shad, stickleback, herring, and sharks also use the estuary.

[1] Oregon Department of Environmental Quality (OR DEQ). 2008. Rogue River Basin Total Maximum Daily Load (TMDL).

Demographics

The City of Gold Beach has a population of about 2000. The total population within 5 miles of the estuary is approximately 5000, which includes small communities and an urban and rural interface concentrated along the Rogue River estuary and its tributaries. According to the 2010 Census, the median age in the city was 50.6 years. There were 16.5 percent of residents under the age of 18; 5.8 percent between the ages of 18 and 24; 18.4 percent from 25 to 44; 36.5 percent from 45 to 64; and 22.7 percent were 65 years of age or older. The median income for a household in the city was $30,243, and the median income for a family was $37,634. About 8.8 percent of families and 12.4 percent of the population were below the poverty line, including 12.8 percent of those under age 18 and 6.9 percent of those ages 65 or over[1].

The Rogue River supplies drinking water for the City of Gold Beach. The River is an economic focus for the community, especially for sports and commercial fishing. A recent study estimated the value of Rogue River salmon in the Rogue Basin to be $17.4 million annually, and non-use values of the river at $1.5 billion annually[2]. An economic analysis for 1996-1997 calculated 58 percent of the recreational fishing use occurred in the brackish portion of the Rogue River[3]. Restoring and maintaining a healthy watershed and a healthy fishing industry is especially important in a community where greater than 15 percent (pockets of up to 37 percent) of the population is designated below poverty level and 50 percent of the school population is eligible for free and reduced school meals[4].

Construction services are the second largest employer in Curry County. Construction costs and employment opportunities are tied to availability of natural resources. The Rogue Estuary has one active gravel mining operation – Freeman Rock, Inc. A study found that economic output would decline by $9.2 million annually with a loss of 97 local jobs with closure of river-based mining[5]. Meetings for renewal of annual permits for mining are always well-attended and controversial due to conflicting opinions as to the virtues of mining to the economy versus the environmental impacts to the river.

Historic Information

One of the first major modifications of the estuary was to manage the estuary for the commercial harvest of fish to support a cannery. The cannery was originally constructed at river mile 1.0 on the south side of the Rogue River, and later moved across the river and upstream. The old pilings can still be seen under the Highway 101 bridge. Habitat modifications of the river likely included the removal of large wood in later years from some areas of the estuary and after winter flows to allow for boat traffic and the use of harvesting nets[6].

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[1] U.S. Department of Commerce. US Census Bureau. 2010. http://censtats.census.gov/data/OR/1604129900.pdf.

[2] ECONorthwest. Helvoigt, T. and D. Charlton. 2009. *The Economic Value of Rogue River Salmon.*

[3] Sea Grant. Waldvogel, J. 2008. *Southern Oregon/Northern California Salmon and Steelhead Fishing Guides Use and Economic Analysis (1996-1997).*

[4] Curry County Commission on Children & Families. 2001. *Curry County Agency Board Collaboration Demographic Project.*

[5] ECONorthwest. Whelan, R. 2007. *An Economic Impact Forecast of the Potential Closure of River Rock Mining on the South Coast.*

[6] Frick, R. 2005. Fisheries Biologist, United States Forest Service – Rogue/Siskiyou National Forest. Personal communication.

Rogue River salmon fishing in the bay, circa 1940.
Photo credit: Curry Historical Society

Due to onshore transport, the Rogue River historically formed a sand bar at the mouth during low flows in the summer months at the mouth and was considered virtually unnavigable with the depth varying between 2 feet in late summer and 9 feet in the winter. In 1960, the Army Corps of Engineers (ACOE) constructed jetties 1,000 feet apart to stabilize the position of the entrance, and a 13-foot channel was dredged in 1961 with a turning basin on the north side of the river. This shallowing continued to be a problem for navigation after the project was complete and a breakwater dike from the highway 101 bridge tangent to the south jetty was initiated by ACOE in 1964, but was abandoned due to record floods. Severe sand build up halted lumber barge traffic and the dredge boat could not enter the estuary for maintenance. In 1971, work was resumed on the dike and it was completed in 1973. The constructed dike also created a breakwater for the large shallow area to the south, part of which the Port developed into the marina. The entrance to the boat basin is also subject to annual sedimentation from waves moving material along the south jetty and into the entrance. In order to keep the entrance and the Boat Basin channel passable, the entrance channel into the Boat Basin was relocated approximately 1,100 feet upstream in 1998 to reduce shoaling and dredging requirements.

Estuary shallowing continues to be a problem and 54,000 cubic yards were dredged to maintain the waterway in 2014[1]. Since 1986, the Army Corps of Engineers has dredged a total 1,281,900 cubic yards of material from the Rogue River estuary and Boat Basin[2]. Over the last 25 years there has been an average of 49,300 cubic yards dredged from the estuary and Boat Basin each year, according to the Army Corps of Engineers 2012 Annual Report. Jones et al.[3] report estimated that winter floods up to 400,000 cubic feet per second could transport a million cubic yards of sand and gravel. Dredging navigable waters is a continuous impact primarily affecting benthic and water-column habitats in the course of constructing and operating marinas, harbors, and ports. Routine dredging, that is the excavation of soft bottom substrates, is used to create deep water navigable channels or to maintain existing channels that periodically fill with sediments,

[1] Port of Gold Beach. Collins, D. 2014. Port Manager. Personal communication.
[2] Army Corps of Engineers. 2012. Annual Report. *Rogue River ODMDS*.
[3] Jones, K.L., O'Connor, J.E., Keith, M.K., Mangano, J.F., and Wallick, J.R. 2012. Preliminary assessment of channel stability and bed-material transport in the Rogue River basin, southwestern Oregon: U.S. Geological Survey Open-File Report 2011–1280, 96 p.

and can have many detrimental impacts to aquatic ecosystems[1]. To help avoid and minimize impacts of dredging on essential fish habitat, NOAA Fisheries engages in interagency coordination on such projects.

