The Application of Geographic Information Systems for Delineation and Classification of Tidal Wetlands for Resource Management of Oregon's Coastal Watersheds

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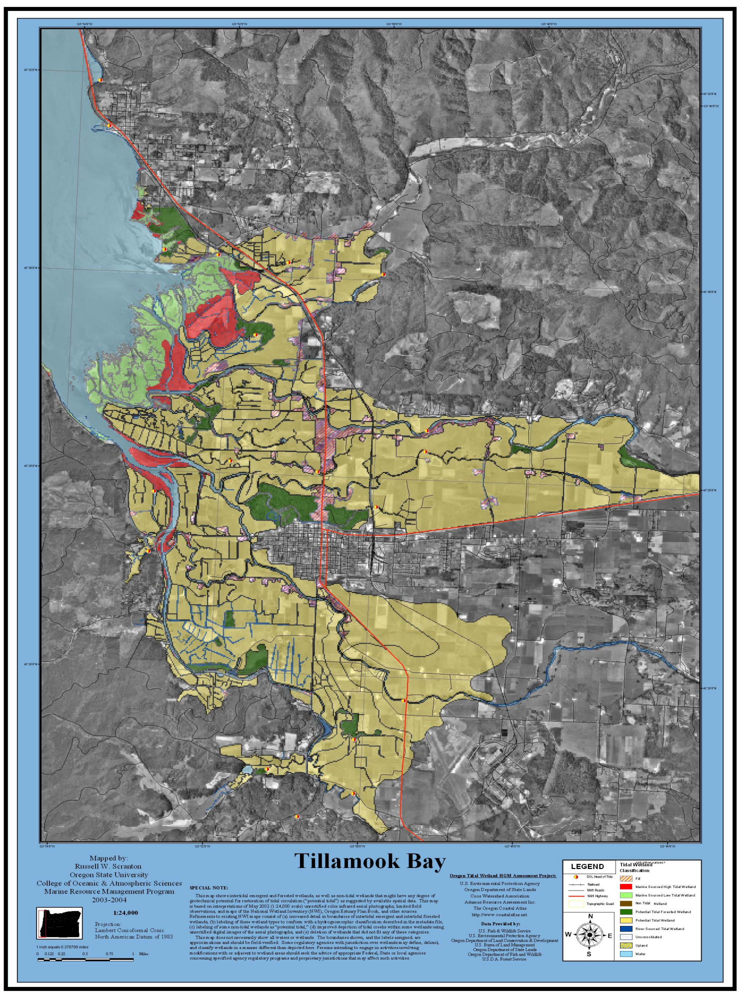

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Abstract:

Resource managers of Oregon's tidal wetlands require an improved GIS layer for management of existing tidal wetland habitat and areas considered for tidal wetland restoration. A reconnaissance project was initiated, such that interpretations of remote sensing data, the National Wetland Inventory, Oregon Estuary Plan Book and additional management tools were used to create a "tidal wetland" in an ArcGIS Geodatabase, for Oregon's coastal estuaries, excluding the Columbia River. With an improved hydrologic delineation of tidal waters and channels this data set classifies existing tidal wetlands for future resource management use based on the Hydrogeomorphic (HGM) classification (adopted nationally and by the State of Oregon) and for habitat classification based on the Oregon Estuary Plan Book classification system. The classification "restoration consideration areas" was developed for lands where restoration of tidal circulation might be geotechnically feasible pending further investigations. Additional groundwork and validation of the data set classification's is recommended before this interpretation is used as an official reference for resource management.

In addition to wetland classification this project was partly developed to provide a GIS base layer, which when combined with supplementary data sets, would enhance the ability of resource mangers and citizens to prioritize tidal wetland restoration efforts and evaluate the ecological integrity of an individual tidal wetlands or an entire estuarine complex. A simple spatial analysis of this data set's classification system by watershed and comparison to the Oregon State of the Environment Report 2000 (SER) shows improvements to total existing tidal marsh habitat. It also shows that the SER underestimated the total habitat lost due to anthropogenic alteration based on information

and techniques available for their assessment. Additional development of the data set may enhance management of Goals 16 and 17 of Oregon's Statewide Planning Goals Guidelines, aid in management of non-point source pollution and the designation Critical Habitat and restoration priorities for the endangered Coastal Coho. Resource managers and citizens will be able to view and interpret this data set and supporting documentation at the OSU Library or in part online at the Oregon Coastal Atlas (www.coastalatlas.net).

Introduction:

Past and present land use practices in Oregon's Coastal watersheds continue to threaten and degrade the environmental integrity, functionality and sustainability of Oregon's tidally influenced habitats and salmon stocks. Today management of Oregon coastal watershed's tidal wetlands and estuaries is complex with many government agencies, non governmental organizations and private interests involved. The need to involve all these interests and to balance the social and economic growth and development with the preservation of the overall ecological integrity of estuarine resources is ever more challenging given the recent and projected population growth and changing social and political structure of the Oregon coast.

Historical land use practices in tidal wetlands areas in the late 19th and early 20th century resulted in the decrease in estuarine wetlands. This changed the estuarine ecosystems dramatically, disrupting the hydrologic flow, eliminating flood plain area and decreasing overall habitat. Estuary land use and water use plans developed in the late 1970's and 1980's have protected more than 90% of the remaining tidal wetlands from anthropogenic alteration. Efforts for conservation and restoration of tidal wetlands will achieve broader technical and public support, as scientific knowledge of how the functions and interactions of estuarine resources serve the natural and human environment are disseminated to resource managers, scientists, the government and the general public. The recent reports of two blue ribbon panels (Pew Ocean Commission 2003; US Commission on Ocean Policy 2004) give added impetus to the importance of improving watershed management policies and techniques for the restoration of coastal ecosystems and the prevention of further social and environmental degradation. In most estuaries opportunities for tidal wetland restoration are poorly documented, with no existing management strategy established to prioritize or track areas restored and monitor their condition. This in part can be attributed to a lack of information on the ecological integrity and the restoration potential of specific sites and estuaries as a whole.

To address state and national goals for estuarine resource management in 2002 Oregon's Coastal Watershed Councils, Oregon's Department of State Lands (DSL) and the US Environmental Protection Agency (USEPA) recognized the need for new tools to evaluate the ecological integrity and functionality of Oregon's existing tidal wetlands by initiating the "Oregon Coastal Tidal Wetland Hydrogeomorphic Assessment Project" (HGM Project). The HGM project was applied to Oregon's coastal watersheds and estuaries- excluding the Columbia River. HGM projects' goals were to apply a regionalized Hydrogeomorphic (HGM) classification to Oregon's existing tidal wetlands and analyze existing data to characterize these wetlands. The HGM classification (Brinson 1993) varies from the traditional Cowardin classification used by the National Wetland Inventory (Cowardin 1979) and habitat maps for the Oregon Estuary Plan Book (Bottom 1979) by placing greater emphasis on geomorphic and hydrologic properties, rather than the vegetation of the tidal wetland. A third component of the HGM project was to develop a new inventory with GIS of existing wetlands using existing management data sets to monitor and evaluate the changes in ecological integrity of Oregon's tidal wetlands. The third component of the HGM project initiated the development of this graduate research project to develop a GIS Data layer and complete a spatial analysis to compare today's habitat conditions with those ascertained the Oregon State of the Environment Report 2000 (SER).

This research project discusses the techniques and data used to develop a high resolution geospatial database and mapping system for existing tidal wetlands in each of Oregon's coastal estuaries. The database also includes a reconnaissance study of areas that may have been tidal prior to anthropogenic alterations from diking, filling or ditching, which have potential for restoration of tidal function in the future. This potential for restoration depends on many additional factors that will need further evaluation with Lidar or on the ground elevation surveys, which at this time is beyond this projects capability.

This report includes brief background on Oregon's estuaries, shortcomings of existing tidal wetland protection and restoration policies, information about historic alterations that have taken place, Stakeholder Involvement and data that is needed and available to describe tidal wetlands function in these ecosystems. This report will also detail the development and distribution of the GIS Geodatabase data set and additional products created for evaluation and future management of tidal wetlands, restoration consideration areas and tidal waterways of Oregon's coastal watersheds. It will address how the data set will be used with the HGM project assessment technique that are subsequently developed for the Hydrogeomorphic classification of Oregon's Coastal watersheds (Adamus 2005). In the results and discussion sections this report will further detail the limitations of this Geodatabase and other management tools and produce results of a simple spatial analysis to understand the present status of tidal wetlands. These results are also compared to the Oregon State of the Environment Report 2000 (Good 2000) to validate the report and show some shortcomings of the SER tidal wetland assessment with the advances in GIS. The discussion also suggests how this Geodatabase data set might be used in future management of estuarine aquatic and terrestrial resources and makes suggestions for additional research topics.

Oregon's Estuaries & Tidal Wetlands:

Oregon's tidal wetlands have many functions and values that influence the natural and human environment. The most prominent are their contributions to providing essential habitat and food source to many animal species including endangered and threatened species of many different phyla of the animal kingdom. The most prominent species is the endangered Coastal Coho salmon. Additionally tidal wetlands improve water quality by removal of sediments, excess nutrients and other pollutants from the water column, which positively impacts navigation, wild fisheries and Oregon's aquaculture. Unlike the Columbia River the coastal watersheds are not as severely hydrologically regulated by dams. Much of the historic diking and channelization resulting in the loss of tidal habitat has lead to the decrease in lag time to peak flood stage resulting in more severe flooding events. Tidal wetlands serve as a natural flood mitigator by decreasing the rate of runoff and channel velocity when the water spreads out over the natural floodplain providing larger surface area and a greater drag coefficient that may slow the velocity of flow during flooding , which may damage human infrastructure.

While in other capacities tidal wetlands serve recreational or an aesthetic use for the human population. Ecotourists and naturalists benefit from their existences from the ability to view the natural environment or the wildlife, which inhabit tidal wetlands. Oregon's estuaries are diverse in physical attributes, biological fauna and how they are managed to protect resources and promote economic development.

The Hydrogeomorphic assessment hopes to identify the similarities and differences of tidal wetlands in each estuary, which helps define the classification of habitat and the overall ecological integrity of an ecosystem. This project focuses on Oregon's coastal watersheds excluding the Columbia River. Oregon's coastal watersheds are small in comparison to the Columbia River with only the Umpqua River and Rogue River watersheds extending beyond the Coast Range. Geomorphological, physical properties and environmental factors add to the diversity of Oregon's estuaries. Geologically the estuaries may vary from regional tectonic uplift or subsidence, while hydrologic properties also define how the tidal flooding produces certain tidal marsh habitats by the degree of tidal mixing. Although the tidal range for Oregon's coast may reach 12- 14 feet tidal influence may extend beyond 20 feet in select estuaries (Frenkel 1976). The majority of the north coast is subsiding and the estuaries are dominantly drowned river valleys that developed as a result of post-glacial sea level changes. The exceptions of this classification are Netarts Bay and Sand Lake, which are bar-built estuaries. They have many attributes of a relict drowned valley with many small streams feeding them, however these estuaries are dominated by marine water with well developed sand spits at their mouths. Unlike the northern coast, the southern coast estuaries are experiencing tectonic uplift. Some of these estuaries are drowned river valleys; however some are river dominated, like the Rogue River, while other smaller estuaries are blind estuaries, like the Elk and Sixes Rivers with low summer in stream flow. Additional physical properties and other environmental factors define biologically diverse estuaries with many endemic species unique to Oregon making management of the estuaries difficult.

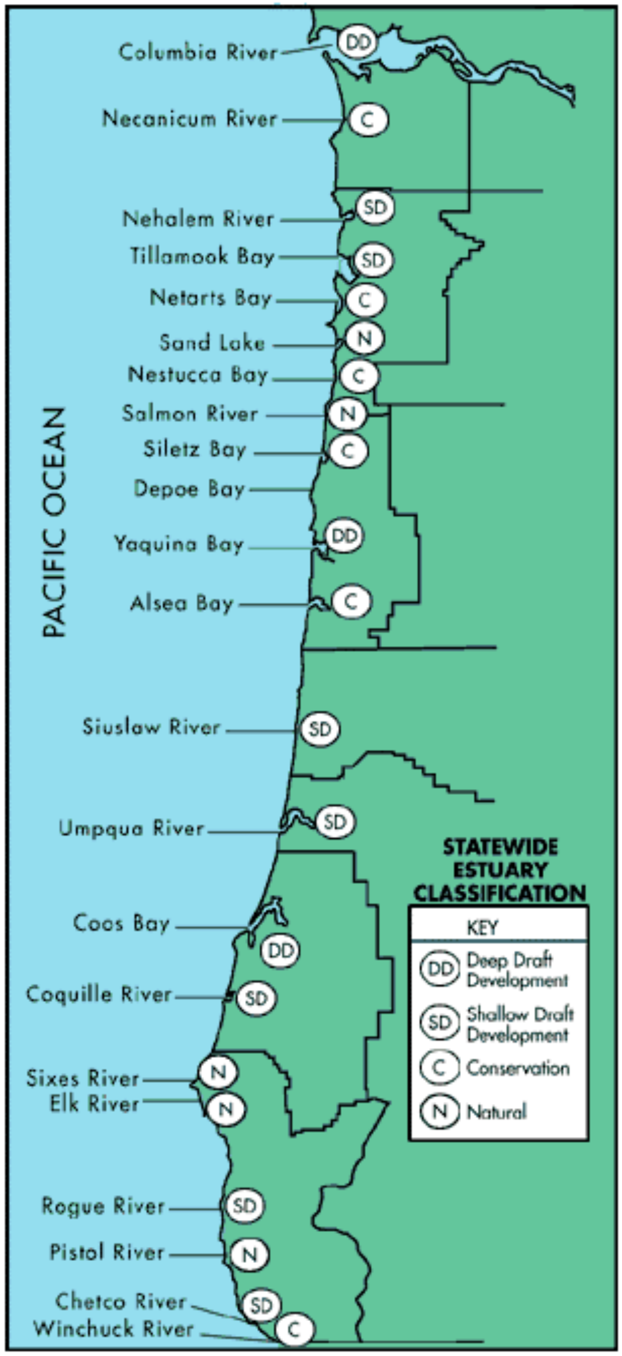
Estuary Management:

Estuaries are also classified by political designations. The Oregon Land Conservation and Development Commission adopted a classification system defining the level of development for estuaries in the Oregon Estuary Plan Book *"This system was designed to preserve diversity among Oregon's estuaries and guide development to estuaries that have been altered and which can support more development."* (Cortright 1987). This has permanently protected over 90 % of the remaining tidal marsh habitat. Unfortunately this classification initially focused development to all large estuaries decreasing the overall diversity of Oregon's coast by creating fragmented management units in these larger estuaries. In these larger estuaries restoration efforts have been focused eliminating the fragmentation. One successful example of eliminating the fragmentation and restoring functional tidal habitat to the larger estuaries is the work in Coos Bay's South Slough National Estuary Research Reserve. The Oregon Estuary Plan Book defined four management schemes, Natural, Conservation, Shallow Draft Development and Deep Draft Development, (figure 1).

Natural Estuaries: Sand Lake, Salmon River, Elk River, Sixes River, Pistol River, Big Creek, Berry Creek, Siltcoos River, Sutton River, Tahkenitch Creek, Tenmile Creek, Twomile Creek, Fourmile Creek New River, Floras Creek, Euchre Creek, and Hunter Creek are classified as "Natural" estuaries. These are defined as "estuaries lacking maintained jetties or channels, and which are usually little developed for residential, commercial or industrial uses. They may have altered shorelines, provided that these altered shorelines are not adjacent to an urban area. Shore lands around natural estuaries are generally used for agriculture, forestry, recreation and other rural uses. Natural estuaries have only natural management units." (Cortright 1987).

Conservation Estuaries: The Necanicum River, Netarts Bay, Nestucca River, Siletz Bay, Alsea Bay, Winchuck River, Ecola Creek, Neskowin Creek, Beaver Creek and the Yachats River are classified as conservation estuaries. This classification is defined for "Estuaries lacking maintained jetties or channels, but which are within or adjacent to urban areas which have altered shorelines adjacent to the estuary. Conservation estuaries shall have conservation and natural management units." (Cortright 1987).

Figure 1. Oregon's Major Estuaries Statewide Classification (Oregon Estuary Plan Book)



Shallow Draft Development Estuaries: Nehalem Bay, Tillamook Bay, Depoe Bay, Siuslaw River, Umpqua River, Coquille River, Rogue River and the Chetco River are classified as "Shallow Draft Development" estuaries. These are defined as "Estuaries with maintained jetties and a main channel (not entrance channel) maintained by dredging at 22 feet or less. Shallow draft development estuaries have development, conservation and natural management units." (Cortright 1987).

Deep Draft Development Estuaries: The Columbia River, Yaquina Bay and Coos Bay are designated as Deep Draft Development Estuaries. This classification is defined for "Estuaries with maintained jetties and a main channel maintained by dredging to deeper than 22 feet. Deep draft development estuaries have development, conservation and natural management units" (Cortright 1987).

Policies, Regulations and Jurisdiction of Tidal Wetlands:

Management of Oregon's estuaries and tidal wetlands is a diverse and complex issue with multiple regulation and state and federal regulatory agencies involved. To have a better understanding of the complexities of estuarine management this paper will attempt to give a brief overview of the development of regulations established to protect tidal wetlands and estuarine resources to show how this project can be used as an aid to existing regulations.

Since the beginning of the environmental movement and the passing of the National Environmental Policy Act (NEPA) in 1969 and the Clean Water Act (CWA) in 1972, state and federal agencies have more stringently regulated tidal wetlands and waters for their values to society and the environment. Today applications for wetland alteration must exhaust all alternatives before alteration of a wetland's functions is to occur. If an alteration is to be permitted mitigation is required. Mitigation may involve the restoration, enhancement or creation of a new wetland to compensate for the loss in the former wetland's function. In the 1990's a National goal of "No Net Loss of

Wetlands" was adopted under the Presidency of George H. Bush. However to fully understand how tidal wetlands and estuarine resources are managed today and the direction management may head in the future it is necessary to look at the major statutes established to regulate estuarine resource use.

The preservation of estuarine resource by federal and state governments was established in 1892 with the adoption of the English Common Law of the Public Trust Doctrine. The Public Trust Doctrine is a federal and state contract to the public for states to hold all navigable waters of the US and submerged lands to the "Mean High Tide" in trust for uses in commerce, navigation, and fishing, protection of esthetics, habitat and recreation for today's public and future generation's (Kalo 1999). Even though the Public Trust Doctrine does not specifically mention tidal wetlands it has served to protect them navigable waters of the US. Like the Public Trust Doctrine other statutes may have been established for another purpose, but indirectly they have served to protect wetland's functions. The Navigation Servitude and Rivers and Harbors Act (RHA) of 1899 regulated by the US Army Corp of Engineers (USACE) for the general purpose of navigation defined the term "navigable waters of the United States" to be waters subject to the ebb and flow of the tide and/or have been used in past or may be susceptible for use to transport interstate or foreign commerce (Kalo 1999). This helped solidify that tidal wetlands were included in the term "Waters of the United States" under the protection of the Public Trust Doctrine and future legislation.

It was not until 1972 that Congress developed more stringent regulations explicitly for the management of wetlands. The federal government strengthened wetland protection with the passage of the Federal Water Pollution Control Act (FWPCA), later reauthorized as the Clean Water Act (CWA). The jurisdictions of the Environmental Protection Agency (EPA) and the USACE were extended to aid in protection of "waters of the United States" specifically wetlands and estuarine resources under Sections 303d 319, 401 and 404 of the CWA. The end result has been the procurement of permits from the EPA and the USACE for actions that may negatively impact wetlands or water quality (Kalo 1999).

The most significant legislation passed in the management of tidal wetlands for Oregon was the Coastal Zone Management Act (CZMA) of 1972. The CZMA confirmed State governments authority to develop laws and regulations within the State's Coastal Zone, where all federal agency actions must be consistent with the State's federally approved Coastal Zone Management Plan (CZMP) with federal support to protect resources defined in state CZMP (Kalo 1999). Oregon's Ocean Coastal Management Program (OCMP) was federally approved in May of 1977. It established Oregon's Statewide Planning Goals & Guidelines as the cornerstone for management of estuarine resources. It defined the "coastal zone" to include the coastal watersheds from the ocean beaches east to the Coast Range drainage divide, with the exception defining the easternmost boundary for the Columbia River as Puget Island, Agness for the Rogue River and Scottsburg for the Umpqua River. With oversight by Oregon's Department of Land Conservation and Development the goal for management of its estuaries was established in the revised 1999 Statewide Planning Goals and Guidelines, Goal 16: Estuarine Resources. Its purpose "*to recognize and protect the unique environmental, economic and social values of each estuary and associated wetlands; and to protect, maintain, where appropriate restore the long-term environmental, economic and social* *values, diversity and benefits of Oregon's Estuaries*." This goal outlines the four different management systems, Natural, Conservation, Shallow Draft Boat Development or Deep Draft Boat Development of its estuaries. Additional goals have been developed for managing Coastal Shorelands (Goal 17), Forest Lands (Goal 4), Agricultural Lands (Goal 3) and Land Use Planning (Goal 2), which may impact tidal wetlands. Additional regulations were established to regulate wetlands through the OCMP, however this paper will focus primarily on Goal 16 and 17 of the Statewide Planning Goals and Guidelines.

