Puget Sound

Northern Skagit County Bays and Shoreline Habitat Conservation and Restoration Blueprint 2005 Update

A Plan to Restore and Protect the Habitats and Heritage of the Northern Bays of Skagit County

Prepared for the Skagit County Marine Resources Committee

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Skagit County Marine Resources Committee

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Executive Summary

While there is now a significant body of information collected for nearshore habitat in Puget Sound, it has not been organized or analyzed in such a way to make it useful to identify specific conservation and restoration targets. To address this critical need, the Skagit County Marine Resources Committee (MRC) and People For Puget Sound developed the Bays Blueprint. This tool gathers together the available information in an organized fashion, incorporates the information into a GIS-based spatial nearshore habitat analysis, and prioritizes specific on-the-ground actions and projects based on biological information, social, political, and economic constraints. The strength of the Skagit Bays Blueprint project lies in the partnerships developed in the feasibility study phase that can lead to on-the-ground projects. The overall methodology includes four phases:

- Compile and organize existing datasets on nearshore habitat conditions and marine resources in the project area and provide available documentation for each dataset.

- Inventory the nearshore habitat using oblique shoreline photos (WA Department of Ecology, 2000).

- Analyze and evaluate habitat conditions based on their ability to support forage fish, juvenile salmonid use of the nearshore habitat, aquatic vegetation, shorebird use of the nearshore, and sediment supply to the nearshore, and apply criteria for prioritizing nearshore habitat restoration and conservation areas.

- Apply feasibility criteria based on social, political, and economic constraints that identify a short list of possible conservation and restoration projects. These projects are summarized in site-reports that provide rationale for choosing these projects, benefits of these projects, and anticipated "hurdles" to site conservation/restoration actions. People For Puget Sound and the Skagit MRC will present these findings to property owners and land managers to identify and scope at least two projects for conservation or restoration actions in 2004 and 2005.

The important first step in the Bays Blueprint project was gathering key geographic information systems (GIS) datasets and compiling a database of all datasets characterizing nearshore habitats. We added to that existing knowledge base by using well-trained volunteers to survey shorelines using the Washington Department of Ecology's Shoreline Oblique Photographs from 2000. Each oblique photograph captures a section of shoreline approximately 800 to 1000 feet long during extreme low daytime tides.

We synthesized all the collected data from both the compiled GIS datasets *and* the Nearshore Photo Inventory, using a series of conceptual models that were selected from the Rapid Shoreline Inventory (RSI) Analysis and redeveloped to encompass new information gathered by this project. These models describe the relationship between habitat features and indicators of habitat quality. The five models characterized nearshore habitat for:

- Forage fish spawning (species group)
- Juvenile salmonid use of nearshore (species group)
- Aquatic vegetation (species group/ecosystem process)
- Sediment Supply to the nearshore (ecosystem process)
- Birds that depend on Marine Shorelines and Features (species group)

The resulting data, restoration and conservation scores, and the spatial location of each photo point can be found in the data tables in Appendix G, and are displayed visually in the Map Book. A percentile-ranking scheme was created to display and present the model results visually in maps 44 through 55. This aided in systematically ranking and prioritizing the analysis results.

The overall maps and model maps provided the MRC sub-committee with tools to visually identify areas with the highest biological importance along their shorelines. In 2004, the MRC sub-committee with the help of People For Puget Sound was able to select 21 sites from the 343 original points to be assessed for potential actions to be taken.

The aerial oblique photographs and other on-the-ground data, such as the Battelle report recommendations and the data results from the models, guided People For Puget Sound in proposing actions to be taken at each site and developing potential projects. The MRC sub-committee met with People For Puget Sound to evaluate the multiple actions proposed at the 21 sites and to begin project development. Local knowledge and diverse expertise shared though exchanges between the MRC sub-committee and People For Puget Sound made the process of assigning feasibility scores exceedingly more complete and accurate.

The MRC sub-committee's deliberation of the 21 prioritized sites with multiple proposed actions resulted in 24 potential projects. People For Puget Sound produced Site Reports for each of these potential projects, which can be found in **Appendix F**. The criteria questions of the feasibility worksheets were designed to detect a discernable difference in the scoring of the potential projects, giving the MRC an additional way of prioritizing projects to be implemented.

The ultimate goal of the prioritizing process is to begin implementing potential projects that currently have the highest feasibility. Several of the potential projects fell into this arena. The MRC subcommittee, again, using their local knowledge and expertise, selected three sites for further project development. People For Puget Sound elaborated with project recommendations that included scope of work, cost estimates, and potential funding possibilities.