As a result of the dike and jetties, currents in the main channel are probably stronger throughout the year. These structures have also stabilized the location of the channel and spits, which historically fluctuated to the north and the south of its current location. The dike also restricts circulation in the protected basins to a single small opening.

Historically, the Boat Basin was a shallow subtidal and intertidal area with unrestricted circulation. The southern margin has been extensively riprapped and there are several boat moorages. Jerry's Rogue Jet Boats, located inside the Boat Basin, has been making regular trips up the river from the estuary since 1958. Other developments in the estuary waterway include the U.S. Highway 101 bridge abutments, two gravel removal operations and several boat docks, which are removed before winter flows. The northern shore has also been extensively riprapped and there are several boat moorages as well.

Rogue River Boat Basin.
Photo credit: Kelly Timchak, 2015

[1] NOAA Fisheries: West Coast Region. "Habitat Threats: Navigational Dredging." National Oceanic and Atmospheric Administration. Web access. 5 Mar. 2015.

ESTUARY ASSESSMENT

Tidal Wetland Summary

Assessment[1] of the tidal wetlands included two methods

- Estuary Module of the Oregon Watershed Enhancement Board (OWEB) Watershed Assessment Guide[2]; and
- Hydrogeomorphic (HGM) Rapid Assessment Method[3]

The OWEB Assessment is focused on restoration and conservation of tidal wetlands, and excludes some elements of estuaries such as aquatic beds and water quality. Estuarine water quality is addressed in the 2012-2013 Investigation of Storm Runoff Sources of Turbidity, E.coli bacteria & Indicator Metals (Cu, Pb, Zn): Rogue River Estuary and Urban Area, Oregon[4].

The OWEB Assessment identified the extent of sixteen tidally-influenced wetlands, as well as the alterations evident on historic aerial photographs. The wetland sites were merged for this assessment based on similar intensity of alteration. Sites that have only minor alterations to small areas of the site and are otherwise undisturbed are defined as Conservation Sites.

To prioritize tidal wetlands for restoration or conservation, the assessment considers the following ecological criteria for the 16 Wetland Sites:

- area (larger areas store more sediment, process more nutrients, provide more habitat)
- tidal channel condition (tidal flow, no barriers, un-ditched, quality of remnant channels)
- wetland connectivity (proximity of wetlands of all types to one another)
- salmonid diversity (number of stocks spawning)
- historic wetland type (percentage of historic tidal swamp)
- diversity of current vegetation classes (emergent, scrub-shrub, forested)

Wetland Sites, grouped by the results of the ecological prioritization, are shown in *Figure 2* on page 21.

Figure 2 identifies tidal wetland areas as having a high, med-high, med-low, or low ecological priority. *Tables 4* and *5*, on page 23, identify specific sites for either restoration or conservation actions. This does not imply that one cannot apply restoration strategies to a conservation site, or vice versa.

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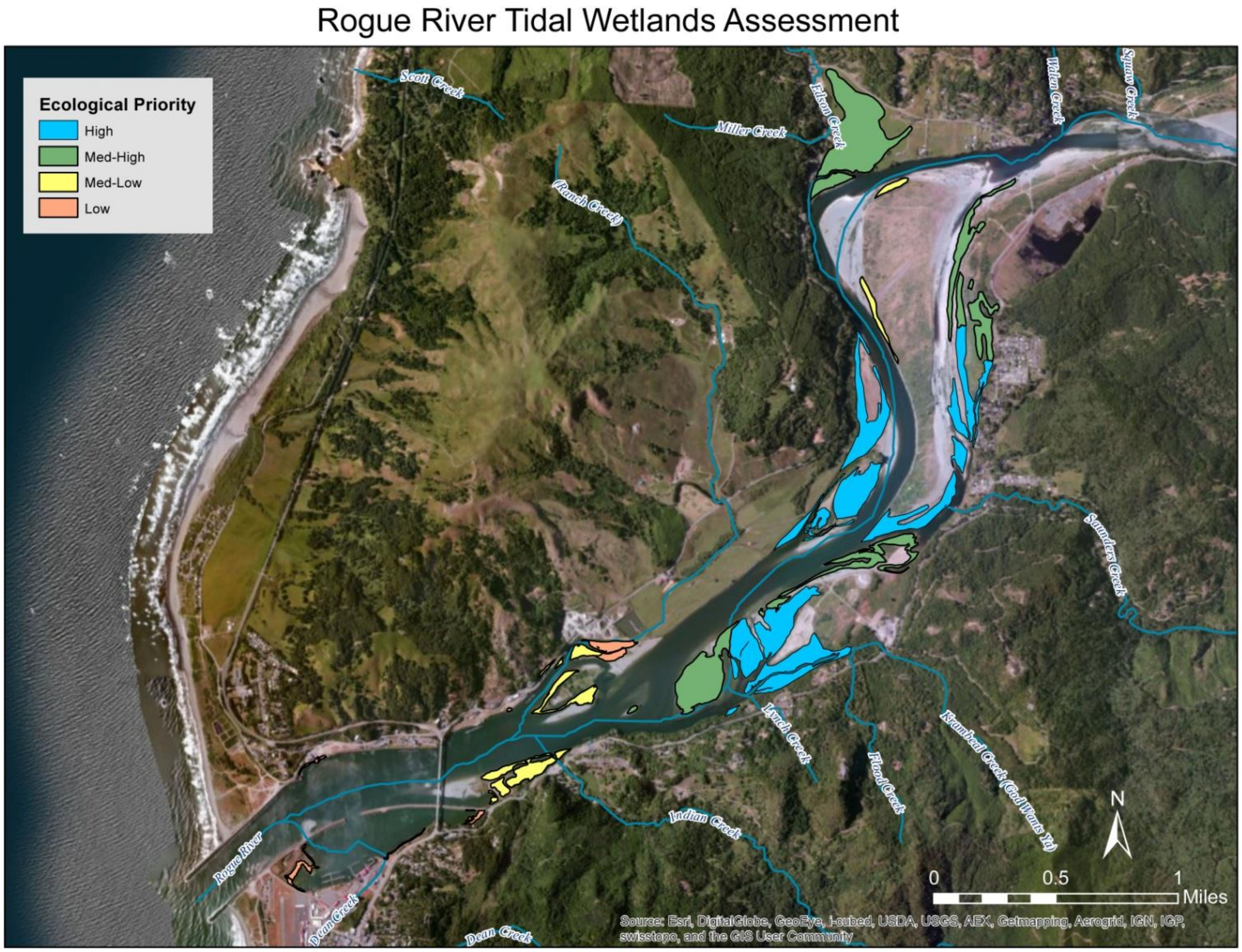
[1] Myers, C.R. 2015a (unpublished). Rogue River Estuary Tidal Wetlands Assessment.