The Endangered Species Act of 1973 (ESA) gives jurisdictional management for marine species to the Department of Commerce's National Oceanographic and Atmospheric Administration (NOAA) and riverine and terrestrial species to the US Fish and Wildlife Service in the U.S. Department of the Interior. The plight of the salmon has been linked to habitat degradation, harvest activities, hatchery production and hydropower operations. Although the ESA primarily works by limiting direct actions that result in "Takings" of threatened and endangered species the designation of essential habitat of threatened and endangered salmon may prove to be very effective in preservation and restoration of tidal wetlands (Kalo 1999). NOAA recognized tidal wetlands as critical habitat for salmon species and is still working on implementation of restoration and management plans of the critical habitat on the Oregon coast. It was not until 1998 when the Oregon Coastal Coho Evolutionary Significant Unit (ESU) and later in 1999 when the Columbia River Chinook ESU salmon stocks became listed as threatened and endangered species that the ESA impacted how existing and altered tidal wetlands of Oregon were to be regulated. The ESA today is one of the most contentious legislations in existence. It is considered by some to the greatest hindrance to future growth and development, while others see it to be an effective tool in the restoration of tidal wetlands aiding proper resource management and maximizing the long-term economic gains of the salmon fishery.

By the turn of the 21st century the culmination of short-term economic gains from unsustainable resource consumption practices has come to fruition. The mindset of managers and many resource users has turned toward sustainability, as the once believed unlimited resources of the ocean and Oregon coast decline in revenue, quantity and quality. The Oregon State of the Environment Report 2000 estimated that since 1870 Oregon has lost 68% of its tidal marshes resulting in the decline of ecological integrity and productivity of Oregon's estuarine resources. The coastal population and industry demographics have changed as a result of these losses. The traditional industries of fishing, agriculture and logging are no longer the only voice that the State Legislature or Agencies heed in management of its coastal resources. The development of additional interest groups for recreation, the environment, and retirement have placed pressure on the State to manage its resources more efficiently to restore riparian and estuarine habitat, restore the endangered salmon populations and recover the overall ecosystem health improving management for all land use and future growth. Consequently the Oregon Department of State Land's 2002 Strategic Plan (Goals and Actions for waters and wetlands: Agency Measure # 7) mandates that the number of acres for estuarine wetlands be increased by 250 acres annually by 2005(DSL 2002). Also on April 22nd 2004, Earth Day, the George W. Bush administration adopted a new stance on wetland management "We will move beyond the no net loss of wetlands in America to having an overall increase of Americans' wetlands over the next five years" (Bush, 2004). This echoes

Oregon's state agency management plans and shifts the Nation and Oregon's policy on tidal wetland management to a net gain of estuarine wetlands.

The advances in the technology of GIS science gave way to the development of this project to create a better inventory and to help manage the restoration efforts of tidal wetlands for Oregon's coastal watersheds in recognition of these policies and regulations. Appendix B outlines the various Federal and State agencies and the regulation involved in managing estuarine resources, which may serve as an aid in how this projects products can be used in future tidal wetland restoration and management.

Historic Alteration of Tidal Wetlands:

The secondary objective of this project focuses on a reconnaissance study of areas that may be considered for restoration of tidal inundation or habitat that has been filled or altered in a manner that future restoration is unlikely to occur. In the discussion section this paper will compare the findings of existing and historic tidal marsh habitat of this project to the results of the Oregon State of the Environment Report 2000 (SOER report). As a reconnaissance study this is a rapid assessment and further work needs to determine the true potential for restoration and habitat loss in Oregon's estuaries. This is not a historical reconstruction project for estuaries and in many cases erring in the side of caution it may overestimate the natural potential for restoration. Although this project consults many historical secondary sources it is not an attempt to define what is historically altered, but rather what may have the potential for restoration today and how filled or impervious lands may impact neighboring tidal wetlands.

Since the 1870's major anthropogenic and natural alterations to the estuarine landscape have occurred. Natural changes in the environment should anticipate sedimentation and localized general transgressions of tidal habitat over a period of 150 years. For the Oregon coast the most visible alterations are a result of agricultural and forest resource use and the development of estuaries for commerce through the construction of dikes, ditches, ports, roads and railways. The creation of diking districts promoted development favoring diking and ditching of tidal marsh habitat for development of estuaries to help economic growth and social prosperity of the region. While some losses of wetlands have resulted from industrial, commercial and more recent residential growth and development, the agricultural industry occupies the vast majority of historic tidal wetlands of the Oregon coast and is concerned with protection of existing farmland. The 2000 State of the Environment Report estimated that 68% of the states estuarine wetlands have been lost since the 1870 (Good 2000). Until the 1970's management rarely considered the negative impacts of diking and ditching. It was not until the Estuary Plan's management units were developed for Goal 16 and 17 of the Statewide Planning Goals and Guidelines that further alterations of tidal wetlands were prohibited, protecting over 90% of the remaining tidal wetlands. While these plans protected marsh habitat other area were still susceptible to alteration. The Estuary Plans designated areas for deposition of dredging spoils. Although theses spoil islands filled aquatic habit an indirect result has been the creation of new tidal marshes on the fringes of these dredge spoils island sites. Today alteration to estuarine ecosystems is taking a new direction, that of restoration of tidal marsh habitat. This is occurring through natural processes or manual removal of dikes and ditches. Watershed Stewardship Education Programs have been developed by Oregon Sea Grant and the State to coordinate restoration efforts between local landowners and regional watershed councils. However there is no system established to track these changes and it is uncertain if these changes or natural regressions are accounted or rezoned in the State's shoreline planning for future protection.

The SOER report's section on estuary quality analyzed how tidal wetlands have been altered since the 1870's to 1970's. Figure 2, a table from the SOER report that shows the calculations of existing tidal wetland, swamp habitat and habitat lost from diking and filling of tidal wetlands. This table can be viewed in an enlarged format in

Estuary	Actual 1970 Area (acres)[1]		Diked or Filled	Estimated 1870 Area (acres)[2]		Percent Change (1870-1970)	
	Tidal Wetland	Total Estuary	Tidal Wetland[3]	Tidal Wetland	Total Estuary	Tidal Wetland	Total Estuary
Columbia	16,150	119,220	30,050	46,200	149,270	-65%	-20%
Necanicum	132	451	15	147	466	-10%	-3%
Nehalem	524	2,749	1,571	2,095	4,320	-75%	-36%
Tillamook	884	9,216	3,274	4,158	12,490	-79%	-26%
Netarts	228	2,743	16	244	2,759	-7%	-1%
Sand Lake	462	897	9	471	906	-2%	-1%
Nestucca	205	1,176	2,160	2,365	3,336	-91%	-65%
Salmon	238	438	313	551	751	-57%	-42%
Siletz	274	1,461	401	675	1,862	-59%	-22%
Yaquina	621	4,349	1,493	2,114	5,842	-71%	-26%
Alsea	460	2,516	665	1,125	3,181	-59%	-21%
Siuslaw	746	3,060	1,256	2,002	4,316	-63%	-29%
Umpqua	1,201	6,544	1,218	2,419	7,762	-50%	-16%
Coos Bay	1,727	3,348	3,360	5,087	16,708	-66%	-20%
Coquille	276	1,082	4,600	4,876	5,682	-94%	-81%
Rogue	44	880	30	74	910	-41%	-3%
Chetco	4	171	5	9	176	-56%	-3%
TOTAL	24,176	160,301	50,436	74,612	220,737	-68%	-24%

Figure 2. Oregon State of the Environment Report 2000 Estuarine tidal habitat assessment (Good 2000)

Appendix D of this paper. The methodology, data sources and time frame used for the calculations in the SOER report's habitat state in the 1970's differs from this report's analysis of today's habitat. The SOER report used many secondary references to estimate the habitat lost. This study picks up where the SOER report left off using some of the same secondary sources, like the Division of State Lands 1972 Filled Lands Inventory, but it also takes advantage of primary sources of historic and present air

photos to delineated lands that have been altered from their natural conditions. It also focuses on how much additional habitat exists as results of restoration efforts that have transpired since the 1970's or how the SOER assessment technique may
have underestimated the existing and altered habitat.

This project uses additional secondary references to estimate the loss of habitat. To get a glimpse at the original environment the National Ocean Service's Coast Surveys are a good documentation of the predevelopmental state of some of Oregon's estuaries. Figure 3a shows an original coast survey for the Coos Bay estuary.

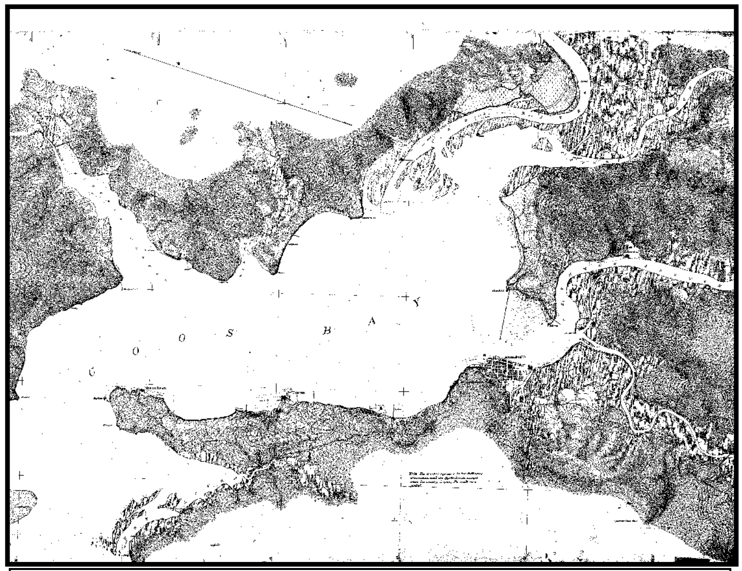


Figure 3a. Coos Bay 1890's NOS Coast Survey

Also the works by Patricia Benner and Robert Coulton for the Tillamook and Coquille estuaries were consulted for interpretation of pre development conditions. While figure 3b shows the work done, by Benner and Coulton for the Tillamook Estuary. It is important to recognize that their study also uses a different classification scheme than that developed for the HGM project. This study recognizes that that although these secondary sources may be historically accurate, these resources should not act as an allegory for what conditions should be today as natural changes in sedimentation should alter the natural environment with a transgression of vegetation. Alterations are expected to continue with natural change and restoration efforts into the future. With this knowledge it is important to continue to update this work and track how these alterations may impact the overall integrity of Oregon’s Coastal ecosystem

Stakeholder Involvement & Interests:

Today ecosystem health and how wetlands are managed effects the livelihood of many diverse industries and social backgrounds. The traditional industries of forestry and agriculture that developed early management practices have to compete with the interests many new stakeholders today. The motivations for each group may differ, but all are interested in how management of tidal wetlands and estuarine resources will occur in the future. This project was developed with consideration of how various interest groups may receive its products. The creation of a GIS data set that shows existing tidal wetlands and areas to be considered for restoration of tidal circulation for ecological benefits will serve as a resource not only for state and federal agencies, but for industries, environmental programs, City and County administrators, watershed councils and the public. The following section addresses how different stakeholders are invested in estuarine and tidal wetland resource management.

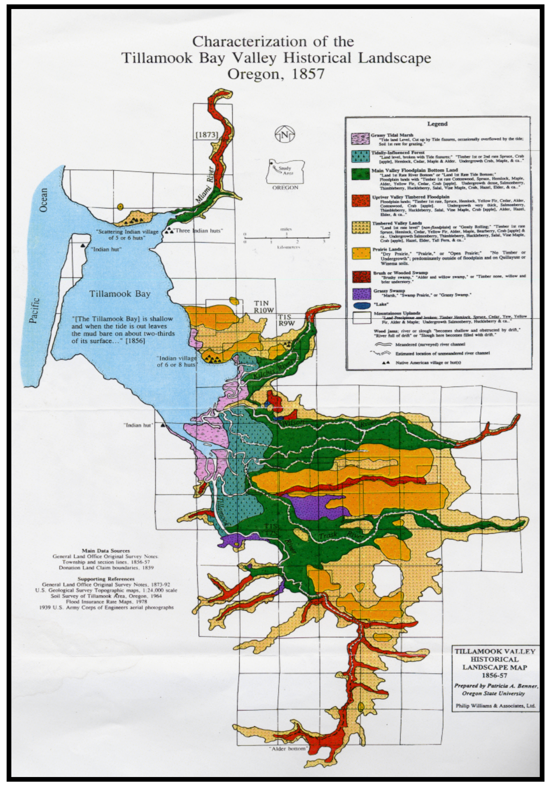


Figure 3b. P. Benner & R. Coulton’s 1957 characterization of the Tillamook Bay Valley

Agricultural resources and stakeholders are diverse and occupy the majority of Oregon’s former estuarine tidal wetlands and floodplains. The major concerns of this industry are compliance with the CWA by reducing non point source pollution from sediment and chemicals in fertilizers and pesticides; and the adverse economic impacts to their land use plans with the designation of Essential Fish Habitat for the Coho salmon and restoration of tidal wetlands. This project outlines most agricultural lands as areas for potential restoration effort. However, it is important to recognize that even if an area has been labeled with the potential for restoration it does not mean that the area should be altered. In many cases the best land use may be for agriculture and the Shoreline management units of Goal 17 will remain the same. Also this study's findings can potentially be used by the Natural Resource Conservation Service to aid the agricultural industry with additional grants to improve land use practices or environmental quality under the Conservation Reserve Program, Environmental Quality Incentives Program and the Wetland Reserve Program.

Similar to the agriculture industry many of the forest resource users operate mills, timber export facilities & log storage sites that also occupy former tidal wetlands. As many mills have decreased production the timber industry primarily is concerned fair economic compensation for the loss of land with restoration efforts concentrating on converting closed facilities or log storage sites back to tidal marsh habitat.

The traditional interests of the timber and agricultural and port industries of the Coastal estuaries have expanded to include additional stakeholders. With the recent accommodation of thousands of tourists and retirees the Oregon coast's economy is shifting its focus on future growth and development, changing the overall economic and social mindset of the region. Recreational endeavors, like golfing, hiking, ecotourism, bird watching and dune buggy riding, in some fashion have benefited from the use or alteration of tidal marshes and all have a stake in future estuary or tidal marsh management. Economic and social supports for nonuse values of lands are increasing for tidal wetlands. This is evident from growth of the environmental lobby that represents the natural environment and the wildlife for environmentalists, conservationists, preservationists or naturalists. These lobbyists may represent individuals, non-governmental organizations or environmental consulting firms, such as the Audubon Society, Ducks Unlimited, the Ecotrust or the Nature Conservancy. The scientific community will also be interested in the use of the GIS Geodatabase for the establishment of baseline conditions for 2002. Tribal groups have also had significant influence on decisions effecting restoration of their natural heritage and the habitat for native salmon and steelhead populations

Shifts in the management protocols of the recreational and commercial fishing industries of Salmon and Steelhead have manifested resulting in the demand for improved ecosystem management over harvest or catch limits. For recreational fishermen the State's claim for "Title Navigability" on Oregon's rivers is an issue that would benefit fishermen with the reclamation of more tidal wetlands on select rivers. Other sectors interested in the future of tidally influenced wetland management include the aquaculture industry, salmon hatcheries, port commissions and the shipping industry.

It is important to understand laws and regulations managing tidal wetlands may be amended or even repealed to accommodate stakeholder interests, which may vary from quality of life, to property ownership or economic gains. Initially tidal wetlands in estuaries were not subject to private ownership and were held in the public trust. Later the establishment of Oregon Diking Districts through the Oregon Legislature allowed for private ownership and alterations to tidelands to benefit the public with economic growth and development. Today the legislative goals and regulations provide incentives to restore the ecological integrity and social and economic prosperity to Oregon's Coastal watersheds. It is important to understand that this GIS data set is meant to be an objective information source that can accommodate many needs and uses.

Data Available Delineation and Classification of Tidal Wetlands:

Many resources are in use by state and federal agency today to manage Oregon's estuarine tidal wetlands. Unfortunately many of these products are outdated, do not adequately classify the wetlands today or were created at a resolution that is too coarse for the management objectives desired from the HGM project. Additionally it was found that many of the tools do not provide coverage for the entire Oregon coast and it was necessary to create a new data set improve tidal marsh management and compliment the existing management tools.

Many existing resources were consulted and interpreted in the development of this GIS data set. The work "A Protocol for Reconstructing Historical Wetland Landscapes in Oregon Estuaries" outlines many of the data resources available for use in studying tidal wetlands (Gupta, 2000). The primary wetland management tools consulted were the USFWS's 1979 original and 2004 rough draft of the National Wetland Inventory data sets and the Oregon DLCD's Oregon Estuary Plan Book's Estuarine Habitat Classification, Estuary Management Units & Shoreline Management Units data sets. The NWI is based upon the work by Cowardin et al. (Cowardin 1977). The Estuarine habitat classification was developed by the Oregon Department of Fish and Wildlife in the early 1970's base on interpretations of aerial photographs and limited field work and later incorporated into the Oregon Estuary Plan Book (Cortright 1987). Additionally the NRCS's SSURGO & STATSGO hydric soils data sets were also consulted as a proxy for identification of existing and potential tidal wetlands.

Additional resources used for the delineation included the Department of State Land's Local Wetland Inventories, 1972 Ownership and Filled Lands Inventory & the 1986 Head of Tide Data Set and NOAA's Tillamook National estuary program's tidal marsh habitat data set, the Office of the Coast Survey's original coastal survey maps of Oregon's estuaries from 1881 to 1908 & NOAA's Salinity Field Maps.

As primary reference sources the remote sensing data used included 1:24,000 2001 color infrared aerial photographs, 1:12,000 2002 natural color aerial photographs, 1:48,000 1986 natural color aerial photographs, select 1939 and 1941 black and white aerial photos and the 2001 Black & White Digital Ortho Quads (DOQ). The U.S. Geological Survey 10-meter Digital Elevation Model (DEM) was incorporated for analyzing regional elevation and surficial geomorphology, which may play a role in the delineation of tidal wetlands.

Additional resources including fieldwork, consultation of wetland specialists and additional published work on individual wetlands or watershed was used in the delineation of Oregon's coastal tidal wetland GIS Geodatabase data set. A publication from Adamus Resources Incorporated will be available in 2005 for more information on the development of the HGM project and its uses.

Materials & Methods:

Geodatabase Development

New developments in technology have changed the capabilities of GIS. This project used Environmental Systems Research Institute's (ESRI) ArcGIS 8.2's new feature of a Geodatabase to create this data set. The Geodatabase has replaced the use of Shapefiles and Coverages by adding object orientation improved relations between data sets and the creation of arcs, rather than only strait lines. This is ideal for delineating water features, which are more sinuous rather than linear features. For the purposes of the HGM project it is important to know how much fringe habitat exists between habitats.

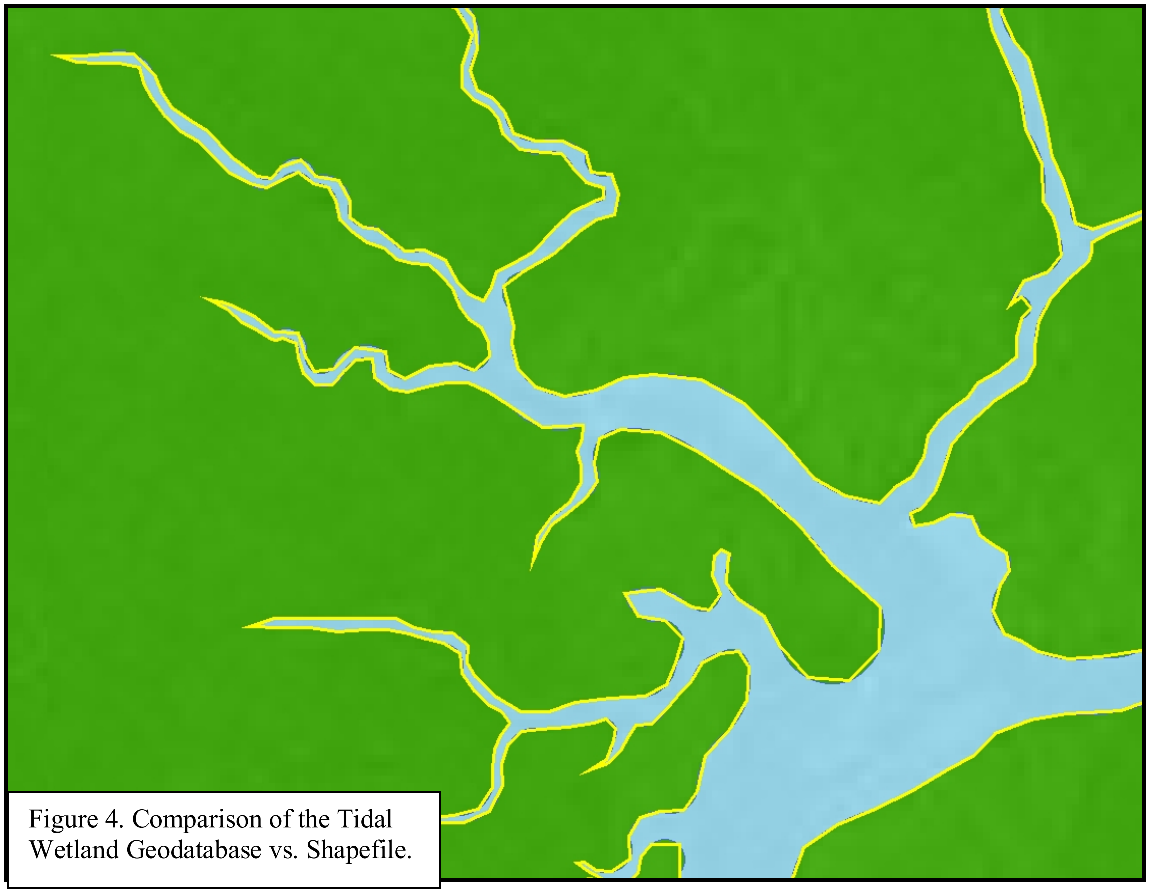


Figure 4. Comparison of the Tidal Wetland Geodatabase vs. Shapefile.

Fringe habitat can be used as an aid in estimating biodiversity, which is important to assess for the overall ecological integrity of tidal wetlands. Figure 4 is an example that shows how the Geodatabase can provide a better delineation. The Geodatabase file is the base layer of green for marsh and blue for water. The yellow line represents the data as a Shapefile with a linear delineation for the same work. The Shapefile is fairly jagged compared to the smooth delineation of the boundary of the green and blue for the

Geodatabase. For this project the case can be made that the Geodatabase gives a better delineation of the boundary habitat.

Besides boundary habitat the Geodatabase it was important to create database that could use relational fields for other portions of the HGM project involving fieldwork and future development depending on the relation of multiple data sets with key identification attributes. Unfortunately a Geodatabase can only be viewed in the newer versions of ESRI software. To compensate for this problem a Shapefile has been created with the disclaimer that the Shapefile is not as accurate of delineation for people to view this data set.

Initial Wetland Data set Development:

The primary software program used for the development of the data set was ESRI's ArcGIS versions 8.1 and 8.2. The first phase of the delineation involved the collection of all reference data sets outlined in the introductory section "Data Available Delineation and Classification of Tidal Wetlands". Most data sources were acquired online from the Oregon Coastal Atlas: http://www.coastalatlas.net/, the Oregon Geospatial Data Clearinghouse: http://www.gis.state.or.us/, the Ecotrust's online GIS data clearinghouse: http://www.inforain.org/ and the Regional Ecosystem Office: http://www.reo.gov/gis/gisdata.htm. However, select data sets were not available online, like the USFWS' NWI 2004 rough draft, these were acquired through direct correspondence and cooperative efforts with state and federal agencies.

Three major data sets were selected for initial collection and interpretation of wetlands for field data collection for the HGM project. The primary resource referenced in wetland management was the US Fish and Wildlife Service's 1979 National Wetland

Inventory (NWI) (USFWS 1979). However, during the project's development the NWI data set was in the process of editing for a new 2004 edition, to account for anthropogenic and natural alterations in the geomorphology and wetland classification of the Oregon coast. This rough draft edition was also consulted during the delineation. As a reference for location of tidal wetlands or potential tidal wetlands, the NWI was queried to select "polygons" (a GIS component representing as specified area) with the attributes classifications E2EM* (Estuarine Tidally Influenced Emergent Marsh), E2SS*(Estuarine Tidally Influenced Scrub Shrub) E2FO* (Estuarine Tidally Influenced Forested), PEM* (Palustrine Emergent Marsh), *h (diked/impounded), *d (partially drained or ditched) and *x (filled). These attributes represented all area classified by the NWI that should have experienced tidal flooding. A spatial query was completed to locate potential forested tidal wetlands, or other wetlands with alternate classifications in close proximity to tidal waterways, not selected in the first query. This spatial query was completed for all NWI polygons by selecting polygons that were within 100 meters the NWI tidal water polygons with the attribute of E1* (Estuarine Submerged) and R1* (Riverine Submerged). This method allowed for the inclusion of select attributes that are not intuitively tidally influenced, like the attributes of PFO* or PSS*, which can be tidally influenced spruce or willow swamps and allowed for the exclusion isolated non-tidal wetlands. These two queries were merged to create a reference layer for the digitization.

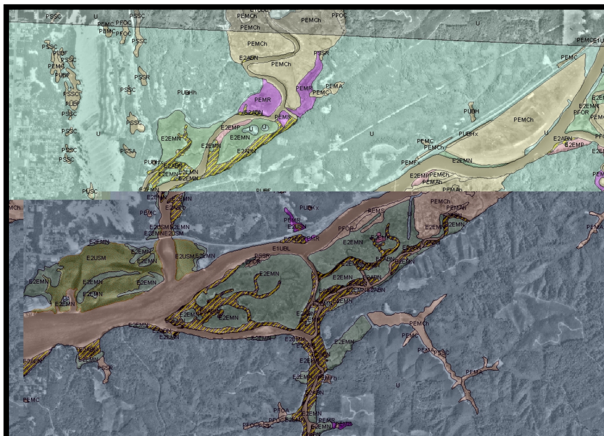


Figure 5. NWI 2004 Classification, Siuslaw Estuary

Figure 5 shows a representation of the NWI for part of the Siuslaw Estuary. Because the NWI is an incomplete GIS data set of the Oregon coast (eg. sections of the Yaquina, Alsea, Siletz, Siuslaw, Umpqua and Tillamook watersheds) additional data sets were compiled to aid as a reference layer to fill in the missing wetland information.

The secondary resource referenced was the Oregon Estuary Plan Book' Estuary habitat. Similar to the selection process of polygons of the NWI attributes, a query was performed for polygons with attributes that were identified as 2.5*(tidal marsh). This included a classification of high and low estuarine, riverine and forested tidal marsh. Unfortunately like the NWI, the ODFW data does not extend far enough upstream and many of the estuaries to serve as a reference of additional freshwater tidal wetlands. Figure 6 is a representation of the Oregon Estuary Plan Books' tidal habitat data for the same region of the Siuslaw River Estuary. These NWI and Estuary Habitat selections had agreement with spatial location of tidal wetlands, however their classification and boundaries disagreed frequently.

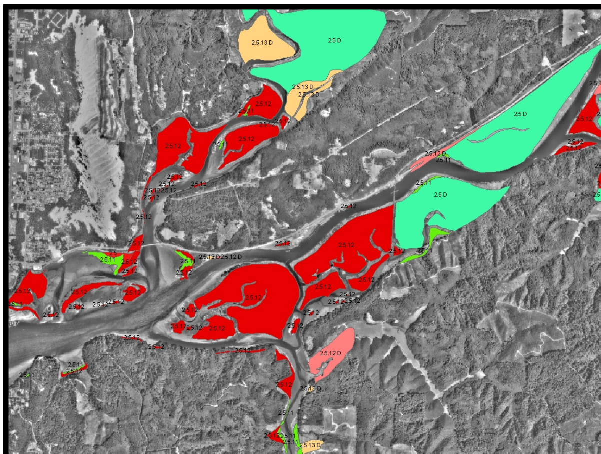


Figure 6. Oregon Estuary Plan Book Habitat Layer, Siuslaw Estuary

Thus for regions that there was no NWI or ODFW habitat coverage, the incorporation of the third type of data set was used - the Natural Resource Conservation Service's (NRCS) SSURGO and STATSGO Soil Survey data sets. The SSURGO classification is linked to a National Soil Information System (NASIS) attribute database and the attribute for hydric soils was selected as a proxy for wetland polygons. It has been documented that many hydric soils can retain hydric features even after decades of continuous drainage; thus they can be used to determine the presence of former wetlands

Figure 9. Existing wetland information: NWI (red), Estuary Plan Book Habitat (blue stripe) & Hydric Soils (orange) for Yaquina Bay.

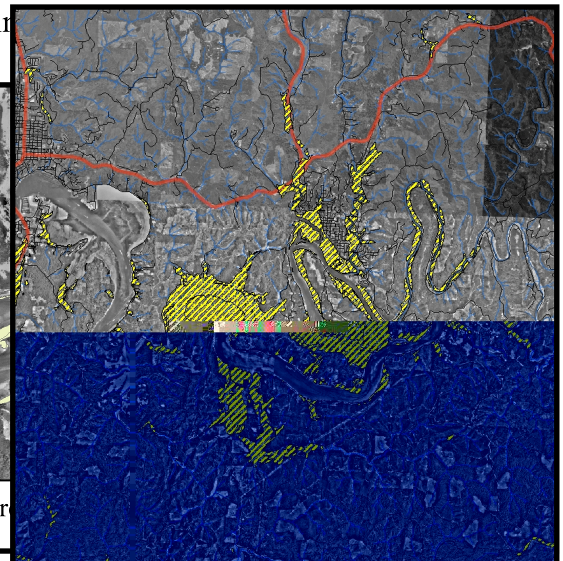


Figure 10. Merged data set used to identify potential wetland locations in Yaquina Bay.

other alteration. However significant alteration to soils may occur through agricultural practices. In Tillamook Bay figure 8 shows how the STATSGO hydric soils data set omits agricultural wetlands that have been altered on the straight line boundaries in the right and middle portions of the image. The STATSGO data's hydric soils was only used for Tillamook County, where the SSURGO data was unavailable in a GIS format. For these data sets a spatial query was completed selecting any hydric soil within 100 meters of the Coastal Landscape Analysis and Modeling Study (CLAMS) stream data set. The CLAMS stream data set was used for a hydrologic reference that extended beyond the bounds of the NWI and ODFW data to select Hydric soils polygons in the upper watershed. In the case of

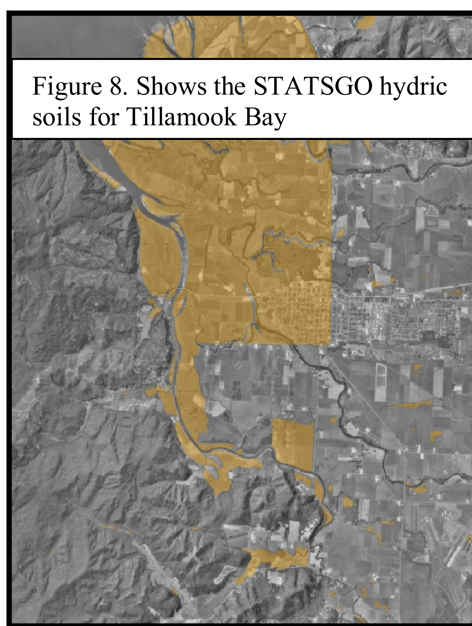


Figure 8. Shows the STATSGO hydric soils for Tillamook Bay

the hydric soils query any polygons that overlapped the initial selection of NWI and ODFW data were deselected, as were ones that were well beyond the bounds of known tidal influence. The queried NWI, ODFW and hydric soils data sets were then merged using ArcGIS into one layer to create a reference layer for the projects digitization of tidal wetlands, figure 10. Figure 9 shows some of the inconsistencies between the data sets and the how the three data sets varied showing Selected NWI habitat in red, ODFW polygons in the blue polygon with yellow lines and the Hydric Soils data in orange for the Yaquina estuary. Figure 10 shows the merged data set and how it could be used as a reference of potential habitat to delineate the tidal wetland Geodatabase.

Tidal Wetland Digitization and Attributes Classification:

Figure 11. Digital Ortho Quad, South Slough, Charleston, OR.

Figure 12. May 2002 Color IR 1:24,000

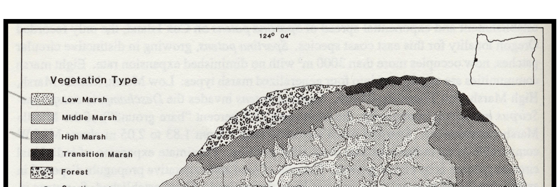
To create a new tidally influenced wetland data set ArcGIS's ArcMap Editor was used for digitizing and delineation of the tidal wetlands. For the creation of this data set the ESRI's AutoComplete, Create and Reshape features were used to create the majority of the new delineation's polygons. It was later discovered that when zoomed out to larger extents, the reshape tool created circular artifacts in the Geodatabase. These artifacts do not interfere with actual measurements of boundaries or areas.

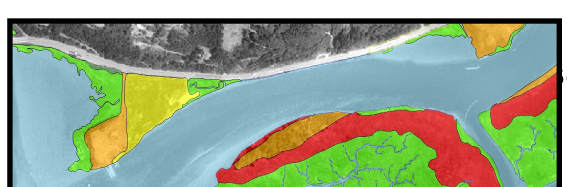
The digitization relied mainly on aerial photography, the NWI, ODFW data, the hydric soil data. The base layer for the digitization phase of the project was the Oregon Department of Forestry's 2001 black & white Digital Ortho Quads (DOQ), figure 11. Additional aerial photos were incorporated into the study for wetland identification and classification. These photos included the EPA's May 2001 1:24,000 color infrared aerial photos for all Oregon coastal estuaries, figure 10. Additionally select 2002, 1:12,000 scale natural color aerial photos, provided by the US Department of Interior Bureau of Land Management (USDI BLM), were also consulted for the delineation, figure 13. For regions that the 2001 and 2002 aerial photos did not cover 1986 1:48,000 natural color photos for the Oregon coast were consulted. These areas were limited to the upper watershed of the Smith River of the Umpqua estuary watershed and a middle portion of the Coquille River. To aid in the delineation of filled lands select 1939 and historic black and white photos were used. Depending on the resolution of the image and type of feature being digitized a scale ranging from 1:150 –1:1,000 was used for the digitization process for most wetlands while a scale of 1:2000 was used for the waterways not connected to tidal wetlands.

Figure 13. BLM's 2002 1:12,000 natural color: South Slough

Elevation data and existing regulatory layers were used to determine the upper limits of the mapping project and the classification of habitat for the new delineation. The true head of tide may vary annually from hydrologic changes in discharge or tidal range. The approximate head of tide for the delineation was determined from the use of two secondary sources and the interpretation of a raw DEM. The primary source referenced was the DSL's 1986 Head of Tide point data file. In many instances this data file delineated the head of tide to the limits of tidal range in 1986, which in many instances stopped at tidegates or dams. To validate the DSL data set for the main head of tide it was compared to NOAA's salinity data for Oregon, which showed an approximate head of tide. This layer was also used later in the classification to help differentiate the classification of marine and river-sourced tidal wetlands. However this project also focused on the delineation of "Restoration Consideration Areas" (RCAs) to aid in restoration planning and an assessment total tidal wetland habitat lost, it was important to interpret how far the natural head of tide may extend beyond a tidegate or dam. The DEM is an important element of this delineation and classification of the wetland type. The raw raster DEM provides a 3 to 4 foot interval in elevation between pixel classes. In areas where the natural head of tide was blocked by a tide gate, the elevation of the head of tide for areas with no tidal restriction were applied to estimate the potential head of tide for the delineation of RCAs. It was also known that the DEM was limited to 10-meters in resolution for each pixel and as a result the 10 square meter area was generalized for its production, having multiple elevations fore each pixel. The combination of these layers and the DEM made a reliable resource for delineation of existing tidal wetlands and Restoration Consideration Areas.

For some tidal wetlands field work from wetland specialist, preliminary research from the HGM project and peer review aided in the delineation of the Tidal Wetland Geodatabase. Figure 14 shows the previous delineations for the Siuslaw River's Cox Island and the resultant delineation in the Tidal Wetland Geodatabase, figure 15 (Boss





1998).

Figure 14. Cox Island Tidal Marsh Delineation (BOSS 1998)

Figure 15. Cox Island Tidal Wetland Geodatabase Delineation.

Classification Existing Habitat and Restoration Consideration Areas:

The classification system for this project was developed for existing tidal wetlands based on subclasses of Brinson's "estuarine fringe" Hydrogeomorphic class and the purposes of developing an aid for restoration management of Oregon's tidal wetlands. (Brinson 1993). The existing tidal marsh classification system will serve as an aid to the function models that are being developed by other components of the HGM project for use in assessing Oregon tidal wetlands for 2005. In the absence of time-series data on daily tidal fluctuation or verified elevation, the task of assigning most polygons to a particular HGM subclass was quite subjective. The need for field-checking the extent of inundation of these sites on neap and spring tide days during each month of the year cannot be overemphasized. Therefore, the assignments of HGM subclasses to particular polygons should not be considered definitive at this point for regulatory purposes. The following is a listing of the definition of each classification developed for this project.

Marine-sourced Low Tidal Marsh (MSL). These are tidal marshes that are inundated at least once daily during the majority of days during the growing season, and which are in portions of the lower estuary usually dominated by marine waters. In most instances they were considered synonymous with polygons labeled E2EMN on NWI maps, and/or 2.5.11 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available.

Marine-sourced High Tidal Marsh (MSH). These are tidal marshes, also in the lower estuary in higher salinity region, not meeting the above duration of inundation criterion (i.e., some may only be once inundated during the highest high tides). In most instances they were considered synonymous with polygons labeled E2EMP on NWI maps, and/or 2.5.12 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available.

River-sourced Tidal Wetland (RS). These are tidal marshes or tidal forested wetlands that experience cyclic water level fluctuations as a direct or indirect result of tides at least once during every annual growing season. They are located in the upper estuary, commonly along river channels with a consistently strong seaward flow. They include some undiked wetland polygons labeled by NWI as PEMR, PEMS, or PEMT, and/or hydric soils in river locations below the DSL-identified head of tide, and/or polygons labeled 2.5.13 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available. In some instances where channels are deeply incised it is doubtful that some polygons labeled as RS are truly tidal wetlands, because tidal range may be merely on the order of inches, incapable of flooding adjacent lands over natural levees. However, in other upriver settings channels are not incised and have the capability of being tidally inundated, this could not be determined from the remote sensing data used in the interpretation.

Potential Tidal Forested Wetland (*PF).* This classification includes lands currently covered by woody vegetation that are suspected of experiencing tide-related inundation at least once annually, but for which definitive field data are lacking. This includes wetlands labeled E2F* or E2S* by the NWI, as well as wetlands that NWI labeled PSS* or PFO* and which adjoin tidal channels and apparently are not diked. It also includes wetlands coded 2.5.14* by ODFW in the Oregon Estuary Plan Book. These are mostly relict spruce swamps and willows existing near their physiological threshold for salinity. Many probably became established in tidal zones due to fresher hillslope seepage. However the classification label "potential" was derived also as a result of the inability to interpret true hydrology remotely through the canopy. This classification needs to be refined in future work to reclassify these polygons as Tidal Forested Wetlands, Forested Wetlands or Upland Forest.

Restoration Consideration Areas (RCA): Due to the uncertainty of response in terminology the classification of "Restoration Consideration Areas" was changed from its original classification, Potential Tidal Wetlands. This classifies lands, which could not be accurately classified based on existing remote sensing data or lands that are presently defined as upland or non-tidal wetland areas by other sources, which deserve closer scrutiny as possible candidates for restoration of tidal circulation. These areas were identified based solely on coarse-scale geotechnical information from available data sets. No on-site feasibility investigations were conducted, and sociopolitical factors were not considered. These are generally lands that are diked or may have been partially filled or ditched for agricultural or commercial purposes.

RCAs were identified primarily by reviewing digital elevation information, NWI and ODFW habitat maps, the hydric soils layer from NRCS and other historical sources. Rigid criteria were not developed to identify and map these areas systematically. Rather, mapping employed considerable judgment and consequently the results are very approximate, but err on the side of over-approximation based on the “precautionary principle” of resource management (Cican-Sain 1998). Unknown portions of the RCAs are palustrine wetlands or riparian uplands that never experienced tidal flooding, due to naturally-formed barriers.

Water (*W*). This represents an improved hydrological layer, delineated to the edge of any upland vegetation or tidal wetland, whichever it adjoined or intersected. This was created as a byproduct of the tidal delineation of the tidal wetlands and is only shown where waterways are believed to be tidally influenced. Although most tidal channels were digitized at a scale finer than 1:1,000, most regions of the main estuary were digitized at a 1:2,000 scale. This is not a complete hydrology layer. Surely there were portions of many tidal channels that could not be detected from aerial photographs, and in numerous cases small tidal channels were too numerous to digitize within the time available for this project. In addition, non-tidal channels, tidal channels unassociated with tidal wetlands associated with them, and all non-tidal waters above 23 ft elevation were not mapped.

Fill (*F*). This includes lands that have been filled and/or compacted for human use and no longer function as a wetland. This includes dikes, dirt and paved roads, railroads, highways, gravel driveways, golf courses, dredging spoils, marina jetties and buildings that are spatially connected to the attributes listed above. A few of these polygons may never have been tidal wetlands; such post-facto determinations are difficult to make without field data. Due to time constraints this layer is not complete and there are locations where infrastructure has not yet been classified as filled lands. The DSL *Inventory of Filled Lands* was consulted, as was the Corps of Engineers permits database. From these it was apparent that most fills identified by these sources are shown as such on this map, but information from the sources was not applied systematically in creating the map. Also, not all dikes could be identified with the imagery used and therefore this map should not be used as an inventory of diked marshes.

Non-tidal wetlands (NT). These are only the wetland polygons that were initially classified as RCAs, but peer reviewers suggested that they likely were never tidal and have been converted to the non-tidal wetland classification.

Upland (U). This includes non-wetland areas isolated hydrologically from other uplands due to geologic formations or geomorphology of the floodplain. However, in most cases the Uplands are a byproduct of the digitization's auto complete process. They were retained to denote the implausibility of classification as tidal areas.

Unconsolidated (UC). This was reserved for gravel bars in rivers and some beach or dune environments. These polygons have the potential to be vegetated, but were gravel bars at the time of the delineation. These features are not mapped comprehensively.

Compilation of the Oregon Tidal wetland Geodatabase:

The Tidal Wetland data set was created as a Geodatabase file to recognize relational databases created and the inclusion of multiple fields. This section discusses the fields created in this project in more detail.

The standard, *Object_ID, Shape, Shape_Area* and *Shape_Length* fields were created for the Geodatabase. For the purpose of this study the units are in square feet for Shape_*Area* and feet *Shape_Length* fields for each polygon. The following is a list of all additional field created for this project and future development of this data set.

Classification: as discussed in the previous section, is the field with the full name of the classification given to the polygons.

HGM_Code: is an abbreviation of the project's classification field created for map labeling purpose (i.e. MSL, MSH, RS, and RCA).

Estuary: field matches the names in the Oregon Estuary Plan Book, to distinguish the name of the estuary to which the tidal wetland or attribute is hydrologically connected.

Acres: was created converting the area of each polygon to acres for comparison to the SOER report.

Notes: are comments for particular polygons that may discuss methodology of the classification or comments made by peer review.

Site_Name: Common names created for selected water bodies and tidal marshes that have previous work associated with their classification.