[2] Brophy, L.S. (Green Point Consulting). 2007. *Estuary Assessment: Component XII of the Oregon Watershed Assessment Manual*. Prepared for the Oregon Department of Land Conservation and Development, Salem, OR and the Oregon Watershed Enhancement Board, Salem, OR.

[3] Adamus, P.R. 2006. Hydrogeomorphic (HGM) *Assessment Guidebook for Tidal Wetlands of the Oregon Coast, Part 1: Rapid Assessment Method*. Produced for the Coos Watershed Association, Oregon Department of State Lands, and U.S.E.P.A.-Region10. Charleston, OR: Coos Watershed Association.

[4] Myers, C.R. 2015b (unpublished). 2012-2013 Investigation of Storm Runoff Sources of Turbidity, E.coli bacteria & Indicator Metals (Cu, Pb, Zn): Rogue River Estuary and Urban Area, Oregon.

Figure 3: Rogue River Tidal Wetland Priority Map (larger map on page 38)



Wetland sites identified for *Restoration* are shown by their rank in *Table 4*, on the following page, with the types of alterations detected in the historic aerial photographs at each site.

Table 4: Rogue Tidal Wetland Restoration Sites Sorted by Rank (types identified with question marks are suspected, but not verified)

Site Name	Rank	Ecol Priority Score	Dike	Ditch	Exca-vation	Restrictive Culvert	Road/ Railroad Crossing	Channel armor/ riprap	Dredged material disposal	Logging	Grazing	Fill
Lower Saunders (RM 3.0 - 3.2)	1	25.9			x		x					
Elephant Bar Islands (RM 2.2-2.7)	2	25.4					x					
Jerry's Flat (RM 3.8-5.0)	3	25.3	?	x	x	?	x		x		x	
Edson Creek (RM 4.4-4.6)	4	24.7	?	x	?	x		?	?		x	
Elephant Bar Fringe (RM 2.7-3.1)	5	24.6			x		x					
Indian Creek (RM 1.1-1.6)	6	23.2			x	x	x	x	x		?	?
Industrial fringe (RM 0.-1.3)	7	20.4			x	x	x	?	x	x		x
Tidewater (RM 1.8-2.0)	8	15.9			x	x	x	x				

Wetland sites identified for *Conservation* are shown by their rank below in *Table 5* with the types of alterations detected in the historic aerial photographs at each site.

Table 5: Rogue Tidal Wetland Conservation Sites Sorted by Rank (types identified with question marks are suspected, but not verified)

Site Name	Rank	Ecol Priority Score	Dike	Ditch	Exca-vation	Restrictive Culvert	Road/ Railroad Crossing	Channel armor/ riprap	Dredged material disposal	Logging	Grazing	Fill
Saunders Slough (RM 2.8-4.2)	1	30.8		?		?		?				
Elephant Bar Slough (RM 2.3-2.6)	2	29.3									?	
Elephant Rock (RM 2.9-4.0)	3	27.8					x				?	
Snag Patch Island (RM 4.3-4.7)	4	25.0										
Mailboat Slough (RM 1.4-1.7)	5	23.7										
Ferry Hole Bar Fringe (RM 4.0-4.7)	6	22.6										
Boat Basin East (RM 1.0)	7	17.6						x				
Boat Basin West (RM 0-0.2)	8	17.1						x	x			

The HGM Method includes 10 indicators of risk to the wetlands, and common themes emerged among the surveyed wetlands. Vehicle and boat transportation routes, residences, and other facilities are in close proximity to tidal wetlands within the confined valley of the Lower Rogue. Buffers between wetland and upland areas are therefore critical for minimizing associated risks. Wetlands experiencing high visitation are at risk for the functions of habitat for nekton[1]-feeding wildlife, waterfowl, and shorebirds. Water quality risks include nutrient overload (particularly in the Boat Basin), and incoming fine-sediment overload. Risks from spills of chemicals used adjacent to the wetlands are unknown, and could be the focus of outreach. Onsite soil disturbance not only affects water quality, but also the ability to produce aboveground organic matter. Invasive exotic invertebrates including Asian clams and New Zealand mudsnails are a risk for habitat for native invertebrates and the food web. Wetland instability is clearly a result of natural disturbances such as tides and currents, wind waves, and floods, but also a result of human disturbance that adversely affects development of desirable wetland vegetation and native invertebrate habitat.