Elevation: The relative elevation in feet derived from the DEM is limited to entries for the larger RCA polygons which spanned multiple elevations. These polygons are generally areas where it is doubtful that the upper elevations are tidal or where a transition from a classification may occur. This attribute can be found in some wetlands in Nehalem Bay, Tillamook Bay, Coos Bay and the Sixes

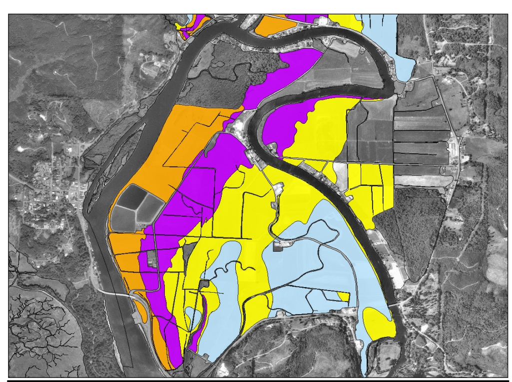


Figure 16. The relative elevation for selected for the Nehalem Bay Estuary

River. These are rough elevations based on the
DEM, not actual elevations verified on the ground. Figure 16 show how this field can be viewed to show data in the Nehalem Bay Estuary.

Verified: is a field created for the purpose of validation of this work by state tidal wetland managers or future work in the HGM project. This is designed to give additional credibility to this projects database.

The following list of attributes is designed to aid in restoration management and planning and further development of the HGM Project.

Ecological_Integrity, and Restoration_Potential: are fields that may be completed by applying standardized criteria and scoring models from the Oregon Tidal Wetland Assessment Guidebook for existing tidal wetlands to determine if enhancement is an option to improve the ecological integrity (Adamus 2005). Similarly, they can be used to assess RCA habitat and be used to prioritize wetland restoration efforts. This will be discussed in more detail in later sections of this paper. The following fields were created to aid in analyzing tidal wetland function and ecological integrity, but are not currently populated, pending anticipated release of the HGM Guidebook in 2005

Native_Marsh_Plants

Production_Aboveground_Organic_Matter

Stabilization_Processing_Sediment_Phosphorus_Metals

Detention_Processing_Carbon_Nitrogen

Export_Plant_Animal_Production

Invertebrate_Habitat

Anadromous_Fish_Habitat

Marine_Fish_Habitat

Resident_Fish_Habitat

Nekton_Feeding_Birds_Habitat

Ducks_Geese_Habitat

Shorebird_Habitat

Landbirds_Small_Mammals_Predators_Habitat

Ecological_Integrity

Spatial Analysis of Watershed Habitat:

A simple spatial analysis was performed to understand how habitat classifications varied for comparisons to each watershed, habitat availability and to compare change to the SOER report. From the Geodatabase, data was exported to Microsoft Excel and calculated – by estuary -- the total areas of MSL, MSH, RS, RCA, PF, Fill and Water in acres. Subtotals and percentages were calculated, by estuary, for total area of marsh (MSL + MSH + RS), altered land (RCA + Fill), and aquatic habitat at high tide (W + MSL). The results of this analysis will be discussed in detail and be compared to the SOER report. The associated tables are located in Appendix C. The Excel Spreadsheets will be made available in the final DVD. No statistical analyses were performed, but a potential exists to calculate additional spatial analysis's on the Restoration Consideration Areas that may facilitate the application of this data for restoration decisions.

Results & Discussion:

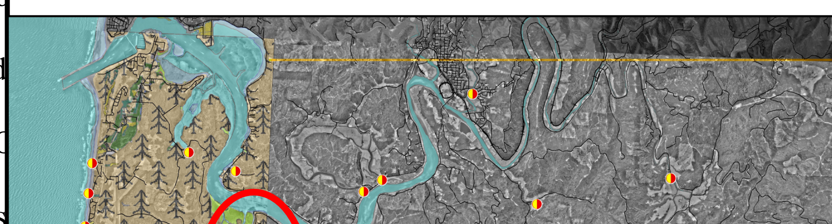
Existing Data limitations

The first phase of this project quickly demonstrated that problems with existing data's spatial resolution, spatial extent, being outdated, inconsistent boundaries and classification of tidal wetlands. This rendered the existing data sets and tools unusable for an accurate spatial analysis of features important to assessing the functions and conditions of today's tidal marshes. The omission or lack of data in a GIS format was common, the NWI data was missing the majority of all freshwater tidal regions of the Alsea Yaquina Siletz Umpqua and Tillamook watersheds, while the ODFW data was limited in it's classification of freshwater tidal wetlands.

Figures 17, 18 and 19 were gene… e limitations of the datasets for Oregon repr… . Figure 17 show the NWI, the ODFW Habita… e NWI tidal wetland habitat is represented by … d polygon represents the ODFW tidal marsh … t hydric soils. This shows the extent an limits … c soils data set is the most extensive, however … e tidal wetland and the hydric soils layers state… r as large as 40 % for the actual area of hydri… e final delineation. Figure 18 shows the limits of the delineation of the National Wetland inventory which did no… d the DSL head of tide d… . Figure 19 shows the C… s evident that this data s… . Also the areas circled … f habitat for the same reg…)

Figure 17. Existing wetland information: NWI (Red), Estuary Plan Book Habitat (Blue Stripe) & Hydric Soils (Orange) for Yaquina Bay.

Figure 18. NWI & DSL head of tide data for the Yaquina Bay Estuary



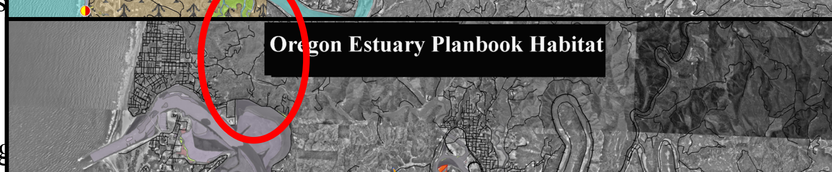
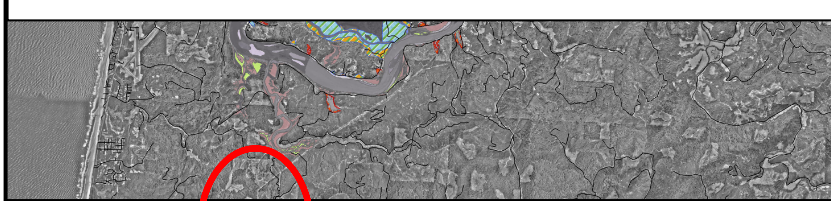


Figure 19. Oregon Estuary Plan Book tidal wetland habitat Yaquina Bay



the ODFW habitat classified the habitat as dominantly high estuarine marsh, (red) and minimal low estuarine marsh (green). As a result of these discrepancies and lack of information the Tidal Wetland data set's classification was dominantly based on aerial photo interpretation and from field work in this region with occasional reference of the existing classification.

DEM Errors

The 10-meter DEM was used to limit the extent to the delineation to regions below 23 ft of elevation. However, it was found that the DEM's relative elevation was unreliable in some regions. Examples of these errors are obvious in the Umpqua River, Yaquina Bay and Coos Bay estuaries. Figure 20 is an overlay of the Coos Bay region and the DEM where zero feet in elevation represented by the color red. This shows a dredge spoil island with an elevation of 0 feet. Although the fringe habitat of the marsh is at sea level this island has known elevation benchmarks that record elevation greater than 16 feet above sea level. These errors make the DEM an unreliable resource to use alone, however with known field observations, known survey benchmark elevations combined with the head of tide data and other classifications the tidal wetland data set should prove to be a reliable interpretation of Oregon's coastal habitat..

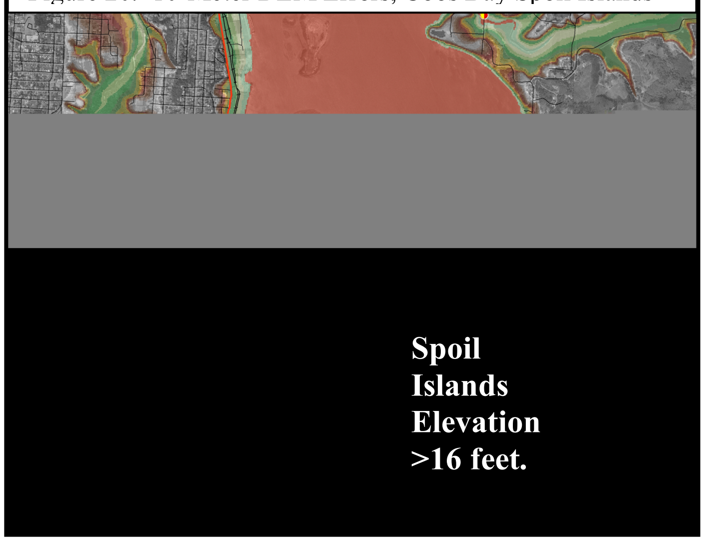


Figure 20. 10-Meter DEM Errors, Coos Bay Spoil Islands

Image Interpretation Errors:

This project provides an improved data set; however the digitization methodology left the potential for several flaws in the interpretation and delineation of the tidal wetland polygons. The 2001 DOQ base layer used had imperfections, which may have allowed for digitization errors. As a result of the rectification process, some regions the orthorectified photos were blurred or pixilated in SID file format. Also the black and white imagery limited the ability to distinguish water features from land and shadows or the glare of reflected solar light left room for misinterpretation of the actual boundaries. The delineation of the marsh attribute edges can have significant errors if the photo was taken when the rivers discharge was at flood stage or at high tide. When this was a concern additional photo sets in different formats and dates were consulted for reference. In addition 2-D limitations of the photos allowed shadows from trees or tree canopy cover to obscure the true boundaries of many marsh edges and may have prevented the digitization of some fringe marshes. Also stream channels may have been overgrown with vegetation and their true width could have been interpreted improperly. Figure 21 shows how brightness or lack of contrast and a moderately high tide may have impaired the true delineation of aquatic habitat from use of the DOQ alone. While figure 21 was taken at a moderately high tide, the color infrared photo was used to help deemphasize the problems associated with viewing delineating the low marsh

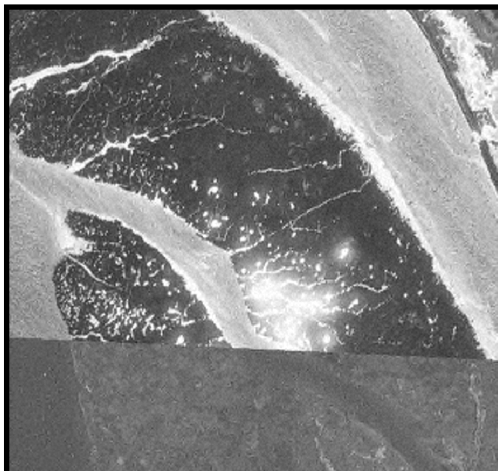


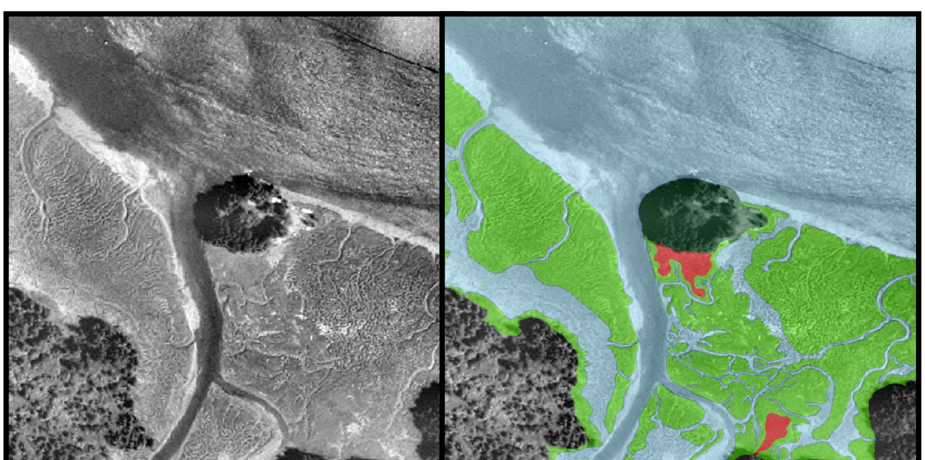
Figure 21. DOQ Limitations, Brightness and Contrast

habitat.

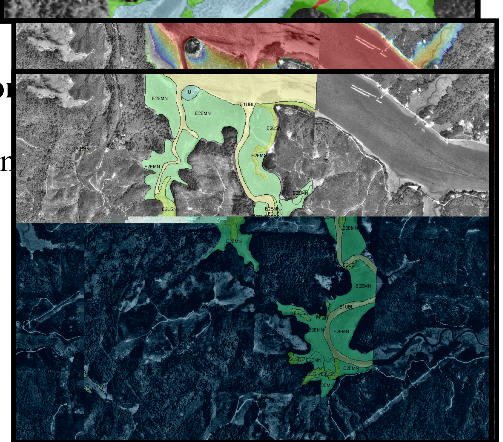
An additional source for delineation error is a result of incomplete coverage of color IR photos for the Oregon estuaries. The 2001 color IR photo flight path missed portions of the upper Smith River of the Umpqua Estuary watershed and the middle sections of the Coquille River Estuary. For these region's interpretations were limited to interpretations of color and black and white photos.

Time limitations for the project combined with poor image resolution resulted in the omission of several smaller features. Generally regions with channels less than 3 feet wide and fringe boundaries where marsh habitat was a patchwork of vegetation and mud posed significant problems by making it impossible to digitize the actual marsh habitat and channels with the time allocated for the project. This resulted in an estimate of missing approximately 20-40% of the linear channel edge habitat for some highly channelized marshes in the Salmon and Yaquina estuaries. Figure 22 show an example of the complexity of a patchwork marsh system in Yaquina Bay and the resulting digitization.

Figure 22. Left Image is the DOQ base layer with high complexity patchwork marsh and the resultant product on the right.



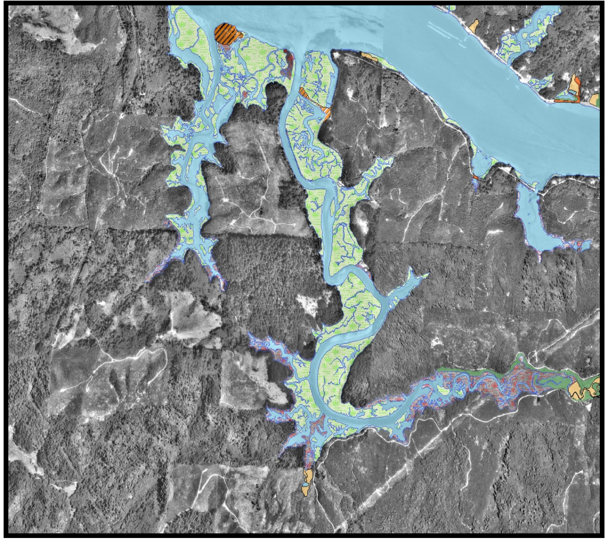
Tidal Wetlands Data Set Classification Limitatio



Field verification based on the HGM prelin for 120 sites to validate the classification and boundaries are accurate, however because this project was completed dominantly based on remote sensing data there exists an uncertainty in the classification of many of the wetlands. These classifications are only estimations, because the true HGM classification need to be assessed on the ground with future field work. Additionally for regions where the classification of a wetland was uncertain it was deemed better to err on the side of caution and classify a polygon as a Restoration Consideration Areas, rather than to omit or misclassify the habitat as a functioning tidal wetland. Other factors that limited the accuracy of this classification were the conflicts in the classification and omission of the NWI and ODFW data and the different classification system for the HGM project. Figures 23, 24 and 25 show how errors with the DEM and the limitations of the NWI played a role in the classification and left room for interpretation. Figure 23 shows the DEM for a region in the lower Yaquina estuary where the known elevations of wetlands are lower than shown in the image. According to the DEM the dark blue is supposedly 23ft or the upper limits of tidal influence in the estuary however this habitat is known low marsh. The classification of the habitat also relied on the NWI, and ODFW habitat. Figure 24 is a zoomed in picture of the NWI habitat represented in Figure 18. This delineation omits the upper third of the Yaquina Bay's Habitat from the NWI data set. Figure 25 shows the final

etland Delineation

Figure 24. NWI limitations for the Yaquina Bay Habitat



delineation of the region based on all references sources in the study.

Another point of uncertainty is the transition habitats between classification zones. Interpretations of aerial photos, field work and existing data did make it possible to delineate many transition zones between classifications accurately. However without field verification based ion the HGM project for all sites the delineations of many sites are only interpretations and not the true transitions zones.

The transition zone between a marine sourced and a river sourced tidal wetland was more difficult to determine without parameters established in the HGM project. These transitions are presently estimated on interpretation of existing delineations from the NWI and ODFW habitat layer, field data collected and interpretations of the DEM and NOAA salinity field data set. The transition was generally demarcated by the transition of the NWI submerged habitat code changed from E1 (estuarine)to R1 (riverine) and transitions form E2EM* (Estuarine Marsh) to PEMF (Palustrine Emergent Marsh Irregularly Flooded). These transitions were also interpreted from the Estuary Plan Book data sets transition of estuarine tidal marsh to riverine tidal marsh.

Another factor adding to the difficulty in determining these transition zones is that these rejoins presently are the most commonly diked sections of the coastal river systems. For this region where there was uncertainty of diking or the true transition some of these regions may be classified, as RCA habitat, to demarcate the need for further work before a true classification could be determined.

The most controversial portion of this delineation deals with the classification of RCA habitat. Although the head of tide may extend to 23 ft in elevation, the uppermost effects of tidal inundation are minimal. It was not possible to determine if the effects of the tide impacted the surrounding habitat with the remote sensing data used. For the main river channel it is very doubtful that tidal influence was able to escape the confines of the channel. However without field data to incontrovertibly prove otherwise, the habitat was classified as RCA. Figures 26, 27, 28 and 29 show how tidegates, elevation and other data led to the current classification. Figures 26 show s the regional elevation and the known head of tide (yellow stars), and figure 27 shows the delineation of habitat based on the information given.

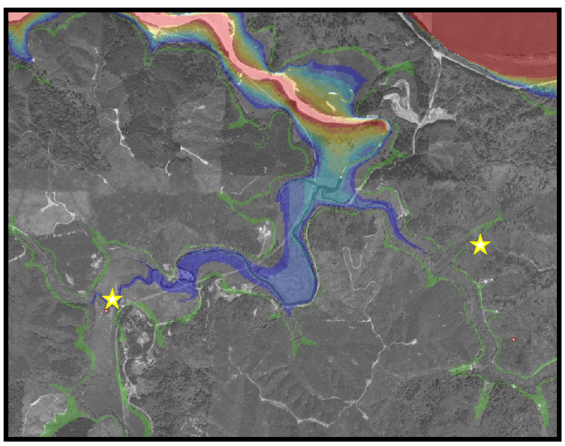


Figure 26. 10m Dem and Head of Tide, Umpqua River

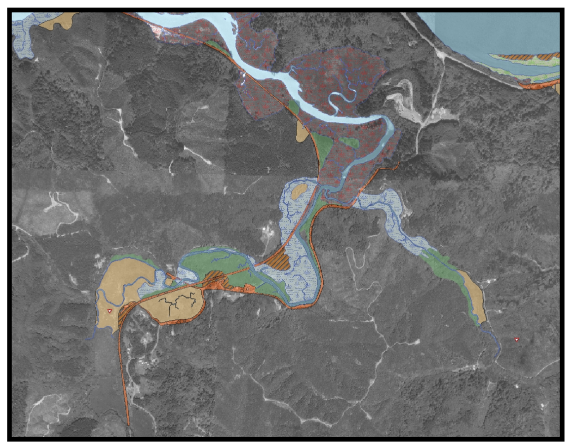


Figure 27. Tidal Wetland Geodatabase Umpqua River Delineation

Figure 28 alternatively shows the regional elevation for a section of Coos Bay that has extensive diking and the current head of tide is marked at a tide gate. The resulting delineation, figure 29, has the majority of habitat listed as RCA up to 23ft. in elevation. 23 ft was used because the known head of tide for this region in areas without tidegates was approximately 23ft. An exception in this delineation is a River Sourced Tidal Wetland directly above the tidegate, where the dike is not functioning.

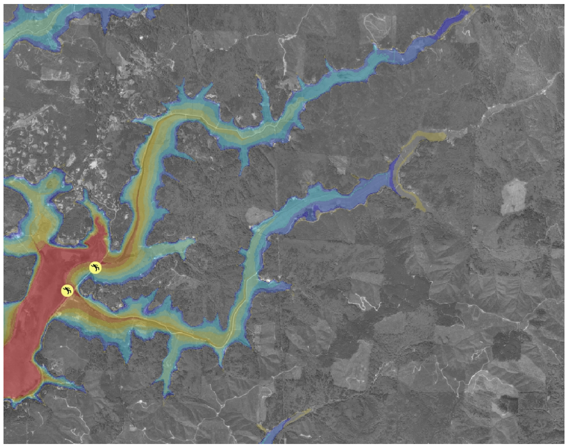


Figure 28. 10m Dem and tidegates, Coos Bay

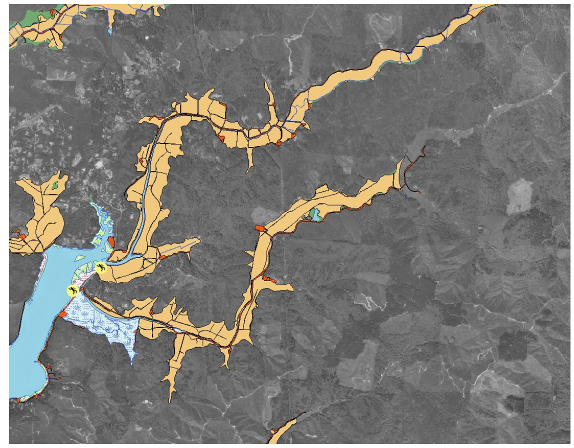


Figure 29. 10m Tidal Wetland Geodatabase RCA Delineation

This delineation erred in favor of RCA without additional data to show the true extent of diking, alteration and the extent of tidal inundation the classification of River Sourced Tidal, RCA, Non-Tidal Wetlands or Upland. Even in cases where inundation lines were visible in some river-sourced marshes the slope of the whole marsh made it impossible to demarcate the extent of the tidal flooding of the wetland, in these cases the known regions were classified as River Sourced, but the upper boundaries were labeled as RCA for later verification.

The final transition zone with a larger degree of uncertainty involves the PF, Potential Forested Tidal Wetland polygons. Most of the PF sites are forested wetlands classified as PFO* or PSS* by the NWI, however the data used was insufficient to determine if the PF were tidal wetlands or if they were Non-Tidal Forested transition wetlands. In some instance elevation was essential in this determination. It was obvious that many sites were above 23 ft in elevation and the site was not classified as PF but rather upland. Some known tidal Spruce wetlands were easy to delineate based on the elevation, hydrology, geomorphology and surrounding tidal wetlands. However most of the PF attributes are fringe habitats to tidal wetlands and do not show direct surface hydrologic connectivity to tidal waters. Other polygons may be on the river border, but the 2-dimensional limitations could not show if they had the capability to be inundated due to bank steepness or if forested lands were on dikes. Other remote sensing data that may have been able to discern this data was unavailable for our study area. For a select group of PF attributes the true polygon boundaries of the classification were difficult to delineate due to canopy cover, therefore a transition from tidal to non-tidal forested or forested uplands was hard to delineate. However if it was felt this attribute could not be classified accurately the attempt would have been abandoned.

As a result of complex interpretational dilemmas and the lack of ground truthing the RCA and PF classifications potentially have the largest degree of error in interpretation. The transitions zones and classifications are interpretations made from existing work and modern imagery and need field validation. The combination of the photos resolution in SID format, color, time and human error have left this data with many imperfections. Overall in combination with the NWI the Tidal Wetlands Geodatabase can be used as a more refined interpretation of existing and potential tidal wetlands for restoration and wildlife management. In the future the acquisition of additional data sets or new remote sensing data conversion techniques can aid in this delineation.

Spatial Analysis:

Each table can be Found in Appendix C: in a larger format. These tables do not include all estuaries that have been mapped in this project; they exclude some of the minor estuaries, like the Yachats and Neskowin estuaries. The results of the simple spatial analysis for area of habitat classification by estuary and the totals sum of area by estuary and sum of habitat for Oregon's coastal watershed shown in Table 1. This table show that the largest areas of available habitat by classification are in the larger estuaries. For example the largest acreage of marine sourced low and high tidal wetland are found in Coos Bay. It also can be used to highlight the estuaries that have the greatest levels of development with the largest areas of filled lands or restoration consideration area, (i.e.

Table 1: Existing & Potential Tidal Wetland Areas (Acres) by Classification & Total Area by Estuary

Estuary	Marine Sourced Low Tidal Wetland	Marine Sourced High Tidal Wetland	Restoration Consideration Area	Potential Forested Tidal Wetland	River Sourced Tidal Wetland	Fill	Water	Total
Necanicum R.	89.44	80.54	101.61	35.30	0.39	0.23	291.19	598.69
Ecola Cr.	0.51	7.85	5.40	34.67	0.00	0.55	11.76	60.75
Nehalem B.	307.11	327.71	2211.77	516.57	72.66	241.67	2245.05	5922.54
Tillamook Bay	687.80	444.09	8801.08	655.67	33.65	894.75	8735.09	20252.13
Netarts Bay	462.02	150.02	74.26	57.60	8.99	8.27	502.22	1263.39
Sand Lake	135.92	129.86	6.19	7.46	3.05	0.58	2394.78	2677.85
Nestucca Bay	149.56	63.68	3139.18	133.85	7.78	52.10	1144.39	4690.54
Salmon R.	302.59	215.41	214.52	57.14	76.66	35.67	275.73	1177.71
Siletz Bay	215.97	379.84	756.36	248.96	31.65	260.26	1631.18	3524.23
Depoe Bay	0.00	0.21	0.71	1.34	0.00	6.46	10.76	19.49
Yaquina B.	386.62	232.71	1416.32	213.50	323.69	651.01	4358.66	7582.52
Beaver Cr.	2.20	94.68	187.26	19.89	0.00	0.52	32.08	336.63
Alsea B.	144.30	434.03	394.75	128.86	117.85	146.79	2448.31	3814.89
Siuslaw R.	919.95	259.44	1892.86	213.57	187.66	584.28	2875.03	6932.78
Umpqua R.	456.22	778.09	3048.35	592.02	311.42	1278.01	8006.85	14470.97
Siltcoos R.	0.72	13.87	9.08	0.00	3.40	0.05	31.98	59.10
Ten Mile Cr.	25.64	53.86	14.54	0.30	5.70	0.00	58.52	158.55
Coos Bay	1140.69	660.11	6878.40	326.92	158.03	2475.31	12672.67	24312.12
Coquille R.	145.39	201.41	13560.98	578.96	77.60	701.24	2159.69	17425.26
Two Mile Cr.	0.51	3.83	2.75	16.14	2.12	0.00	12.54	37.89
New River	67.80	138.27	1132.57	100.69	4.19	5.38	302.59	1751.51
Sixes River	0.89	5.11	240.98	0.67	3.39	5.46	102.58	359.08
Elk River	1.32	13.06	214.46	21.63	4.08	13.32	86.52	354.39
Euchre Cr.	6.18	0.00	19.08	2.19	0.19	20.89	25.74	74.27
Rogue River	29.50	8.81	95.39	112.97	0.99	32.22	631.12	910.99
Pistol River	0.00	4.30	20.23	19.16	0.00	9.42	33.81	86.93
Chetco River	0.17	2.33	0.00	8.60	3.84	6.35	175.81	197.09
Winchuck R.	1.54	0.00	99.32	0.00	1.77	0.00	32.93	135.55
Total	5680.53	4703.13	44538.41	4104.61	1440.77	7430.79	51289.58	119187.82

Tillamook, Coos Bay, the Coquille, and Nestucca estuaries). It is also important to understand that this analysis does not show the degree to which these habitat classifications may be fragmented. This may mean these larger estuaries may have alower overall rating for the ecological integrity if these are mostly isolated wetlands verses large areas of interconnected habitat.

Table 2 shows the classification of habitat for each estuary as a percentage. This may help show the degree of fragmentation of habitat within the estuary or the weight that a habitat may influence the ecosystem of that particular watershed. The differences between table 1 and 2 are obvious. Table two shows that the smaller estuaries may be healthier overall, which shows that the Oregon Estuary management plans and units are working for Conservation and Natural estuaries. Unfortunately the larger estuaries have less habitat available in comparison to its potential and these two tables do not show the degree to which habitat in these estuaries are fragmented.

Table 2: Percentage of Habitat by Classification for all Existing, Potential and Filled Habitat by Estuary

Estuary	Marine Sourced Low Tidal Wetland	Marine Sourced High Tidal Wetland	River Sourced Tidal Wetland	Restoration Consideration Area	Potential Forested Tidal Wetland	Fill
Necanicum River	29.08	26.19	0.13	33.04	11.48	0.07
Ecola Creek	1.04	16.03	0.00	11.02	70.77	1.13
Nehalem Bay	8.35	8.91	1.98	60.14	14.05	6.57
Tillamook Bay	5.97	3.86	0.29	76.42	5.69	7.77
Netarts Bay	60.70	19.71	1.18	9.76	7.57	1.09
Sand Lake	48.02	45.88	1.08	2.19	2.63	0.20
Nestucca Bay	4.22	1.80	0.22	88.52	3.77	1.47
Salmon River	33.55	23.88	8.50	23.78	6.33	3.95
Siletz Bay	11.41	20.07	1.67	39.95	13.15	13.75
Depoe Bay	0.00	2.42	0.00	8.13	15.41	74.04
Yaquina Bay	11.99	7.22	10.04	43.93	6.62	20.19
Beaver Creek	0.72	31.09	0.00	61.49	6.53	0.17
Alsea Bay	10.56	31.76	8.62	28.89	9.43	10.74
Siuslaw River	22.67	6.39	4.62	46.65	5.26	14.40
Umpqua River	7.06	12.04	4.82	47.16	9.16	19.77
Siltcoos River	2.66	51.14	12.54	33.49	0.00	0.17
Ten Mile Creek	25.63	53.84	5.70	14.53	0.30	0.00
Coos Bay	9.80	5.67	1.36	59.10	2.81	21.27
Coquille River	0.95	1.32	0.51	88.83	3.79	4.59
Two Mile Creek	2.02	15.11	8.38	10.85	63.65	0.00
New River	4.68	9.54	0.29	78.17	6.95	0.37
Sixes River	0.35	1.99	1.32	93.95	0.26	2.13
Elk River	0.49	4.88	1.52	80.06	8.08	4.97
Euchre Creek	12.73	0.00	0.40	39.32	4.51	43.04
Rogue River	10.54	3.15	0.35	34.08	40.36	11.51
Pistol River	0.00	8.09	0.00	38.09	36.07	17.74
Chetco River	0.80	10.92	18.06	0.00	40.41	29.82
Winchuck River	1.50	0.00	1.72	96.78	0.00	0.00

Looking at the GIS data set or the maps of the project shows that many of these estuaries have habitat that is not fragmented and is localized, like the Coquille River and Tillamook Bay. This can be good for the ecology for the watershed, however if an event was to occur that damaged this area, it would most likely have a very negative impact on the whole estuary's ecological integrity. Unfortunately there are other estuaries that have large areas of habitat, but they are fragmented and the habitat is scattered across large areas. In some cases this may good for spatial diversity, however in other cases the fragmented habitat may be too sparse to have a positive effect on the regional ecological health. In the cases of Coos Bay it is spatially diverse with good concentrations of Marine Sourced Low and High marsh across the Estuary; however the riverine sourced tidal marsh is very sparse. Hypothetically this may be bad for the regional ecological health of riverine species.

It is important to recognize that the RCA habitat may be over estimated in some locations of estuaries. In many cases, like in the Sixes River, Tillamook Bay and the Nehalem estuaries, it is felt that large portions of the habitat listed as RCA may be converted to upland or non tidal wetland. This means in most cases the percentage of altered or filled habitat will decrease, especially for the Sixes River watershed.

Today for Oregon restoration efforts are not prioritized based on habitat classification, rather it is felt that any restoration can benefit an ecosystem. However data from tables 1 and 2 can be used in the future if restoration efforts are to be based on habitat types. For the Siuslaw Estuary efforts may need to focus on future restoration of high tidal marsh habitat, which presently consists of 6% of the habitat, compared to the 23% of low tidal marsh habitat. In the case of Coos Bay the argument could be made for the need to restore more River Sourced Tidal Wetland habitat, based on the percentages and spatial analysis of Restoration Consideration Areas. While another case to focus on restoring low marsh could be made for the Alsea estuary, where 11% of the habitat is low marsh habitat and 32% is high marsh. It is also important to recognize each estuary is unique and that the percentage of habitat may vary based on the regional geomorphology of the watershed and these percentages may represent the natural state of the ecosystem. Further studies need to be made to determine the values of these habitats and if it is important to emphasize restoration of particular habitat or if there should be a balance or weight to prioritization of restoration of particular habitats. Future work with the HGM assessment and this data set hopefully may be able to provide some of these answers.

Table 3 compares the existing tidal marsh habitat to habitat that may have been altered or may negatively impact the estuarine ecosystem health. The second column is the total amount of marine tidal marsh habitat, while the third column is the total acreage for all existing tidal marsh habitats for an estuary. The fourth column is the total amount of habitat altered and the last columns represent the existing marsh habitat and habitat altered as a percentage of the total area of the estuary. The results are best interpreted from the columns of percentage of existing and altered habitat. The Nestucca, Tillamook, Nehalem, Coos Bay, Coquille and the New river estuaries show large percentages habitat altered. However it is important to remember that these percentages may decrease in favor of larger percentages of existing tidal marsh when verification of this work is completed. It is also important to recognize that Netarts Bay, Sand Lake and the Salmon River are in very good condition.

Table 3: Marsh Habitat: Cumulative Area of Existing Marine Tidal Marsh (MSH + MSL), Cumulative Area of Existing Tidal Marsh (MSH + MSL+ RS), Cumulative Area of Restoration Consideration Area and Filled Lands and the Percentage of Existing and lost Tidal Marsh for each Estuary.

Estuary	Estuarine Marsh Acres(MSH+MSL)	Tidal Marsh Acres (RS+MSL+MSH)	RCA & Filled Tidal Acres	Percent RCA & Filled	Percent Existing
Necanicum River	169.97	170.37	101.84	37.41	62.59
Ecola Creek	8.37	8.37	5.95	41.57	58.43
Nehalem Bay	634.83	707.48	2453.43	77.62	22.38
Tillamook Bay	1131.89	1165.54	9695.83	89.27	10.73
Netarts Bay	612.05	621.04	82.53	11.73	88.27
Sand Lake	265.78	268.84	6.77	2.46	97.54
Nestucca Bay	213.24	221.02	3191.28	93.52	6.48
Salmon River	517.99	594.66	250.19	29.61	70.39
Siletz Bay	595.81	627.47	1016.62	61.83	38.17
Depoe Bay	0.21	0.21	7.17	97.14	2.86
Yaquina Bay	619.33	943.02	2067.33	68.67	31.33
Beaver Creek	96.88	96.88	187.78	65.97	34.03
Alsea Bay	578.34	696.18	541.54	43.75	56.25
Siuslaw River	1179.38	1367.04	2477.14	64.44	35.56
Umpqua River	1234.31	1545.73	4326.36	73.68	26.32
Siltcoos River	14.59	17.99	9.13	33.66	66.34
Ten Mile Creek	79.50	85.20	14.54	14.58	85.42
Coos Bay	1800.79	1958.82	9353.71	82.68	17.32
Coquille River	346.80	424.40	14262.22	97.11	2.89
Two Mile Creek	4.34	6.46	2.75	29.85	70.15
New River	206.07	210.26	1137.96	84.40	15.60
Sixes River	6.00	9.39	246.43	96.33	3.67
Elk River	14.38	18.45	227.78	92.51	7.49
Euchre Creek	6.18	6.37	39.97	86.25	13.75
Rogue River	38.31	42.58	127.61	76.46	23.54
Pistol River	4.30	4.30	29.66	87.34	12.66
Chetco River	2.49	6.34	6.35	50.03	49.97
Winchuck River	1.54	3.31	99.32	96.78	3.22
Total	10383.67	11827.71	51969.20	NA	NA

Table 4 is a more Salmon centric table, which was generated to show the amounts of aquatic habitat available for fish use by estuary on the average high tide. The second column shows the results for open water habitat, while the third column incorporated low marsh habitat into its results of aquatic habitat. The fourth column is an effort to compare the total amounts of habitat available, but this interpretation includes high marsh and river sourced tidal marsh as habitat. The final columns are rough percentages of habitat available for fish use daily. Further calculations can be made to represent this data at the highest high tides where the aquatic tidal habitat includes the river sourced tidal and marine sourced high tidal marsh compared to habitat lost. Additional comparisons to fish stock populations over time or by watershed to compare population sizes to habitat types may be beneficial in future stock assessments for understanding how tidal wetland habitat plays a role in salmon abundance.

Table 4: Aquatic habitat available to fish on average high tides.

Estuary	Water	Total Aquatic Habitat (MSL+ Water)	Total Tidal Habitat	Percent Aquatic Habitat	Percent Non Aquatic Habitat
Necanicum River	291.19	380.62	598.69	48.64	51.36
Ecola Creek	11.76	12.28	60.75	19.37	80.63
Nehalem Bay	2245.05	2552.17	5908.06	38.00	62.00
Tillamook Bay	8735.09	9422.89	20124.07	43.41	56.59
Netarts Bay	502.22	964.24	1255.70	40.00	60.00
Sand Lake	2394.78	2530.70	2681.18	89.32	10.68
Nestucca Bay	1144.39	1293.95	4690.54	24.40	75.60
Salmon River	275.73	578.31	1177.71	23.41	76.59
Siletz Bay	1631.18	1847.16	3486.19	46.79	53.21
Depoe Bay	10.76	10.76	8.73	76.65	23.35
Yaquina Bay	4358.66	4745.28	7582.52	57.48	42.52
Beaver Creek	32.08	34.28	336.63	9.53	90.47
Alsea Bay	2448.31	2592.61	3789.62	64.61	35.39
Siuslaw River	2875.03	3794.98	6932.78	41.47	58.53
Umpqua River	8006.85	8463.07	14162.40	56.54	43.46
Siltcoos River	31.98	32.71	59.10	54.12	45.88
Ten Mile Creek	58.52	84.15	158.55	36.91	63.09
Coos Bay	12672.67	13813.35	23483.64	53.96	46.04
Coquille River	2159.69	2305.08	17425.26	12.39	87.61
Two Mile Creek	12.54	13.05	37.89	33.09	66.91
New River	302.59	370.39	1291.92	23.42	76.58
Sixes River	102.58	103.47	359.08	28.57	71.43
Elk River	86.52	87.83	354.39	24.41	75.59
Euchre Creek	25.74	31.92	74.27	34.65	65.35
Rogue River	631.12	660.62	892.66	70.70	29.30
Pistol River	33.81	33.81	86.93	38.89	61.11
Chetco River	175.81	175.98	190.75	92.17	7.83
Winchuck River	32.93	34.46	135.55	24.29	75.71

Another interpretation of Table 4 shows that for most major estuaries the amount of open water habitat water represents in average over 50% of the total estuary surface area. These results show the Coquille Estuary only has 12% of its surface area as open water habitat. Even though large portions of the Restoration Consideration Areas may be later reclassified as Non Tidal Wetlands, the evidence from aerial photography supports that this estuary could increase the open water surface area by restoration of many diked historic channels.

Table 5 compare the results of this report to the results of the SOER report, figure 2. The second column, HGM existing tidal wetland acreage, is the sum of acreage for Marine Sourced Low, Marine Sourced High and River Sourced Tidal Wetlands, excluding the Potential Forested Tidal Wetlands, which is compared to the third column (SOER existing habitat) which estimated existing tidal marsh habitat and tidal swamps in

Table 5: Comparison of the Tidal Wetland Geodatabase's Area of Tidal Wetlands to the Oregon State of the Environment Report 2000(SER) Results.

Estuary	HGM Existing Tidal Wetland (Acres)	SOER Existing Tidal Wetlands (Acres)	HGM Diked & Filled Land (Acres)	SOER Diked & Filled Land (Acres)	Difference HGM-SOER Altered Wetlands (Acres)	Difference HGM-SOER Existing Wetlands (Acres)	SOER Percent Existing Tidal Wetland	HGM Percent Existing Tidal Wetland
Necanicum River	170.37	132	101.84	15	86.84	38.37	90.00%	66.88%
Nehalem Bay	707.48	524	2453.43	1571	882.43	183.48	25.00%	33.29%
Tillamook Bay	1165.54	884	9695.83	3274	6421.83	281.54	21.00%	15.81%
Netarts Bay	621.04	228	82.53	16	66.53	159.04	93.00%	89.16%
Sand Lake	268.84	462	6.77	9	-2.23	40.84	98.00%	97.61%
Nestucca Bay	221.02	205	3191.28	2160	1031.28	16.02	9.00%	10.01%
Salmon River	594.66	238	250.19	313	-62.81	356.66	43.00%	72.26%
Siletz Bay	627.47	274	1016.62	401	615.62	353.47	41.00%	46.30%
Yaquina Bay	943.02	621	2067.33	1493	574.33	322.02	29.00%	35.87%
Alsea Bay	696.18	460	541.54	665	-123.46	236.18	41.00%	60.37%
Siuslaw River	1367.04	746	2477.14	1256	1221.14	621.04	37.00%	38.95%
Umpqua River	1545.73	1201	4326.36	1218	3108.36	344.73	50.00%	33.07%
Coos Bay	1958.82	1727	9353.71	3360	5993.71	231.82	34.00%	19.64%
Coquille River	424.4	276	14262.22	4600	9662.22	148.4	6.00%	6.57%
Rogue River	42.58	44	127.61	30	97.61	-1.42	59.00%	54.40%
Chetco River	6.34	4	6.35	5	1.35	2.34	44.00%	70.18%
Total	11360.53	8026	49960.75	20386	29574.75	3334.53	28.00%	18.50%

the 1970's. The fourth column is the acreage of altered lands for the HGM project, the sum of Fill and RCA areas, while the fifth column is the sum of altered habitat for the SOER report. It is in my opinion from these results and the delineation process that the SOER report severely underestimated the true amount acreage of habitat altered since the 1870's. The sixth column shows the results of the difference of altered tidal wetlands between the reports (column 4- column 5). The total for the HGM study is significantly larger than that of the SOER report. This is mainly due to the inclusion of more filled lands and some Restoration Consideration Areas that may not be tidal wetlands. The estuaries with the greatest difference are the Coquille and Tillamook estuaries with a significant difference in the Coos Bay and Umpqua River estuaries as well. The seventh column shows the results of the difference of existing tidal wetlands between the reports (column 2- column 3). These results may viewed as the acres of habitat restored since 1970, however it is important to remember that the results of this tidal wetland HGM project analysis may include wetlands omitted and natural transgression of wetland habitat since the SOER study. The greatest difference is that in the Siuslaw river estuary with an increase of 621.04 acres, with the Salmon Siletz, Yaquina, Alsea and Umpqua estuaries posting the more significant gains in tidal marsh habitat since the 1970's. While many of the larger estuaries did not fair as well with minimal gains in estuarine marsh habitat. The fact that the HGM comparison omits the potential forested tidal wetlands from the existing habitat is also important to consider in these results, but in my opinion these increases are not from significant restoration efforts, but rather improved digitization and spatial resolution and the inclusion of many fringe habitats that may not have been accounted for in the previous study. The Rogue River was the only estuary to post a loss of 1.4 acres of existing tidal wetlands, but I feel it is appropriate for the dynamic nature of that estuary.