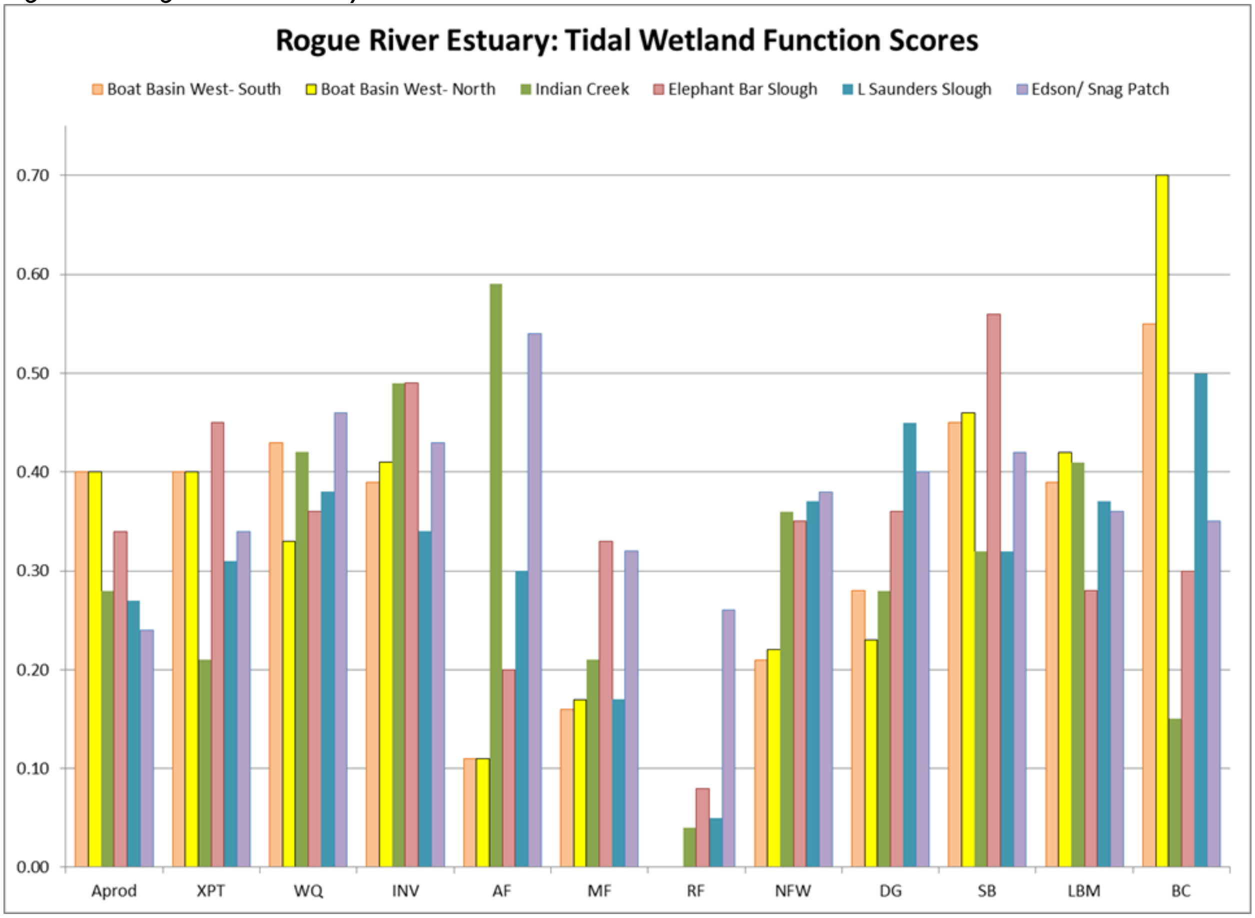
Field surveys were conducted on approximately one-third of the Wetland Sites (by number and acres) using the Hydrogeomorphic Rapid Assessment Method (HGM Method). This method scores 55 indicators which are combined in a model to assess wetland functions (abbreviations for *Figure* 3 below):

- ~ Produce Aboveground Organic Matter (Aprod)
- ~ Export Aboveground Plant and Animal Production (XPT)
- ~ Maintain Element Cycling Rates & Pollutant Processing; Stabilize Sediment (WQ)
- ~ Maintain Habitat for Native Invertebrates (Inv)
- ~ Maintain Habitat for Anadromous Fish (AF)
- ~ Maintain Habitat for Visiting Marine Fish (MF)
- ~ Maintain Habitat for Other Visiting & Resident Fish (RF)
- ~ Maintain Habitat for Nekton-feeding Wildlife (NFW)
- ~ Maintain Habitat for Ducks and Geese (DG)
- ~ Maintain Habitat for Shorebirds (SB)
- ~ Maintain Habitat for Native Landbirds, Small Mammals, & Their Predators (LBM)
- ~ Maintain Natural Botanical Conditions (BC)

For example, functioning fish habitat is the result of a network of wetland services, such as trapping sediment, immobilizing sediment and pollutants, supporting food webs, slowing floodwaters, and thermal regulation by groundwater exchange.

[1] aggregate of actively swimming aquatic organisms in a body of water able to move independently of water currents

Figure 3: Rogue River Estuary Tidal Wetland Function Scores



Comparing indicators of the function of "Maintain Habitat for Anadromous Fish," for two wetlands surveyed in areas designated as Restoration Sites:

- Indian Creek had better indicator scores for: lack of potential for a chemical spill, invertebrate habitat, types of freshwater, percent of tidal marsh shaded, large wood in channel, and onsite soil disturbance.
- Lower Saunders Creek had better indicator scores for: percent of wetland accessible to anadromous fish, tidal channel complexity, length of fish accessible non-tidal channels (i.e. Saunders Creek), and percent shade (a positive factor for organic matter production).