Table 6 focuses on Oregon's Coastal estuaries as a whole. The first second and third columns are the percentages of total habitat for all of Oregon of cumulative area of existing Tidal Wetland (MSH + MSL+ RS), cumulative area of altered tidal lands and the cumulative percent of Potential Forested Tidal Wetland. The

Table 6: Percentages of total habitat for all of Oregon of Cumulative Area of Existing Tidal Wetland (MSH + MSL+ RS), Cumulative Area of Filled and Potential Tidal Wetland and the Cumulative Area of Potential Forested Tidal Wetland. Also a Comparison Marsh Habitat of Percentage of Existing Marsh Habitat to Potential and Filled Marsh Habitat

Percent Tidal Wetland	Percent RCA & Filled	Percent Potential Forested Wetland	Percent Existing Tidal Marsh	Percent Marsh Filled + RCA
17.41	**76.54**	**6.05**	**18.54**	**81.46**

fourth and fifth columns represent a comparison of existing and altered tidal marsh habitat for Oregon's Coastal watersheds. These results both show that less than 20 % of the historic tidal wetlands are functioning, how ever it does not tell if any of theses existing wetlands are in poor condition with no functions being provided.

These results may show that the ecological integrity of many watersheds is in poor stranding based on spatial analysis. It is obvious that further investigations and research may tell a different story of the true ecological integrity of these watersheds, but this study shows that there is plenty of room for improvement for Oregon's coastal estuaries. These results need to be considered in the proper context when considered for use in restoration management. In the more developed estuaries, like the Coquille, Nestucca and Tillamook, restoration efforts also need to proceed in a manner that preserves the integrity of the existing industries, while improving the ecological integrity of these systems.

Additional Work to Complete Tidal Wetland Geodatabase:

Although this data set is improved and a reliable interpretation of exiting tidal marsh habitat, this data set is far from complete and several steps need to be taken in the future to make sure this data set is reliable and maintained.

Verification- Before this data set can be used as an official document in resource management each polygon's classification needs to be verified or be approved by an official state source of the Oregon Department of State Lands, Department of Fish and Wildlife or Department of Land Conservation and Development. Approval would accept this delineation as a valid resource in its present state. While the verification process would entail the approval of the classification and delineation of each of the existing tidal wetlands, potential forested tidal wetlands and RCA habitat. The state can make a general verification, or they can proceed with an in depth study based on the HGM protocol to identify the overall ecological health of the existing tidal wetlands or use another methodology.

Apply HGM protocol to existing wetlands- The HGM protocol needs to be applied to the existing tidal wetlands to create a base line of data for Oregon's tidal wetland ecosystem health. This assessment can identify wetlands where enhancement projects may be beneficial. This assessment method should be repeated in the future to see weather the tidal marsh ecosystem health is improving or declining.

RCA Habitat validation- The RCA areas need closer scrutiny to validate its delineation. Local and regional experts and managers could complete a rough assessment survey for individual watersheds. Another method would develop a statewide rapid assessment method to be applied to all watersheds to evaluate tidal influence, involving elevation surveys of river discharge, tidal range and a geomorphology during the highest high tides of a year. It is important to realize that river discharge and variations in tidal range annually may produce result that may under estimate the RCA habitat if assessed during a drought year. Another method to validate the RCA habitat is to complete a more extensive historical analysis of altered wetlands for each watershed. Although historical works were consulted, they were dominantly available for the lower estuaries.

Updating the Tidal Wetland Geodatabase- While many agencies want this Geodatabase, as of today no entity has stated that they want to update or maintain this data set spatially in the long term. Efforts need to be coordinated to maintain this Geodatabase properly. This should be maintained by the state of by local watershed groups and it is important to correct errors with the original delineation and classification and track future changes. Hopefully a state entity will take responsibility of this document and request spatial edits be directed to them for a master copy. A draft of this or an updated 2001 draft of the database needs to be maintained for future comparisons, because it is also important to track future changes and new versions should be created. The easiest method to update this data set is to identify the Object ID attribute of a polygon being studied and either draw changes to the delineation on a printout or edit the Geodatabase in ArcGIS and submit corrections to the local or state entity responsible for maintenance of this data set.

Columbia River Project- This project will be complete when an additional study completes the same delineation for the Columbia River. To truly prioritize tidal wetland restoration efforts for the state the Columbia River needs to be included. This is another excellent Marine Resource Management Graduate project, with all resources available. However there are additional data sets not mentioned in this report developed for the Columbia River that can be used to aid in the delineation.

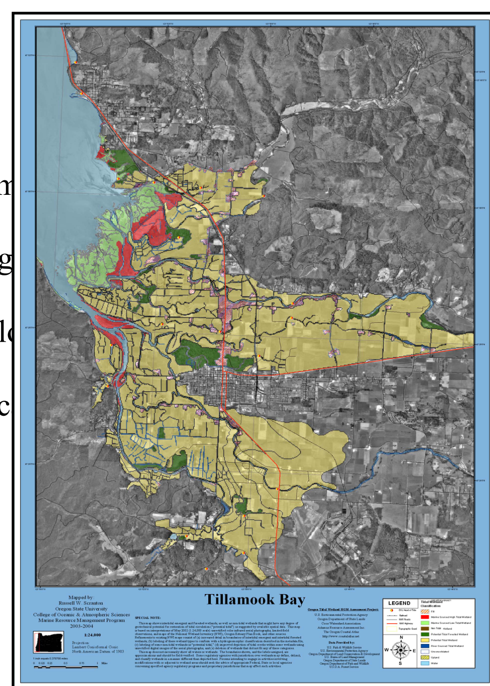
Distribution: Maps, DVD and Online

The products of this project are hard copy m

layer on a geospatial data clearinghouse at the Oreg

The hard copy maps of each U.S. Geol

estuary were created in ArcGIS in a 1:24,000 sc



projection. Figure 30 show a topographic index map of Tillamook Bay for the project. These maps contain a special note as an informational disclaimer for the data represented on the map. The special note can be viewed in Appendix E of this paper. These maps were created in two formats. The first format matched the 1:24,000 topographic index quad maps used for the state of Oregon and printable on most plotters. A second set of maps were created by estuary, these show the entire estuary in one image. Each topographic map quad and estuary map was printed and saved in two formats. Each map was saved as an ArcGIS MXD file, so it could be opened exactly how it was created for the purposes of viewing and later alterations. Figure 31 is a screen shot of what should be available in the MXD format. Secondly, for people without GIS software viewing capabilities it was saved as a PDF file to be viewable in Adobe Acrobat.

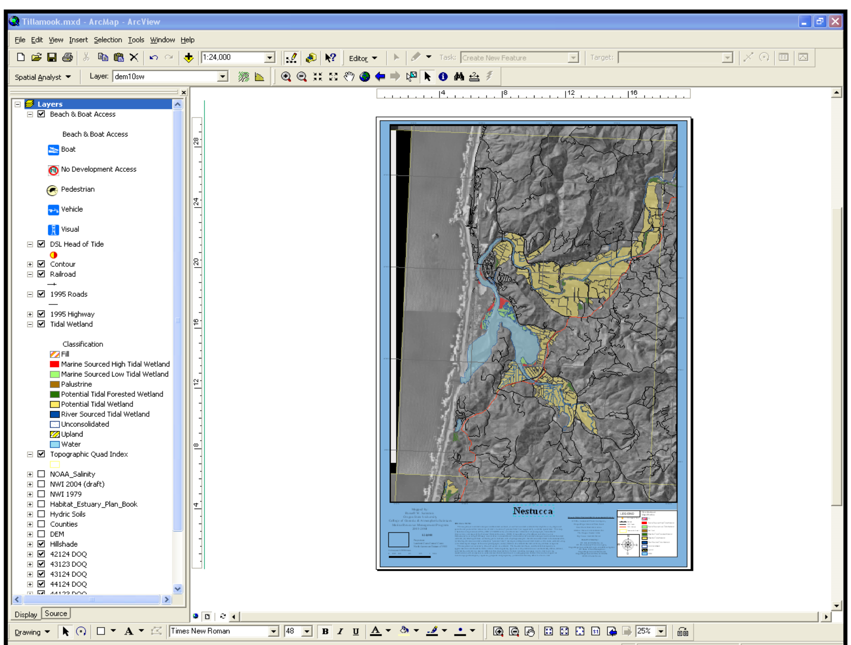


Figure 31. Screen shot shows the Open MXD file for use with the DVD

The primary format for distribution of this project is the creation of a DVD, because the DVD can provide the information used to develop the project in a format the can be reproduced in a manner similar to that used in the development of the project. This DVD was designed so a viewer could view all data sets and the DOQ's used in the creation of the Tidal Wetlands

Geodatabase file. This DVD contains the MXD files and all associated data set files in their relative pathway, which would in ESRI ArcGIS version 8.2. or later with the identical symbology and colors used in the mapping process. These files include the Tidal Wetland Geodatabase, the 2001 DOQs, the original NWI, the 2004 draft version of the NWI, the Oregon Estuary Plan Book Habitat data sets merged for the entire coast and files for individual estuaries, the merged SSURGO and STATSGO Hydric Soils data sets, NOAA Salinity data fields, the DSL Head of Tides layer, Counties, the 5^{th} Field Watersheds, Beach and Boat Access, a merged 1995 roads and highway file, railroads, the CLAMS 1996 vegetation data, the Streams and the Ownership data sets and the Coquille Estuary Historic Wetlands (1857-1872). Three coastal 10-meter DEM files and the Hillshade files, and 1ft contour Shapefile (0-52 feet in elevation) interpolations of these raster have been added. Finally this DVD also contains folders containing both MXD and PDF formats of the maps, a copy of this document, a metadata txt file, the research project presentation in Microsoft PowerPoint and a poster presentation file created for Restore America's Estuaries conference in PowerPoint. Due to their size this DVD does not include the natural color or Color infrared aerial photos. This DVD was distributed to all primary parties involved including the Oregon Department of State Lands, Oregon Department of Land Conservation and Development, US EPA Region 10, US Fish and Wild Life Service's NWI Division, the Coos Watershed Association, the Oregon Watershed Enhancement Board, The Marine Resource Management Program of OSU, and the Ecotrust.

The Tidal Wetland Geodatabase, a shapefile and the maps were distributed to the Coastal Atlas http://www.coastalatlas.net for online distribution and viewing. The Oregon

Coastal Atlas, administered by the state of Oregon Ocean-Coastal Management Program, Oregon State University, and Ecostrust, is a web based GIS Clearinghouse for data associated with the Oregon coast. The Coastal Atlas uses Minnesota Mapserver, ArcIMS, and customized Active Server Page code to create an online portal to view all GIS data they have available to download. This allows for all stakeholders to view the information without the need of GIS software. It also allows anyone to download Geodatabase file and a Shapefile for personal use on a GIS. The Oregon Coastal Atlas has also agreed to post a copy of this report, the PowerPoint presentation and copies of the PDF maps when space is available.

Future Management Potential:

Today GIS has established itself as a reliable tool in resource management. The growing popularity, ease of use, and the accessibility of electronic information make this an ideal platform to distribute information to other agencies and the public. The scope of regulatory and public involvement in management of wetlands is massive. The Tidal Wetland data set can be considered essential in resource management today because it will help agencies identify and protect existing wetlands that may have been omitted by the NWI, ODFW and SSURGO Soils data. It also may act a building block for the creation of additional layers for additional resource management in Oregon's coastal watersheds.

This layer also can be used to help resource managers identify and prioritize restoration sites for better ecosystem management of the Coastal Watersheds. It specifically can be used by DSL to comply with its 2002 Strategic Plan (Goals and Actions for waters and wetlands: Agency Measure # 7), which requires the State to identify and prioritize sites for the annual restoration of 250 acres of wetland. The Oregon Watershed Enhancement Board and Watershed Councils can use the layer to help prioritize funding and restoration efforts. This can be done based solely on the relative scarcity of an HGM classification within an estuary, or by completing additional work to assess overall ecological integrity, functions, or restoration potential of a site or estuary.

An example of how this can be further developed to assess the restoration potential and prioritization, is using the work by the People for Puget Sound and the Washington Department of Fish and Wildlife for restoration prioritization for the Skagit River Estuary as a model for Oregon's coastal management, figure 32 (Dean 2000).
The prioritization of restoration depends on regional hydrology, elevation and current land use and ownership. The data available for analyzing this information in a GIS for Oregon's coast is limited and outdated. This layer can act as the foundation for the development of additional data layers for other management uses. Layers for Oregon's Statewide Planning Goals and Guidelines are available, but they need to be updated. Tidal wetlands that have been restored are not updated and it is extremely important that

Figure 32. Skagit River Estuary Restoration Assessment map developed by People for Puget Sound and the Washington Department of Fish and Wildlife.

the shoreline land use be rezoned for non use. Future restoration efforts need this rezoning written in the permitting process, where lands are rezoned to non development zones and that appropriate entities are notified to update the proper data used in future management of tidal wetlands.

SKAGIT ESTUARY RESTORATION ASSESSMENT MAPS

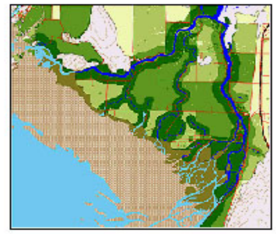


Table of Maps

Region of Study   Historic Tidal Influence

A: Landscape Ecology Criteria:	B: Ease of Restoration Criteria:	Results of Analysis:
1. Habitat Corridors	1. Public Lands	Priority Areas
2. Connectivity of Hydrology	2. Land Cover	
3. Tidal Flooding	3. Parcel Density	
4. Sustainability	4. Combined Ease of Restoration criteria	
5. Combined Landscape Ecology criteria		

Non Point Source pollution (NPS) pollution is a major concern for coastal estuaries in most states. Many of Oregon's coastal waters are listed on the EPA 303d for exceeding the Total Daily Maximum Loads of nutrients, sediments or biological pollutants. In conjunction with improved land use, runoff coefficients and ground water hydrology data this layer can be used to develop additional data sets for land use management for the regulation of NPS.

Other agencies or planners may want to use this layer to help reduce economic damage from flooding or designate to designate critical habitat for some species. FEMA may use the data to help manage and prevent flooding. An example would be to locate old oxbows to convert for use as flood bypasses or storage capacitors or lands with dikes that could be modified as overtopping to limit damage downstream. The USDA's NRCS can use this data layer to develop aids for management for the CRP, WRP and EQIP programs. Fishery management has already expressed interest. Portions of this data set have already been used to aid in NOAA Fishery's Management of Essential Fish Habitat for the Oregon Coastal Coho ESU. The development of additional layers in conjunction with this data layer will help with the proper management to increase economic and developmental growth, while restoring the overall ecological integrity and quality of life to Oregon's coastal watersheds.

Disclaimer:

This data set is not an official document used by the State of Oregon for regulation and management of its tidal wetlands. This data set was created based on information in 2002 and in the future changes may result in additional loss or increase in actual marsh habitat from natural processes or as a result of restoration efforts or development. The classification system for 2002 also needs field verification, especially for many of the locations classified as Restoration Consideration Areas.

Conclusion:

Management of tidal wetlands has proven to be a complex issue with multiple regulations and regulatory agencies involved in their management. Tidal wetlands have been identified for greater protection and preservation for their roles in maintaining the ecosystem health and their role in the public trust. The development of the Oregon Tidal Wetland GIS Geodatabase data set will aid in ecosystem management and restoration for the Oregon coastal watersheds. In conjunction with the Hydrogeomorphic Assessment of Oregon's tidal wetlands, this resource should help maintain or improve the ecological integrity and function of tidal wetlands and provide a better inventory of this habitat in Oregon. This data set should be used with the recognition that all interpretations were made from data in 2002 and future alterations to the areas shown may occur. The distribution of the data to all stakeholders through the Coastal Atlas is a valuable step in encouraging stakeholder involvement in watershed resource management. Keeping in line with Goal 16 of the Oregon Statewide Planning Goals and Guidelines, it is important to use this tool to restore estuaries for their designated uses. It is now in the hands of managers and the public to use and update this data for proper management of tidal wetlands. The development of additional data layers for use in conjunction with this data layer will help with the proper economic, social and developmental growth, while restoring the overall ecological integrity and quality of life to Oregon’s coastal estuaries and watersheds.

Appendix A: Metadata

```
Identification_Information:
  Citation:
    Citation_Information:
      Originator: Russell Scranton
      Publication_Date: 200407
      Title: Tidal Wetlands of Oregon's Coastal Watersheds
      Edition: 1st
      Geospatial_Data_Presentation_Form: vector digital data
      Publication_Information:
        Publication_Place: Corvallis, OR
        Publisher: Oregon State University, C.O.A.S Marine Resource
Management Program
      Other_Citation_Details: Title of MRM Research Paper "The
Application of Geographic Information Systems for Delineation and
Classification of Tidal Wetlands for Resource Management of Oregon's
Coastal Watersheds" by Russell Scranton
      Online_Linkage: http://www.coastalatlas.net/
  Description:
    Abstract: This data set delineates Oregon's coastal watershed's
known tidal wetlands and areas of interest for tidal wetland
restoration, based on interpretation of historic and present remote
sensing data.  Resource managers of Oregon's tidal wetlands required
the creation of an improved GIS layer for management of existing tidal
wetland habitat and areas considered for tidal wetland restoration.  As
a result of this need a reconnaissance project was initiated, where
interpretations of remote sensing data, the National Wetland Inventory,
Oregon Estuary Plan Book and additional management tools were used to
create a Tidal Wetland data set (as an ArcGIS Geodatabase) for Oregon's
coastal estuaries, excluding the Columbia River. With an improved
hydrologic delineation of tidal waters and channels this data set
classifies existing tidal wetlands for future use based on the
Hydrogeomorphic (HGM) classification (adopted nationally and by the
State of Oregon) and for habitat classification based on the Oregon
Estuary Plan Book classification system.  The classification
"restoration consideration areas" was developed for lands where
restoration of tidal circulation might be geotechnically feasible
pending further investigations.
    Purpose: This data set is intended for use as an inventory of
existing wetland functions for use with the Hydrogeomorphic
classification of Oregon's tidal wetlands. It is also intended for use
in checking areas that may warrant further consideration for
restoration of tidal circulation as needed to enhance anadromous fish
habitat and other wetland functions.  The layer also provides
information of potential use to researchers for selecting tidal wetland
sites for intensive studies and baseline information of potential use
to planners for tracking possible future changes of  tidal wetlands.
Some regulatory agencies with jurisdiction over wetlands may define,
delimit, and classify wetlands in a manner different than depicted in
this layer.  Therefore, persons intending to engage in activities
involving modifications within or adjacent to wetland areas should seek
the advice of appropriate government agencies concerning regulatory
programs and proprietary jurisdictions that may affect such activities.
    Supplemental_Information:  Additional groundwork and validation of
the data's classifications is recommended before this interpretation is
```

used as an official reference for resource management. In addition to wetland classification, this project was partly developed to provide a GIS base layer, which when combined with supplementary data sets, would enhance the ability of resource mangers and citizens to prioritize tidal wetland restoration efforts and evaluate the ecological integrity of individual tidal wetlands. While additional development of the data set may enhance management of Goals 16 and 17 of Oregon's Statewide Planning Goals Guidelines, aid in management of non-point source pollution and the designation Essential Fish Habitat for the endangered Coastal Coho salmon. Resource managers and citizens will be able to view and interpret this data set and supporting documentation online at the Oregon Coastal Atlas. For more information refer to publication "The Application of Geographic Information Systems for Delineation and Classification of Tidal Wetlands for Resource Management of Oregon's Coastal Watersheds" by Russell Scranton. This information has been provided to the Oregon Coastal Atlas, Oregon Division of State Lands, Oregon Department of Land Conservation and Development, the US Environmental Protection Agency and the Coos Watershed Association, NOAA and Adamus Resource Assessment, Inc. for further development.

```
  Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 200408
    Currentness_Reference: This layer is based mainly on aerial
photographs from May 2002 with partial ground truthing during summer
2003.
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: For corrections and additions,
please contact Dr. Paul Adamus
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -124.767254
      East_Bounding_Coordinate: -123.572704
      North_Bounding_Coordinate: 46.031950
      South_Bounding_Coordinate: 41.987188
  Keywords:
    Theme:
      Theme_Keyword_Thesaurus: Salt Marsh
      Theme_Keyword: Tidal Wetland
    Theme:
      Theme_Keyword_Thesaurus: Tidal Wetland
      Theme_Keyword: Salt Marsh
    Theme:
      Theme_Keyword_Thesaurus: Watershed
      Theme_Keyword: Estuary
    Theme:
      Theme_Keyword_Thesaurus: Classification
      Theme_Keyword: Hydrogeomorphic
    Place:
      Place_Keyword_Thesaurus: State
      Place_Keyword: Oregon
  Access_Constraints: None. This data set was created with public funds
and with the intent of being updated and refined by others as ground-
checking progresses and new information becomes available. However, the
```

original version should be retained as a benchmark against which future changes may be compared.

Use_Constraints: No legal restraints. It is free for all to use with the disclaimer that, this is not a State regulatory document for classification of wetlands. Many smaller wetlands may still be missing or misclassified.

Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Adamus Resource Assessment Inc.
Contact_Person: Dr. Paul Adamus
Contact_Position: Researcher
Contact_Address:
Address_Type: Mailing and physical address
Address: 6028 NW Burgundy Dr
City: Corvallis
State_or_Province: OR
Postal_Code: 97330
Contact_Voice_Telephone: (541) 737-7092
Contact_Electronic_Mail_Address: adamus7@comcast.net
Contact_Instructions: As PI on the grant for this project Paul Adamus will be the point person for future attribute additions and updates to this dataset.

Data_Set_Credit: Russell Scranton: Graduate student in the Marine Resource Management Program at Oregon State University, College of Oceanic and Atmospheric Sciences

Native_Data_Set_Environment: Microsoft Windows 2000 Version 5.0 (Build 2195) Service Pack 3; ESRI ArcCatalog 9.0.0.535

Data_Quality_Information:
Logical_Consistency_Report:
Delineations of wetland- nonwetland boundaries are believed to be generally and consistently accurate to within approximately 100 ft or less. Delineations of boundaries between classes within wetlands, and the labels assigned to these classes, are very approximate and most have not been ground-checked.

Completeness_Report: Water areas were delineated only for tidal channels lower than 23 feet above mean sea level and below the known head of tide.

Lineage:
Process_Step:
Process_Description: To develop this Data Set many existing resources were consulted and interpreted. These resources include USFWS National Wetland Inventory: the 1979 Data Set & 2004 rough draft Data Set were consulted, DLCD Oregon Estuary Plan Book's Estuarine Habitat Classification, Estuary Management Units & Shoreline Management Units Data Sets, NRCS SSURGO & STATSGO Hydric Soils Data Sets, DSL Local Wetland Inventories, 1972 Ownership and Filled Lands Inventory & 1986 Head of Tide Data Set, Tillamook NEP's Tidal Marsh Habitat Layer, NOAA's historic Coast Surveys & and their Salinity Field Maps (to establish salinity regimes).

Remote Sensing Data included 1:24,000 2001 Color IR Aerial Photographs:, 1:12,000 2002 Natural Color Aerial Photographs, 1:48,000 1986 Natural Color Aerial Photographs and Black & White Digital Ortho Quads.

USGS 30m Digital Elevation Models were incorporated for analyzing regional elevation and surficial geomorphology..

Process_Date: 20031010
Source_Used_Citation_Abbreviation:
\\Scranton_thesis\Maps\Tidal_Marsh\Geodatabase.mdb
Process_Step:
Process_Description: ArcGIS 8.2 was used for the development and delineation of the Data Set. To have an idea of where wetlands may exist a reference layer was created by selecting Existing Delineations by using 2 types of queries. The 1st was a Query by Attribute. For the NWI: codes that signified estuarine high and low marsh and palustrine emergent marsh habitat and lands that have been diked, filled or drained were selected. For the Estuary Plan Book: All attributes beginning with the code 2.5 were selected, these were estuarine, high and low tidal marsh, fresh water tidal wetlands and forested tidal wetlands.

The second query method selected attributes By Location. This query selected any attribute within 100 meters of known tidal waters for the NWI and Soils data. This action Acquired additional NWI Palustrine Wetlands and the forested wetlands near tidal waters And all hydric soils within 100 meters of tidal water ways.
Process_Date: 20040105
Source_Used_Citation_Abbreviation:
\\Scranton_thesis\Maps\Tidal_Marsh\Geodatabase.mdb
Process_Step:
Process_Description: To limit the scope of the project, tidal data sets and elevation data were used to aid in the delineation and classification of the wetlands. The NOAA salinity data was used to aid in distinctions between river-sourced and marine-sourced classifications. The USGS DEM was used to aid in classification based upon elevation. In most cases it was found that the head of tide reached to 23ft in elevation according to the DEM. However, there were errors with the DEM and the DSL data. This project mapped to predict the potential head of tide for regions that had been diked off where data may have suggested errors in the DEM or DSL data.
Process_Date: 20040205
Source_Used_Citation_Abbreviation:
\\Scranton_thesis\Maps\Tidal_Marsh\Geodatabase.mdb
Process_Step:
Process_Description: After the delineation was completed the NWI, Estuary Plan Book data, Hydric Soils data and the air photos were used to determine which classification would be designated for each wetland polygon.
Process_Date: 20040315
Source_Used_Citation_Abbreviation:
\\Scranton_thesis\Maps\Tidal_Marsh\Geodatabase.mdb
Process_Step:
Process_Description: Additional work by researcher was also incorporated into the project. Examples are the delineation for a study of Nehalem Bays West Island and the Siuslaw's Cox Island. In addition The Patricia Benner maps of Tillamook and the Coquille estuaries were consulted. Limitations of the existing data ranged from inconsistencies in Classification, Spatial resolution, Spatial extent, spatial accuracy and whether the date was up to date. Many source data sets (other than photos) were developed 25+ years ago leaving room for natural change of ground condition.
Process_Date: 20040415
Source_Used_Citation_Abbreviation:
\\Scranton_thesis\Maps\Tidal_Marsh\New_Personal_Geodatabase.mdb

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Spatial_Data_Organization_Information:
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  Horizontal_Coordinate_System_Definition:
    Planar:
      Map_Projection:
        Map_Projection_Name: Lambert Conformal Conic
        Lambert_Conformal_Conic:
          Standard_Parallel: 43.000000
          Standard_Parallel: 45.500000
          Longitude_of_Central_Meridian: -120.500000
          Latitude_of_Projection_Origin: 41.750000
          False_Easting: 1312336.000000
          False_Northing: 0.000000
      Planar_Coordinate_Information:
        Planar_Coordinate_Encoding_Method: coordinate pair
        Coordinate_Representation:
          Abscissa_Resolution: 0.002048
          Ordinate_Resolution: 0.002048
        Planar_Distance_Units: International Feet
    Geodetic_Model:
      Horizontal_Datum_Name: North American Datum of 1983
      Ellipsoid_Name: Geodetic Reference System 80
      Semi-major_Axis: 6378137.000000
      Denominator_of_Flattening_Ratio: 298.257222
Entity_and_Attribute_Information:
  Detailed_Description:
    Entity_Type:
      Entity_Type_Label: Tidal_Wetland.dbf
      Entity_Type_Definition: Shapefile Data Table
      Entity_Type_Definition_source: ESRI
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      Attribute_Label: OBJECTID
      Attribute_Definition: Internal feature number.
      Attribute_Definition_Source: ESRI
      Attribute_Domain_Values:
        Unrepresentable_Domain: Sequential unique whole numbers that
are automatically generated.
    Attribute:
      Attribute_Label: Shape
      Attribute_Definition: Feature geometry.
      Attribute_Definition_Source: ESRI
      Attribute_Domain_Values:
        Unrepresentable_Domain: Coordinates defining the features.
    Attribute:
      Attribute_Label: HGM_Class
      Attribute_Definition: Classification Code for Hydrogeomorphic
Assessment
      Attribute_Definition_Source: Hydrogeomorphic Assessment
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value: MSL
```

Enumerated_Domain_Value_Definition: Marine-sourced Low Tidal Marsh. These are tidal marshes that are inundated at least once daily during the majority of days during the growing season, and which are in portions of the lower estuary usually dominated by marine waters. They were labeled MSL. In most instances they were considered synonymous with polygons labeled E2EMN on NWI maps, and/or 2.5.11 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available.

Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Assessment

Enumerated_Domain:

Enumerated_Domain_Value: MSH

Enumerated_Domain_Value_Definition: Marine-sourced High Tidal Marsh. These are tidal marshes, also in the lower estuary, not meeting the MSL inundation criterion (i.e., are inundated less frequently). They were labeled MSH. In most instances they were considered synonymous with polygons labeled E2EMP on NWI maps, and/or 2.5.12 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available.

Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Assessment

Enumerated_Domain:

Enumerated_Domain_Value: RS

Enumerated_Domain_Value_Definition: River-sourced Tidal Wetland.. These are tidal marshes or tidal forested wetlands that experience cyclic water level fluctuations as a direct or indirect result of tides at least once during every annual growing season. They are located in the upper estuary, commonly along river channels with a consistently strong seaward flow. They include some undiked wetland polygons labeled by NWI as PEMR, PEMS, or PEMT, and/or hydric soils in river locations below the DSL-identified head of tide, and/or polygons labeled 2.5.13 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available. In some instances where channels are deeply incised it is doubtful that some polygons labeled as RS are truly tidal wetlands, because tidal range may be merely on the order of inches, incapable of flooding adjacent lands over natural levees. However, in other upriver settings channels are not incised and have the capability of being tidally inundated, but this cannot be determined from aerial photographs.

Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Assessment

Enumerated_Domain:

Enumerated_Domain_Value: PF

Enumerated_Domain_Value_Definition: Possible Tidal Forested Wetland (PF). This includes lands currently covered by woody vegetation that are suspected of experiencing tide-related inundation at least once annually, but for which definitive field data are lacking. This includes wetlands labeled E2F* or E2S* by the NWI, as well as wetlands that NWI labeled PSS* or PFO* and which adjoin tidal channels and apparently are not diked. It also includes wetlands coded 2.5.14* by ODFW in the Oregon Estuary Plan Book. These are mostly relict spruce swamps and willows existing near their physiological threshold for salinity. Many probably became established in tidal zones due to fresher hillslope seepage and/or due to presence of "nurse logs" that, due to elevated position above the marsh surface, provided a microenvironment subject to less-frequent inundation, thus facilitating germination and survival during their sensitive early years.

Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Assessment
Enumerated_Domain:
Enumerated_Domain_Value: W
Enumerated_Domain_Value_Definition: Water (W). This represents an improved hydrological layer, delineated to the edge of any upland vegetation or tidal wetland, whichever it adjoined or intersected. This was created as a byproduct of the tidal delineation of the tidal wetlands and is only shown where waterways are believed to be tidally influenced. Although most tidal channels were digitized at a scale finer than 1:1,000, most regions of the main estuary were digitized at a 1:2,000 scale. This is not a complete hydrology layer. Surely there were portions of many tidal channels that could not be detected from aerial photographs, and in numerous cases small tidal channels were too numerous to digitize within the time available for this project. In addition, non-tidal channels, tidal channels unassociated with tidal wetlands associated with them, and all non-tidal waters above 23 ft elevation were not mapped.
Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Assessment
Enumerated_Domain:
Enumerated_Domain_Value: F
Enumerated_Domain_Value_Definition: Fill (F). This includes lands that have been filled and/or compacted for human use and no longer function as a wetland. This includes dikes, dirt and paved roads, railroads, highways, gravel driveways, dredging spoils, golf courses marina jetties and buildings that are spatially connected to the attributes listed above. A few of these polygons may never have been tidal wetlands; such post-facto determinations are difficult to make without field data. Due to time constraints this layer is not complete and there are locations where infrastructure has not yet been classified as filled lands. The DSL Inventory of Filled Lands was consulted, as was the Corps of Engineers permits database. From these it was apparent that most fills identified by these sources are shown as such on this map, but information from the sources was not applied systematically in creating the map. Also, not all dikes could be identified with the imagery used and therefore this map should not be used as an inventory of diked marshes.
Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Assessment
Enumerated_Domain:
Enumerated_Domain_Value: RCA
Enumerated_Domain_Value_Definition: "Restoration consideration areas" (RCAs) were defined as upland or non-tidal areas that might deserve closer scrutiny as possible candidates for restoration of tidal circulation, pending landowner involvement. These areas were identified based solely on coarse-scale geotechnical information from available data sets. No on-site feasibility investigations were conducted, and sociopolitical factors were not considered. These are generally lands that are diked or may have been partially filled or ditched for agricultural or commercial purposes. An unknown portion of the RCAs are palustrine wetlands or riparian uplands that never experienced tidal flooding, due to naturally-formed barriers.
Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Assessment
Attribute:

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      Attribute_Label: Notes
      Attribute_Definition: Digitization notes related to polygon
      Attribute_Definition_Source: Russell Scranton, MRM project
      Attribute_Domain_Values:
        Unrepresentable_Domain: Positive real numbers that are
automatically generated.
    Attribute:
      Attribute_Label: Site_Name
      Attribute_Definition: Unofficial name used to identify water body
or wetland
      Attribute_Definition_Source: Russell Scranton, MRM project
      Attribute_Domain_Values:
        Unrepresentable_Domain: Character Field.
    Attribute:
      Attribute_Label: Estuary
      Attribute_Definition: Oregon Estuary Name
      Attribute_Definition_Source: Oregon Estuary Plan Book
      Attribute_Domain_Values:
        Unrepresentable_Domain: Character Field.
    Attribute:
      Attribute_Label: Elevation
      Attribute_Definition: Relative elevation of polygon (Left blank
pending future fieldwork / contact Paul Adamus for more information)
      Attribute_Definition_Source: Digital Elevation Model / Fieldwork
      Attribute_Domain_Values:
        Unrepresentable_Domain: Character Field.
    Attribute:
      Attribute_Label: Verified
      Attribute_Definition: Validation of classification Validated by
wetland specialist or state official (Left blank pending future
fieldwork / contact Paul Adamus for more information)
      Attribute_Definition_Source: Hydrogeomorphic Assessment
      Attribute_Domain_Values:
        Unrepresentable_Domain: Character Field.
    Attribute:
      Attribute_Label: Ecological_Integrity
      Attribute_Definition: Rating value to be determined for
ecological integrity of individual wetland (Left blank pending future
fieldwork / contact Paul Adamus for more information)
      Attribute_Definition_Source: Hydrogeomorphic Model for Wetland
Classification
      Attribute_Domain_Values:
        Unrepresentable_Domain: Numeric Field (intended to eventually
hold a coded rating of 1-5)
    Attribute:
      Attribute_Label: Restoration_Potential
      Attribute_Definition: Rating value to be determined for
restoration potential of individual wetland (Left blank pending future
fieldwork / contact Paul Adamus for more information)
      Attribute_Definition_Source: Hydrogeomorphic Model for Wetland
Classification
      Attribute_Domain_Values:
        Unrepresentable_Domain: Numeric Field (intended to eventually
hold a coded rating of 1-5)
    Attribute:
      Attribute_Label: Classification
      Attribute_Definition: Hydrogeomorphic Assessment Classification
```

Attribute_Definition_Source: HGM
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: Restoration Consideration Area
Enumerated_Domain_Value_Definition: "Restoration consideration areas" (RCAs) were defined as upland or non-tidal areas that might deserve closer scrutiny as possible candidates for restoration of tidal circulation, pending landowner involvement. These areas were identified based solely on coarse-scale geotechnical information from available data sets. No on-site feasibility investigations were conducted, and sociopolitical factors were not considered. These are generally lands that are diked or may have been partially filled or ditched for agricultural or commercial purposes. An unknown portion of the restoration consideration areas (RCAs) are palustrine wetlands or riparian uplands that never experienced tidal flooding, due to naturally-formed barriers.
Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Model for Wetland Classification
Enumerated_Domain:
Enumerated_Domain_Value: Marine Sourced Low Tidal Wetland
Enumerated_Domain_Value_Definition: Marine-sourced Low Tidal Marsh. These are tidal marshes that are inundated at least once daily during the majority of days during the growing season, and which are in portions of the lower estuary usually dominated by marine waters. They were labeled MSL. In most instances they were considered synonymous with polygons labeled E2EMN on NWI maps, and/or 2.5.11 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available.
Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Model for Wetland Classification
Enumerated_Domain:
Enumerated_Domain_Value: Marine Sourced High Tidal Wetland
Enumerated_Domain_Value_Definition: Marine-sourced High Tidal Marsh. These are tidal marshes, also in the lower estuary, not meeting the Marine Sourced Low Tidal Wetland inundation criterion (i.e., are inundated less frequently). They were labeled MSH. In most instances they were considered synonymous with polygons labeled E2EMP on NWI maps, and/or 2.5.12 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available.
Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Model for Wetland Classification
Enumerated_Domain:
Enumerated_Domain_Value: River Sourced Tidal Wetland
Enumerated_Domain_Value_Definition: River-sourced Tidal Wetland. These are tidal marshes or tidal forested wetlands that experience cyclic water level fluctuations as a direct or indirect result of tides at least once during every annual growing season. They are located in the upper estuary, commonly along river channels with a consistently strong seaward flow. They include some undiked wetland polygons labeled by NWI as PEMR, PEMS, or PEMT, and/or hydric soils in river locations below the DSL-identified head of tide, and/or polygons labeled 2.5.13 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available. In some instances where channels are deeply incised it is doubtful that some polygons labeled as RS are truly tidal wetlands, because tidal range may be merely on the order of inches, incapable of flooding adjacent lands over natural levees. However, in other upriver settings channels are not incised and have the capability

of being tidally inundated, but this cannot be determined from aerial photographs.

Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Model for Wetland Classification

Enumerated_Domain:

Enumerated_Domain_Value: Potential Forested Tidal Wetland

Enumerated_Domain_Value_Definition: Potential Tidal Forested Wetland (PF). This includes lands currently covered by woody vegetation that are suspected of experiencing tide-related inundation at least once annually, but for which definitive field data are lacking. This includes wetlands labeled E2F* or E2S* by the NWI, as well as wetlands that NWI labeled PSS* or PFO* and which adjoin tidal channels and apparently are not diked. It also includes wetlands coded 2.5.14* by ODFW in the Oregon Estuary Plan Book. These are mostly relict spruce swamps and willows existing near their physiological threshold for salinity. Many probably became established in tidal zones due to fresher hillslope seepage and/or due to presence of "nurse logs" that, due to elevated position above the marsh surface, provided a microenvironment subject to less-frequent inundation, thus facilitating germination and survival during their sensitive early years.

Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Model for Wetland Classification

Enumerated_Domain:

Enumerated_Domain_Value: Fill

Enumerated_Domain_Value_Definition: Fill (F). This includes lands that have been filled and/or compacted for human use and no longer function as a wetland. This includes dikes, dirt and paved roads, railroads, highways, gravel driveways, dredging spoils, golf courses marina jetties and buildings that are spatially connected to the attributes listed above. A few of these polygons may never have been tidal wetlands; such post-facto determinations are difficult to make without field data. Due to time constraints this layer is not complete and there are locations where infrastructure has not yet been classified as filled lands. The DSL Inventory of Filled Lands was consulted, as was the Corps of Engineers permits database. From these it was apparent that most fills identified by these sources are shown as such on this map, but information from the sources was not applied systematically in creating the map. Also, not all dikes could be identified with the imagery used and therefore this map should not be used as an inventory of diked marshes.

Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Model for Wetland Classification

Enumerated_Domain:

Enumerated_Domain_Value: Water

Enumerated_Domain_Value_Definition: Water (W). This represents an improved hydrological layer, delineated to the edge of any upland vegetation or tidal wetland, whichever it adjoined or intersected. This was created as a byproduct of the tidal delineation of the tidal wetlands and is only shown where waterways are believed to be tidally influenced. Although most tidal channels were digitized at a scale finer than 1:1,000, most regions of the main estuary were digitized at a 1:2,000 scale. This is not a complete hydrology layer. Surely there were portions of many tidal channels that could not be detected from aerial photographs, and in numerous cases small tidal channels were too numerous to digitize within the time available for this project. In addition, non-tidal channels, tidal channels

unassociated with tidal wetlands associated with them, and all non-tidal waters above 23 ft elevation were not mapped.
          Enumerated_Domain_Value_Definition_Source: Hydrogeomorphic Model for Wetland Classification
    Attribute:
      Attribute_Label: Acres
      Attribute_Definition: Area of polygon in acres.
      Attribute_Definition_Source: Computer calculated value
      Attribute_Domain_Values:
        Unrepresentable_Domain: Numeric Field
    Attribute:
      Attribute_Label: Native_Marsh_Plants
      Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
      Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
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      Attribute_Label: Production_Aboveground_Organic_Matter.
      Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
      Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
      Attribute_Domain_Values:
        Unrepresentable_Domain: Numeric Field (intended to eventually hold a coded rating of 1-5)
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      Attribute_Label: Stabilization_Processing_Sediment_Phosphorus_Metals
      Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
      Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
      Attribute_Domain_Values:
        Unrepresentable_Domain: Numeric Field (intended to eventually hold a coded rating of 1-5)
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      Attribute_Label: Detention_Processing_Carbon_Nitrogen
      Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
      Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
      Attribute_Domain_Values:
        Unrepresentable_Domain: Numeric Field (intended to eventually hold a coded rating of 1-5)
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      Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)

Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
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Attribute:
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Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
Attribute_Domain_Values:
Unrepresentable_Domain: Numeric Field (intended to eventually hold a coded rating of 1-5)
Attribute:
Attribute_Label: Anadromous_Fish_Habitat
Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
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Unrepresentable_Domain: Numeric Field (intended to eventually hold a coded rating of 1-5)
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Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
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Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
Attribute_Domain_Values:
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Attribute:
Attribute_Label: Nekton_Feeding_Birds_Habitat
Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
Attribute_Domain_Values:
Unrepresentable_Domain: Numeric Field (intended to eventually hold a coded rating of 1-5)
Attribute:
Attribute_Label: Ducks_Geese_Habitat

Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
Attribute_Domain_Values:
Unrepresentable_Domain: Numeric Field (intended to eventually hold a coded rating of 1-5)
Attribute:
Attribute_Label: Shorebird_Habitat
Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
Attribute_Domain_Values:
Unrepresentable_Domain: Numeric Field (intended to eventually hold a coded rating of 1-5)
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Attribute_Definition: Hydrogeomorphic Assessment Function Value (Left blank pending future fieldwork / contact Paul Adamus for more information)
Attribute_Definition_Source: Hydrogeomorphic Model for Wetland Classification
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Attribute_Definition: Length of feature in internal units.
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Attribute_Definition: Area of feature in internal units squared.
Attribute_Definition_Source: Computer generated
Attribute_Domain_Values:
Unrepresentable_Domain: Numeric Field
Overview_Description:
Entity_and_Attribute_Overview: As an interpretation of data this delineation is not perfect. Although this data set was developed at a greater resolution there are areas that represent concern for errors in the delineation. Interpretation of the aerial photos were made where Shadows, Image Contrast and Brightness, or Canopy Cover obscured the true width of the tidal channels or fringe habitat. The level of the tides may impact the interpretation where in some cases photos taken at high tide could not accurately delineate the low marsh fringe habitat. Additionally, blurring or Pixilization and time constraints limited final delineation of many small scale channels. The delineation of transition habitats in many cases are accurately based on field data and imagery, but in some cases the transition from one classification to another may be subject to change with Additional ground work. Or in some cases habitat may be found to be non tidal.
Additional work is also needed for the Potential Forested classification, which suffered from our

inability to accurately interpret ground hydrology through the canopy. Further work will determine if the classification is a Tidal Forested Wetland, a Forested Wetland or Forested Upland. In other cases alterations to the environment played a significant role in the classification (eg. Diked Areas). The upper watershed posed the greatest challenge with the inability to see the characteristics of levees and the channel bank morphology, or lack of knowledge of how much flux in tidal elevation occurred. For the majority of the upper watershed quick ground surveys of bank slope, elevation of tidal inundation and vegetation will tell if the delineation of restoration consideration areas could be converted to non tidal, or Tidal wetland. The development of this data set adheres to the precautionary principle, where it was felt that under uncertain circumstances it was better to include data and classify it f
or later review rather than to omit the data.

```
    Entity_and_Attribute_Detail_Citation: N/A
Distribution_Information:
  Distributor:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: Oregon Coastal Atlas
        Contact_Person: Tanya Haddad
      Contact_Position: Atlas Administrator
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 800 NE Oregon Street #18
        City: Portland
        State_or_Province: OR
        Postal_Code: 97232
        Country: U.S.A.
      Contact_Voice_Telephone: (503) 731-4065
      Contact_Facsimile_Telephone: (503) 731-4068
      Contact_Electronic_Mail_Address: tanya.haddad@oregonstate.edu
      Hours_of_Service: 8:30-5:30, M-F, PST
  Resource_Description: Tidal Wetlands of Oregon's Coastal Watersheds
  Distribution_Liability:
```

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  Custom_Order_Process: Download from http://www.coastalatlas.net/
Metadata_Reference_Information:
  Metadata_Date: 20040805
  Metadata_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: Oregon State University, C.O.A.S Marine
Resource Management Program
        Contact_Person: Russell Scranton
      Contact_Position: Graduate Student
      Contact_Address:
        Address_Type: Mailing and physical address
        Address: 104 Ocean Admin. Building, Oregon State University
        City: Corvallis
        State_or_Province: OR
        Postal_Code: 97331-5033
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Contact_Voice_Telephone: (541) 737-8268
Contact_Electronic_Mail_Address: rscranto@coas.oregonstate.edu
Contact_Instructions: My ability to access this data ends September 2004. I am no longer funded to work on this project, please contact state agencies with this information, and they may be able to help with requests.
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Extensions:
Online_Linkage: http://www.esri.com/metadata/esriprof80.html
Profile_Name: ESRI Metadata Profile

Appendix B: Outline of Federal and State Agency Jurisdiction, Management, Regulations and Tools for Estuarine Resources:

Federal Agencies:

National Oceanic and Atmospheric Administration

- NOAA Fisheries:
    1. The management of the threatened Oregon Coastal Coho Evolutionary Significant Unit
    2. Defining essential fish habitat for preservation of this species.
- National Estuarine Research Reserve at South Slough in Charleston is involved with marsh restoration science and management. "A natural laboratory dedicated to the scientific understanding of estuaries of the coast of Oregon"
- National Estuary Program of Tillamook and the Columbia River involved with marsh restoration science and management. "The Program is finding ways to protect both the area's natural resources and its natural-resource-dependant economy."
- Oregon Sea Grant: **"** *to increase the understanding, assessment, development, utilization and conservation of the nation's ocean and coastal resources."*

U.S. Environmental Protection Agency

- Jurisdiction and management of Clean Water Act
    i. Section 303d: Point Source pollution Total Maximum Daily Load (TMDL) management

ii. Section 319: Non Point Source Pollution Management

iii. Section 401: wetland management

iv. Section 404: Regional or nationwide general permits for removal & fill

- Environmental Monitoring and Assessment Program

U.S. Department of the Army; Army Corp of Engineers

- Clean Water Act: Section 404: Regional or nationwide general permits for removal & fill
- Rivers & Harbors Act

U.S. Fish and Wildlife Service (Department of the Interior) manages the existing

- National Wetland Inventory, existing management tool for wetlands
- Endangered Species Act Coastal Coho Habitat Conservation Plans
- National Wildlife Refuge management: Bandon Marsh, Siletz Bay and Nestucca Bay

U.S. Department of Agriculture Natural Resource Conservation Service

- Conservation Reserve Enhancement Program (CRP)
- Environmental Quality Incentives Program (EQIP)
- The Wetlands Reserve Program (WRP)

Federal Emergency Management Agency:

- Mitigation Division
- Federal Flood Insurance Plan

U.S. Bureau of Land Management

- Federal Land stewardship and management

U.S. Department of Agriculture Forest Service

- The Umpqua & Siuslaw National Forest land stewardship and management
- Aquaculture management

State Agencies:

Department of State Lands:

- Removal/Fill regulations and permitting for waters and wetlands
- National Estuarine Research Reserve at South Slough
- Agency Measure # 7: Estuarine Wetland Restoration Regulation

Oregon Department of Land Conservation and Development:

- Oregon's Statewide Planning Goals & Guidelines
- Estuary Plans

Oregon Department of Environmental Quality:

- State CWA management, 9401 certification

Oregon Department of Fish and Wildlife

- Restoration management of estuarine habitat.

Oregon Parks & Recreation Department:

- Stewardship of estuarine tidal wetlands in State Parks

Oregon Department of Forestry:

- Stewardship of tidal wetlands in State's forest lands.

Appendix C: Spatial Analysis Tables

Table 1: Existing & Potential Tidal Wetland Areas (Acres) by Classification & Total Area by Estuary

Estuary	Marine Sourced Low Tidal Wetland	Marine Sourced High Tidal Wetland	Restoration Consideration Area	Potential Forested Tidal Wetland	River Sourced Tidal Wetland	Fill	Water	Total
Necanicum River	89.44	80.54	101.61	35.30	0.39	0.23	291.19	598.69
Ecola Creek	0.51	7.85	5.40	34.67	0.00	0.55	11.76	60.75
Nehalem Bay	307.11	327.71	2211.77	516.57	72.66	241.67	2245.05	5922.54
Tillamook Bay	687.80	444.09	8801.08	655.67	33.65	894.75	8735.09	20252.13
Netarts Bay	462.02	150.02	74.26	57.60	8.99	8.27	502.22	1263.39
Sand Lake	135.92	129.86	6.19	7.46	3.05	0.58	2394.78	2677.85
Nestucca Bay	149.56	63.68	3139.18	133.85	7.78	52.10	1144.39	4690.54
Salmon River	302.59	215.41	214.52	57.14	76.66	35.67	275.73	1177.71
Siletz Bay	215.97	379.84	756.36	248.96	31.65	260.26	1631.18	3524.23
Depoe Bay	0.00	0.21	0.71	1.34	0.00	6.46	10.76	19.49
Yaquina Bay	386.62	232.71	1416.32	213.50	323.69	651.01	4358.66	7582.52
Beaver Creek	2.20	94.68	187.26	19.89	0.00	0.52	32.08	336.63
Alsea Bay	144.30	434.03	394.75	128.86	117.85	146.79	2448.31	3814.89
Siuslaw River	919.95	259.44	1892.86	213.57	187.66	584.28	2875.03	6932.78
Umpqua River	456.22	778.09	3048.35	592.02	311.42	1278.01	8006.85	14470.97
Siltcoos River	0.72	13.87	9.08	0.00	3.40	0.05	31.98	59.10
Ten Mile Creek	25.64	53.86	14.54	0.30	5.70	0.00	58.52	158.55
Coos Bay	1140.69	660.11	6878.40	326.92	158.03	2475.31	12672.67	24312.12
Coquille River	145.39	201.41	13560.98	578.96	77.60	701.24	2159.69	17425.26
Two Mile Creek	0.51	3.83	2.75	16.14	2.12	0.00	12.54	37.89
New River	67.80	138.27	1132.57	100.69	4.19	5.38	302.59	1751.51
Sixes River	0.89	5.11	240.98	0.67	3.39	5.46	102.58	359.08
Elk River	1.32	13.06	214.46	21.63	4.08	13.32	86.52	354.39
Euchre Creek	6.18	0.00	19.08	2.19	0.19	20.89	25.74	74.27
Rogue River	29.50	8.81	95.39	112.97	0.99	32.22	631.12	910.99
Pistol River	0.00	4.30	20.23	19.16	0.00	9.42	33.81	86.93
Chetco River	0.17	2.33	0.00	8.60	3.84	6.35	175.81	197.09
Winchuck River	1.54	0.00	99.32	0.00	1.77	0.00	32.93	135.55
Total	5680.53	4703.13	44538.41	4104.61	1440.77	7430.79	51289.58	119187.82

Table 2: Percentage of Habitat by Classification for all Existing, Potential and Filled Habitat by Estuary

Estuary	Marine Sourced Low Tidal Wetland	Marine Sourced High Tidal Wetland	River Sourced Tidal Wetland	Restoration Consideration Area	Potential Forested Tidal Wetland	Fill
Necanicum River	29.08	26.19	0.13	33.04	11.48	0.07
Ecola Creek	1.04	16.03	0.00	11.02	70.77	1.13
Nehalem Bay	8.35	8.91	1.98	60.14	14.05	6.57
Tillamook Bay	5.97	3.86	0.29	76.42	5.69	7.77
Netarts Bay	60.70	19.71	1.18	9.76	7.57	1.09
Sand Lake	48.02	45.88	1.08	2.19	2.63	0.20
Nestucca Bay	4.22	1.80	0.22	88.52	3.77	1.47
Salmon River	33.55	23.88	8.50	23.78	6.33	3.95
Siletz Bay	11.41	20.07	1.67	39.95	13.15	13.75
Depoe Bay	0.00	2.42	0.00	8.13	15.41	74.04
Yaquina Bay	11.99	7.22	10.04	43.93	6.62	20.19
Beaver Creek	0.72	31.09	0.00	61.49	6.53	0.17
Alsea Bay	10.56	31.76	8.62	28.89	9.43	10.74
Siuslaw River	22.67	6.39	4.62	46.65	5.26	14.40
Umpqua River	7.06	12.04	4.82	47.16	9.16	19.77
Siltcoos River	2.66	51.14	12.54	33.49	0.00	0.17
Ten Mile Creek	25.63	53.84	5.70	14.53	0.30	0.00
Coos Bay	9.80	5.67	1.36	59.10	2.81	21.27
Coquille River	0.95	1.32	0.51	88.83	3.79	4.59
Two Mile Creek	2.02	15.11	8.38	10.85	63.65	0.00
New River	4.68	9.54	0.29	78.17	6.95	0.37
Sixes River	0.35	1.99	1.32	93.95	0.26	2.13
Elk River	0.49	4.88	1.52	80.06	8.08	4.97
Euchre Creek	12.73	0.00	0.40	39.32	4.51	43.04
Rogue River	10.54	3.15	0.35	34.08	40.36	11.51
Pistol River	0.00	8.09	0.00	38.09	36.07	17.74
Chetco River	0.80	10.92	18.06	0.00	40.41	29.82
Winchuck River	1.50	0.00	1.72	96.78	0.00	0.00

Table 3: Marsh Habitat: Cumulative Area of Existing Marine Tidal Marsh (MSH + MSL), Cumulative Area of Existing Tidal Marsh (MSH + MSL+ RS), Cumulative Area of Restoration Consideration Area and Filled Lands and the Percentage of Existing and lost Tidal Marsh for each Estuary.

Estuary	Estuarine Marsh Acres(MSH+MSL)	Tidal Marsh Acres (RS+MSL+MSH)	RCA & Filled Tidal Acres	Percent RCA & Filled	Percent Existing
Necanicum River	169.97	170.37	101.84	37.41	62.59
Ecola Creek	8.37	8.37	5.95	41.57	58.43
Nehalem Bay	634.83	707.48	2453.43	77.62	22.38
Tillamook Bay	1131.89	1165.54	9695.83	89.27	10.73
Netarts Bay	612.05	621.04	82.53	11.73	88.27
Sand Lake	265.78	268.84	6.77	2.46	97.54
Nestucca Bay	213.24	221.02	3191.28	93.52	6.48
Salmon River	517.99	594.66	250.19	29.61	70.39
Siletz Bay	595.81	627.47	1016.62	61.83	38.17
Depoe Bay	0.21	0.21	7.17	97.14	2.86
Yaquina Bay	619.33	943.02	2067.33	68.67	31.33
Beaver Creek	96.88	96.88	187.78	65.97	34.03
Alsea Bay	578.34	696.18	541.54	43.75	56.25
Siuslaw River	1179.38	1367.04	2477.14	64.44	35.56
Umpqua River	1234.31	1545.73	4326.36	73.68	26.32
Siltcoos River	14.59	17.99	9.13	33.66	66.34
Ten Mile Creek	79.50	85.20	14.54	14.58	85.42
Coos Bay	1800.79	1958.82	9353.71	82.68	17.32
Coquille River	346.80	424.40	14262.22	97.11	2.89
Two Mile Creek	4.34	6.46	2.75	29.85	70.15
New River	206.07	210.26	1137.96	84.40	15.60
Sixes River	6.00	9.39	246.43	96.33	3.67
Elk River	14.38	18.45	227.78	92.51	7.49
Euchre Creek	6.18	6.37	39.97	86.25	13.75
Rogue River	38.31	42.58	127.61	76.46	23.54
Pistol River	4.30	4.30	29.66	87.34	12.66
Chetco River	2.49	6.34	6.35	50.03	49.97
Winchuck River	1.54	3.31	99.32	96.78	3.22
Total	10383.67	11827.71	51969.20	NA	NA

Table 4: Aquatic habitat available to fish on average high tides.

Estuary	Water	Total Aquatic Habitat (MSL+ Water)	Total Tidal Habitat	Percent Aquatic Habitat	Percent Non Aquatic Habitat
Necanicum River	291.19	380.62	598.69	48.64	51.36
Ecola Creek	11.76	12.28	60.75	19.37	80.63
Nehalem Bay	2245.05	2552.17	5908.06	38.00	62.00
Tillamook Bay	8735.09	9422.89	20124.07	43.41	56.59
Netarts Bay	502.22	964.24	1255.70	40.00	60.00
Sand Lake	2394.78	2530.70	2681.18	89.32	10.68
Nestucca Bay	1144.39	1293.95	4690.54	24.40	75.60
Salmon River	275.73	578.31	1177.71	23.41	76.59
Siletz Bay	1631.18	1847.16	3486.19	46.79	53.21
Depoe Bay	10.76	10.76	8.73	123.35	-23.35
Yaquina Bay	4358.66	4745.28	7582.52	57.48	42.52
Beaver Creek	32.08	34.28	336.63	9.53	90.47
Alsea Bay	2448.31	2592.61	3789.62	64.61	35.39
Siuslaw River	2875.03	3794.98	6932.78	41.47	58.53
Umpqua River	8006.85	8463.07	14162.40	56.54	43.46
Siltcoos River	31.98	32.71	59.10	54.12	45.88
Ten Mile Creek	58.52	84.15	158.55	36.91	63.09
Coos Bay	12672.67	13813.35	23483.64	53.96	46.04
Coquille River	2159.69	2305.08	17425.26	12.39	87.61
Two Mile Creek	12.54	13.05	37.89	33.09	66.91
New River	302.59	370.39	1291.92	23.42	76.58
Sixes River	102.58	103.47	359.08	28.57	71.43
Elk River	86.52	87.83	354.39	24.41	75.59
Euchre Creek	25.74	31.92	74.27	34.65	65.35
Rogue River	631.12	660.62	892.66	70.70	29.30
Pistol River	33.81	33.81	86.93	38.89	61.11
Chetco River	175.81	175.98	190.75	92.17	7.83
Winchuck River	32.93	34.46	135.55	24.29	75.71

Table 5: Comparison of the Tidal Wetland Geodatabase's Area of Tidal Wetlands to the Oregon State of the Environment Report 2000(SER) Results.

Estuary	HGM Existing Tidal Wetland (Acres)	SOER Existing Tidal Wetlands (Acres)	HGM Diked & Filled Land (Acres)	SOER Diked & Filled Land (Acres)	Difference HGM-SOER Altered Wetlands (Acres)	Difference HGM-SOER Existing Wetlands (Acres)	SOER Percent Existing Tidal Wetland	HGM Percent Existing Tidal Wetland
Necanicum River	170.37	132	101.84	15	86.84	38.37	90.00%	66.88%
Nehalem Bay	707.48	524	2453.43	1571	882.43	183.48	25.00%	33.29%
Tillamook Bay	1165.54	884	9695.83	3274	6421.83	281.54	21.00%	15.81%
Netarts Bay	621.04	228	82.53	16	66.53	159.04	93.00%	89.16%
Sand Lake	268.84	462	6.77	9	-2.23	40.84	98.00%	97.61%
Nestucca Bay	221.02	205	3191.28	2160	1031.28	16.02	9.00%	10.01%
Salmon River	594.66	238	250.19	313	-62.81	356.66	43.00%	72.26%
Siletz Bay	627.47	274	1016.62	401	615.62	353.47	41.00%	46.30%
Yaquina Bay	943.02	621	2067.33	1493	574.33	322.02	29.00%	35.87%
Alsea Bay	696.18	460	541.54	665	-123.46	236.18	41.00%	60.37%
Siuslaw River	1367.04	746	2477.14	1256	1221.14	621.04	37.00%	38.95%
Umpqua River	1545.73	1201	4326.36	1218	3108.36	344.73	50.00%	33.07%
Coos Bay	1958.82	1727	9353.71	3360	5993.71	231.82	34.00%	19.64%
Coquille River	424.4	276	14262.22	4600	9662.22	148.4	6.00%	6.57%
Rogue River	42.58	44	127.61	30	97.61	-1.42	59.00%	54.40%
Chetco River	6.34	4	6.35	5	1.35	2.34	44.00%	70.18%
Total	11360.53	8026	49960.75	20386	29574.75	3334.53	18.50%	28%

Table 6: Percentages of total habitat for all of Oregon of Cumulative Area of Existing Tidal Wetland (MSH + MSL+ RS), Cumulative Area of Filled and Potential Tidal Wetland and the Cumulative Area of Potential Forested Tidal Wetland. Also a Comparison Marsh Habitat of Percentage of Existing Marsh Habitat to Potential and Filled Marsh Habitat

Percent Tidal Wetland	Percent RCA & Filled	Percent Potential Forested Wetland	Percent Existing Tidal Marsh	Percent Marsh Filled + RCA
17.41	76.54	6.05	18.54	81.46

Appendix D: State of the Environment Estuary Tidal Marsh Habitat Assessment Results.

Estuary	Actual 1970 Area (acres)[1]		Diked or Filled	Estimated 1870 Area (acres)[2]		Percent Change (1870-1970)	
	Tidal Wetland	Total Estuary	Tidal Wetland[3]	Tidal Wetland	Total Estuary	Tidal Wetland	Total Estuary
Columbia	16,150	119,220	30,050	46,200	149,270	-65%	-20%
Necanicum	132	451	15	147	466	-10%	-3%
Nehalem	524	2,749	1,571	2,095	4,320	-75%	-36%
Tillamook	884	9,216	3,274	4,158	12,490	-79%	-26%
Netarts	228	2,743	16	244	2,759	-7%	-1%
Sand Lake	462	897	9	471	906	-2%	-1%
Nestucca	205	1,176	2,160	2,365	3,336	-91%	-65%
Salmon	238	438	313	551	751	-57%	-42%
Siletz	274	1,461	401	675	1,862	-59%	-22%
Yaquina	621	4,349	1,493	2,114	5,842	-71%	-26%
Alsea	460	2,516	665	1,125	3,181	-59%	-21%
Siuslaw	746	3,060	1,256	2,002	4,316	-63%	-29%
Umpqua	1,201	6,544	1,218	2,419	7,762	-50%	-16%
Coos Bay	1,727	3,348	3,360	5,087	16,708	-66%	-20%
Coquille	276	1,082	4,600	4,876	5,682	-94%	-81%
Rogue	44	880	30	74	910	-41%	-3%
Chetco	4	171	5	9	176	-56%	-3%
TOTAL	24,176	160,301	50,436	74,612	220,737	-68%	-24%

Appendix E: Map Special Note

"This map does not show all wetlands or waters. It shows intertidal emergent wetlands, possible intertidal forested wetlands, and non-tidal areas termed Restoration Consideration Areas that might have any degree of geotechnical potential for restoration of tidal circulation as suggested by available spatial data. Many are former tidal wetlands. This map is based on interpretations of May 2002 (1:24,000 scale) unrectified color infrared aerial photographs, limited field observations and peer review, as well as maps of the National Wetland Inventory (NWI), Oregon Estuary Plan Book, and other sources. Refinements or additions to existing NWI maps consist of (a) increased detail in boundaries of intertidal emergent and intertidal forested wetlands, (b) labeling of these wetland types to conform with a Hydrogeomorphic classification described in the metadata file, (c) deletion of wetlands that did not fit these categories, (d) labeling of some areas as Restoration Consideration Areas, (e) improved depiction of tidal creeks within some wetlands using unrectified digital images of the aerial photographs.

The boundaries shown, and the labels assigned, are approximations and should be field verified. Some regulatory agencies with jurisdiction over wetlands may define, delimit, and classify wetlands in a manner different than depicted here. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate government agencies concerning regulatory programs and proprietary jurisdictions that may affect such activities."

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South Coast Watershed Council

Lower Rogue Watershed Council

Midcoast Watershed Council