Comparing indictors of the function of "Maintain habitat for Native Invertebrates"

- Indian Creek had better ability to maintain aboveground productivity, diversity of vegetation structure and forms, percent of upland bounded by alder, pieces of wood in tidal channel, less exposure to chemical pollutants, and less possible instability of the wetland
- Lower Saunders had better wetland species per plot, is more protected from waves and currents, and less incoming fine-sediment overload.

Comparing indicators of the function of "Maintain Element Cycling Rates & Pollutant Processing; Stabilize Sediment," a measure of benefits for water quality. Both wetlands have low scores for narrow width.

- Indian Creek had better soil texture and less onsite soil disturbance.
- Lower Saunders had better channel complexity, percent of area experiencing tidal inundation, and is more protected from waves and currents

Plant species and cover were recorded in plots (quadrats) along transects of each wetland. These data were used to calculate a score for wetland integrity and to characterize the wetlands by species diversity, wetness, native/invasive species, perennial/annual, tap-rooted plants, stoloniferous (spreading by underground stems) species, and tuft-rooted (clumping) species.

Of the 73 quadrats, all but two contained at least some obligate wetland species and these two contained facultative wetland species as well. Wetland indicator categories are defined in Table 6.

Table 6: Indicator categories

Indicator Code	Indicator Status	Designation	Comment
OBL	Obligate Wetland	Hydrophyte	Almost always occur in wetlands
FACW	Facultative Wetland	Hydrophyte	Usually occur in wetlands, but may occur in non-wetlands
FAC	Facultative	Hydrophyte	Occur in wetlands and non-wetlands
FACU	Facultative Upland	Nonhydrophyte	Usually occur in non-wetlands, but may occur in wetlands
UPL	Obligate Upland	Nonhydrophyte	Almost never occur in wetlands

Within the 73 quadrats, 85 species were recorded, including 54 percent native, 32 percent introduced, and 14 percent not determined. Of the" not determined" species, most averaged 5 percent or less cover on the quadrats where they were observed. Of these three, two were aquatic plants that were identified to genus, but not species, Callitriche and Myriophyllum. Gnaphalium spp averaged 7.5 percent cover, and is most likely one of four native species found in Curry County.

Reed canarygrass (*Phalaris arundinacea)* is included in the non-native group based on its status in the TidalWet Calculator spreadsheet provided by Adamus. The origin of reed canarygrass as a native North American species appears to be clear, but sources also agree that its pre-agricultural distribution is uncertain due to widespread cultivation from European introductions[1]. Reed canarygrass threatens wetland and aquatic wildlife habitat by displacing desirable native wetland plants. Where present, Phalaris arundinacea (reed canarygrass), covered an average of 34 percent of quadrats.

From observations off-transect, 33 additional taxa were recorded, including 64 percent native and 36 percent introduced species.

The average percent cover of native plants among all of the quadrats is 59 percent. Within the wettest part of these transects, in the first two quadrats, native plant cover averaged 78 percent.

At least 14 plant species important to waterfowl were present within plots on the Rogue wetlands, and additional species within the genus *Polygonum* (smartweed) are present[2]. Six additional waterfowl food taxa were recorded during off-transect surveys. Of the 73 plots in Rogue wetlands, 66 contained at least some cover of waterfowl food species. Five plots that lacked plant foods were located at Lower Saunders Slough, and cover in these plots were dominated by other species including reed canarygrass and the invasive purple loosestrife.

Wetland descriptions are included in the Rogue River Estuary Tidal Wetlands Assessment[2], and provide scores for Risk Assessment and Wetland Integrity, as well as species cover and presence.

[1] http://www.fs.fed.us/database/feis/plants/graminoid/phaaru/all.html

[2] Myers, C.R. 2015a (unpublished). Rogue River Estuary Tidal Wetlands Assessment.

Restoration and Design Considerations

The information described in the previous sections under Tidal Wetland Assessment and Summary was used to develop the recommendation table below (larger version located on page 36).

Table 7: Restoration and Design Recommendations for Field-Surveyed Wetlands (approximate river mile locations shown as RM)

Field- Surveyed Wetland	Boat Basin West (RM 0.0-0.2)	Indian Creek (RM 1.1-1.6, south bank)	Elephant Bar/Krambeal [1] Slough (RM 2.3-2.6, south bank)	Lower Saunders Slough (RM 3.0-3.2, south bank)	Snag Patch/ Edson Creek (RM 4.3-4.7, north bank)
Treat Invasive Plant Species	protect remnant dune habitat; treat creeping bentgrass, bird's-foot trefoil, & white clover	*Crocosmia*	yellow flag iris, purple loosestrife	purple loosestrife, white clover, reed canarygrass	bindweed (at old garden), English ivy, thistle, marshland goosefoot, annual rabbitsfoot grass, & foxtail prickle grass
Revegetation/ Cover Objectives	buffer upland and higher elevation areas, requires drought-tolerant trees & shrubs	increase vegetation structure	increase vegetative structure & wood recruitment for channel cover, increase shade over slough, discourage removal of wood deposited in floodplain & riparian	increase vegetative structure, wood lacking in channel	root strength to slow bank erosion at Clay Banks (RM 4.8-5.0)
Dredge/fill rehabilitation	redistribute some dredge spoils to lower elevations, fringe of jetty	redistribute fill (may include dredge spoils) to lower elevations		decrease soil disturbance; determine whether road drainage re-routes hillslope springs & seeps away from wetland	
Monitoring/ Design	fill mapping of soil texture & buried organic layer (may include coring)	fill mapping of soil texture & buried organic layer (may include coring)			
Monitoring/ Risk Assessment	nutrient load from fish cleaning station, see Boat Basin water quality recommendations	upstream sediment sources, nutrients; assess spill potential from fish hatchery	screen for pollutants from old cars in creek & septic systems		

Estuary Water Quality Summary

The Oregon Department of Environmental Quality (DEQ) has established pollution limits to protect human health and salmon and trout in the Rogue River Basin[1]. The *Rogue River Basin Total Maximum Daily Load* (TMDL) contains the required components, described by the U.S. Environmental Protection Agency (EPA), for compliance with the Federal Clean Water Act. TMDLs are limits on pollution which are intended to bring rivers and streams into compliance with water quality standards. That document provides a thorough analysis of pollutant sources and accumulation processes in the Rogue River Basin.

The Rogue River Basin TMDL applies to all perennial and intermittent streams, rivers, and lakes within the Rogue River Basin in Oregon with the exception of those areas where TMDLs have been previously developed including Bear Creek Watershed, Applegate Subbasin, Lobster Creek Watershed, and Sucker Creek Watershed. The 5,156 square mile Rogue River Basin is located within Jackson, Josephine, Curry, Douglas, and Klamath Counties in Oregon and Siskiyou and Del Norte Counties in California.

Storm Conditions

In 2012-2013, water quality investigations[2] were intended to address sources of pollutants in storm runoff affecting tidal wetlands, salmonid rearing habitat, and recreational contact. During three storms, runoff samples were collected from 1) a developed urban area to the south of the Rogue River watershed; 2) the Boat Basin and associated watershed areas (including Dean Creek) and 3) tributaries draining into the Rogue River Estuary (excluding the Boat Basin). Additional details can be found in the *2012-2013 Investigation of Storm Runoff Sources of Turbidity, E.coli bacteria & Indicator Metals (Cu, Pb, Zn) Rogue River Estuary and Urban Area, Oregon*[2].

Dissolved minerals (as measured by specific conductivity) were higher during early “first flush” storms than during a later larger storm. Samples from Dean Creek contained the highest concentrations of dissolved minerals, double the concentrations measured in the incoming Rogue River, upstream of the estuary.

During the larger storm, turbidity in the urban area was elevated over 1,000 NTU in Riley Creek, evidently originating in the South Fork Riley Creek watershed. In the Boat Basin drainage area, Dean Creek was the most turbid at 600 NTU, and appeared to have increased turbidity at the Boat Basin station closest to Dean Creek. Among tributaries to the estuary, Saunders Creek and Indian Creek were 3 and 4.5 times more turbid than the Rogue during the larger storm. Edson Creek was about half as turbid, and clean water was also contributed by numerous unnamed tributaries, primarily on the north bank.

The Oregon *E.coli* bacteria standard for recreational contact (406 colonies/100 mL) was exceeded at each of the four urban area stations tested. During first flush conditions, concentrations measured as high as 6,490 colonies/100 mL at the mouth of Cunniff Creek. Bacteria standards were exceeded in 22 of 23 samples of runoff into the Boat Basin. Among these runoff sources, the 2013 first flush event resulted in 3,873 colonies/100 mL in the creek at Tom Cat Hill. This station also recorded the lowest value during the 2012 first flush event. Samples from the Boat Basin exceeded the standard during the first two storms, but not during the 2013 first flush event. Water entering the Rogue estuary from upstream met the *E.coli* standard during all three storms, with the highest concentration during the largest storm, at 344 colonies/100 mL. Ranch Creek measured nearly 10 times higher than the Rogue during the 2013 first flush storm (at 24,200 colonies/100 mL). Tributaries contributed higher concentrations to the Rogue during the first flush storms in most samples, and did not meet standards in 11 of 14 samples.

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[1] Oregon Department of Environmental Quality (OR DEQ). 2008. Rogue River Basin Total Maximum Daily Load (TMDL).
[2] Myers, C.R. 2015b (unpublished). 2012-2013 Investigation of Storm Runoff Sources of Turbidity, E.coli bacteria & Indicator Metals (Cu, Pb, Zn): Rogue River Estuary and Urban Area, Oregon.

In addition to the three storm sampling events, six bimonthly samples established that *E.coli* concentrations are always greater in the Boat Basin than in the Rogue mainstem. During eight of the nine sampling events, *E.coli* concentrations increased on the Rogue River mainstem between the station upstream of the estuary and near Highway 101. Near Highway 101, only the larger storm exceeded the *E.coli* standard, and in the Boat Basin, the standard was exceeded only during storms as discussed above. These results indicate that human health risks are probably limited to water contact during storms, primarily within the Boat Basin, and that *E.coli* sources are local (in town).

Concentrations of indicator metals of copper, zinc, and lead from runoff sources into the Boat Basin were tested in water and substrate grab samples. No samples exceeded levels of concern established by EPA criteria. Among metals sampled during two first flush storms, zinc concentrations were the highest. If all of the zinc extracted from the particles in the water sample were in the dissolved form (unlikely due to the water chemistry of the Boat Basin), then one sample from the commercial area would have exceeded the marine aquatic life chronic criteria. Metals in substrate were all highest near the Dean Creek outlet. Copper concentrations were the highest relative to a limit of concern, but still rated as "good." The limit of concern is based on the concentration at which 10 percent of studies showed adverse ecological or biological effects on organisms.

Summer Conditions

Summer water temperatures are inhospitable for rearing of juvenile salmonids in the Rogue River, based on the Oregon standard of 64 °F for the mean of 7 consecutive maximum daily temperatures (7-day max). The 7-day max regularly exceeds 75 °F at multiple locations on the mainstem. Rogue River temperatures vary by streamflow, augmented by releases from dams. Water temperature records in *Table 8* are displayed with streamflow statistics from the Rogue River near Agness U.S. Geological Survey gage. The percent of median streamflow, actual flow divided by median flow for a particular date, was calculated for the 7-day temperature maximum period in Table 8 below.[1]

Table 8: Streamflow on Rogue River during Summer Water Temperature Records, as percent of median

Station	Year	Temperature 7-day max, °F	% of Median Streamflow	Data Source
Rogue at Kimball Bend dock	1994	75.8	58	ODFW
Rogue at Kimball Bend dock	1995	74.3	118	ODFW
Rogue upstream of Lobster Creek	2002	76.1	90	Lower Rogue WS Council
Rogue upstream of Lobster Creek	2003	77.1	93	ODEQ
Rogue at Huntley Park	2003	75.9	93	ODFW
Rogue Boat Basin (top layer)	1995	67.7	140	Lower Rogue WS Council
Rogue Boat Basin (bottom layer)	1995	57.2	116	Lower Rogue WS Council

Salmonids can tolerate elevated maximum temperatures better when part of the day is spent below 64 °F. Upstream of Lobster Creek, temperatures remained warmer than 65 °F during the entire period of June 28th-August 26th, 2002. Within the Boat Basin *(Table 8)* the top layer (influenced by the Rogue) was cooler than typical Rogue mainstem temperatures, but streamflow was also relatively high that year. At the mouth of Indian Creek in 2002, warmer temperatures within the intertidal area (7-day max 70.0 °F) contrasted with flows from Indian Creek (7-day max 65.1 °F). Tributaries to the estuary are believed to be important as

[1] Myers, C.R. 2015b (unpublished). 2012-2013 Investigation of Storm Runoff Sources of Turbidity, E.coli bacteria & Indicator Metals (Cu, Pb, Zn): Rogue River Estuary and Urban Area, Oregon.

thermal refuges. Multiple years of water temperature measurements in these tributaries are summarized below in *Table 9*.

Table 9: Summer Water Temperatures for Tributaries to Rogue River Estuary, 7-day max in degrees F

Tributary	Max	Min	Median	N
Edson Creek at North Bank	69.4	66.1	68.1	5
Saunders Creek near Jerry's Flat	65.3	64.0	65.0	4
Indian Creek upstream of tidal influence	67.4	63.8	65.0	4

During six summer sampling events of 24 hours each (2005 and 2010-2011), temperature, salinity, dissolved oxygen (DO), and pH were monitored continuously at two stations, and by grab sampling at ~3 hour intervals at two stations.

Sampling in 2005 focused on comparing conditions in the Boat Basin and Rogue River. DO was lower in the bottom than in the top layers, and the continuous measurements were taken from the top layer at ~1 meter depth. During July 2005, the Boat Basin station at Hwy 101, most isolated from tidal circulation and river currents, did not meet the estuarine DO standard of 6.5 mg/L for five hours, dropping to 5.7 mg/L in mid-morning under overcast skies. The pH level slightly exceeded the standard of 8.5 units for 3.5 hours at two stations within the Boat Basin, while the Rogue station remained slightly below the standard. In August 2005, the Boat Basin station didn't meet the estuarine DO standard for one hour, dropping to 5.2 mg/L. The pH level reached at least 8.5 units at the recreational dock, but was not collected for the Boat Basin at Hwy 101 station. In September, DO and pH standards were met at all stations.

Sampling stations for 2010-2011 were distributed along the mainstem Rogue Estuary. During August 2010, summer streamflow was greater than average and temperatures were cooler than average due to late season rainfall and dam releases. Within the freshwater intertidal zone at Elephant Bar, the minimum recorded DO was 7.8 mg/L and 84 percent saturation, which does not meet the summer freshwater standard (8.0 mg/L, 90 percent saturation). In September 2011, discharge was lower, temperatures were higher, and DO variation was greater. At Elephant Bar, evening respiration coincided with an ebbing tide of backwater from upstream, that either lost DO from stagnation, or from respiration in the water column. Under these conditions DO standard was not met for four hours with a 5.7 mg/L minimum. This was unusual because minimum DO from respiration usually occurs in the early-mid morning. Maximum pH was recorded as 8.8 units.

Recommendations

- Focus sediment reduction activities, including stormwater runoff infiltration and detention, road storm proofing, and erosion control, within the following three areas:
    1) tributary watersheds that flow into off-channel habitat in sloughs. Of these, Saunders Creek had the highest turbidity, followed by Krambeal Creek, and Ranch Creeks.
    2) the watershed of Indian Creek, which has the highest flows into the saltwater influenced part of the estuary, and also the overall highest turbidity.
    3) tributaries important to over-wintering and rearing habitat for salmonids; such as Indian Creek, Saunders Creek, Krambeal Creek, and Edson Creek.
- Evaluate access locations and perform focused synoptic sampling (collection of samples from many locations during a short period of time, typically a few hours) on Saunders Creek and Indian Creek which may help identify turbidity sources within these watersheds.

- Provide technical resources for earthflow stabilization, particularly where they interact with roads and other facilities (e.g. Indian Creek Fish Hatchery).
- Protect less turbid watersheds: Edson Creek
- Reduce *E.coli* input into the Boat Basin:
    - ~ Use remote sensing and field observations to assess potential *E.coli* sources within the watersheds of Dean Creek and the stream at Tom Cat Hill
    - ~ Conduct additional synoptic sampling of first flush storms (i.e. Stormchaser Events)
    - ~ Promote proper disposal of pet wastes in Buffington Park and in neighborhoods adjacent to Dean Creek
    - ~ Promote riparian and wetland buffers for filtration and detention of storm runoff
- Develop flow-weighted storm sampling for metals at Dean Creek outlet (currently funded by ODEQ 319 grant)
- Conduct additional synoptic sampling of specific conductivity in Dean Creek to help isolate pollutant sources.
- Continue to seek opportunities to record the magnitude and duration of DO and pH conditions that do not meet state standards for juvenile salmonid rearing, particularly during low flow and high temperature years, focusing on the Boat Basin at depth and on freshwater intertidal areas.
- Expand the data set for temperature, salinity, DO and pH into the estuarine sloughs.
- Increase shade in tributaries, taking advantage of opportunities shown on the riparian vegetation mapping from the Rogue Watershed Assessment[1] to build up current cold-water refugia locations.
- Promote water infiltration and storage in the tributaries to the Rogue Estuary (this can also meet the objective of reducing stormwater runoff).
- Promote vegetation that captures, stores, and processes organic matter transported downstream during high flow. This is important because excessive organic matter contributions can increase the biochemical oxygen demand and decrease dissolved oxygen.

Elephant Bar (series of islands in foreground) during high water, with Saunders Slough leading upstream around bend. Photo credit: Kelly Timchak, 2015

[1] Hicks, D. 2005. *Lower Rogue Watershed Assessment*. Lower Rogue Watershed Council.

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TABLES

Table 7: Restoration and Design Recommendations for Field-Surveyed Wetlands (approximate river mile locations shown as RM)

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Revegetation/ Cover Objectives	buffer upland and higher elevation areas, requires drought-tolerant trees & shrubs	increase vegetation structure	increase vegetative structure & wood recruitment for channel cover, increase shade over slough, discourage removal of wood deposited in floodplain & riparian	increase vegetative structure, wood lacking in channel	root strength to slow bank erosion at Clay Banks (RM 4.8-5.0)
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Monitoring/ Design	fill mapping of soil texture & buried organic layer (may include coring)	fill mapping of soil texture & buried organic layer (may include coring)			
Monitoring/ Risk Assessment	nutrient load from fish cleaning station, see Boat Basin water quality recommendations	upstream sediment sources, nutrients; assess spill potential from fish hatchery	screen for pollutants from old cars in creek & septic systems		
[1] local name God Wants Ya					

FIGURES

Figure 1: Rogue River Estuary Map used for SWOCC Estuarine Education Course

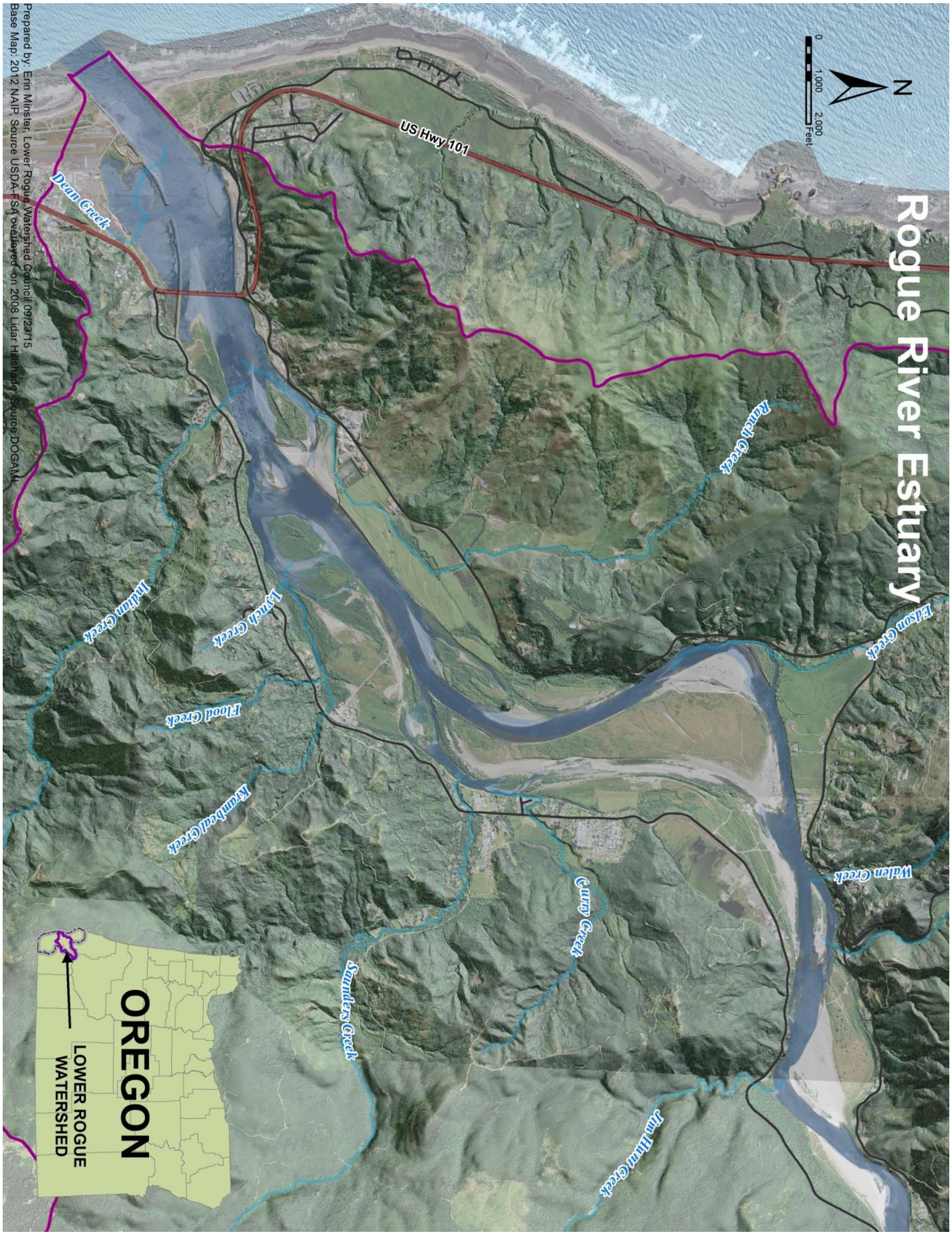

Figure 3: Rogue River Tidal Wetland Priority Map