Applying the Bays Blueprint methodology in Skagit County has occurred in two stages. Compiling existing datasets and creating the GIS occurred in 2003, followed by inventory and analysis of the Skagit County mainland shoreline in 2004. This first stage captured the shoreline area from the Whatcom/Skagit border through Samish Bay, Padilla Bay, Fidalgo Bay across the top of Fidalgo Island. The update of the project occurred in 2005 and captured Guemes, Huckleberry, Saddlebag, Hat and Dot Islands. Data inventoried from these Islands was included in the larger Skagit County GIS and the entire area was re-analyzed for conservation and restoration priorities. In addition, staff ran the analysis on Guemes Island alone to provide the Guemes Island Planning Committee (GIPAC) with much needed information of the Island's habitats. This additional Blueprint of Guemes is available in the Guemes Rapid Shoreline Inventory (RSI) 2005. Guemes Island residents assisted People For Puget Sound and the Skagit MRC in conducting the RSI in priority areas to capture on-the-ground habitat information.

In fall of 2005 Guemes, Saddlebag, Huckleberry, Hat, and Dot Islands were surveyed adding another 120 points to the original 343 points, for a total of 463 points surveyed. No additional sites were selected and studied for feasibility. The inclusion of the islands into the survey area changed the conservation and restoration priorities in two ways. The additional points added to the total number of points in each rank category and shifted the ranking of certain points to a lower or higher priority. This shifting of rank was most apparent in the conservation scores, due to the high conservation potential of Guemes Island's shorelines, and lowered the ranking of some of the mainland sites. Secondly, the improvements to the model have also changed the resulting scores.

Recommendations and Next Steps

- As the science and understanding of nearshore habitats increase, new data will become available to include into the Bays Blueprint analysis. Datasets such as new forage fish spawning data, bird surveys, and juvenile salmonid use of the nearshore, more detailed drift cell analyses, new oblique aerial photographs, and new county data arising from Shoreline Master Plans (SMP) updates should be included.

- A technical team comprised of scientists, GIS modelers and analysts, would develop a more powerful and efficient modeling tool that produces biologically significant results from which to build the feasibility component.

- This is an important tool for analyzing restoration and conservation priorities, and should be considered in the updates of Shoreline Master Plans and Critical Area Ordinances. Education about the best available science for planning purposes should be conveyed to the public.

- Expand the Northern Skagit County Bays and Shoreline Habitat Conservation and Restoration Blueprint to the rest of Puget Sound basin and the Northwest Straits.

Introduction

Puget Sound is a unique environment consisting of a diverse array of marine resources. These waters also serve as a center of economic activity resulting in an increase of human settlement and development throughout the region. The heavy concentration of shoreline development has caused the modification and destruction of nearshore habitats and the depletion of important marine resources. About one-third of Puget Sound's shorelines have been developed and over 80 percent of estuaries have disappeared. Since 1980, populations of invertebrates, bottom fish, salmonids, marine birds, and marine mammals have declined precipitously (Washington Sea Grant, 1998).

In response to the depletion of marine resource in Puget Sound, and subsequently the Northwest Straits, U.S. Senator Patty Murray (D) and U.S. Congressman Jack Metcalf (R) convened a citizen's panel in 1997 to identify possible strategies and solutions to the decline of marine resources in the region. The resulting Northwest Straits Marine Conservation Initiative established the Northwest Straits Commission (NWSC) to provide oversight and coordination of restoring and protecting the marine resources of the Northwest Straits ecosystem.

The NWSC is a voluntary panel of citizens who are charged with recommending steps to improve the region's sustainability. County-based Marine Resource Committees (MRCs) were formed in each of the seven northwest counties of the state including Clallam, Jefferson, San Juan, Whatcom, Skagit, Snohomish, and Island counties to support the mandates of the Initiative. The MRCs coordinate all their activities through the NWSC.

The Northwest Straits Marine Conservation Initiative outlines "Benchmarks for Performance", which guide the work of the MRCs and provide measures of success for the program. The Northern Skagit County Bays and Shoreline Habitat Conservation and Restoration Blueprint (Bays Blueprint) was developed to inventory and evaluate nearshore habitats in order to address the benchmark specifying the need to restore and protect nearshore habitats that support marine resources in the Northwest Straits. The results intend to accomplish the following:

- Assist the MRC in compiling existing datasets characterizing nearshore habitats, and
- Identify high priority areas for specific on-the-ground habitat restoration or increased levels of conservation actions and projects.

Goal and Objectives

While there is now a significant body of information collected for nearshore habitat in Puget Sound, it has not been organized or analyzed in such a way to make it useful to identify specific conservation and restoration targets. To address this critical need, the Skagit County MRC and People For Puget Sound developed the Bays Blueprint. This tool gathers together the available information in an organized fashion, incorporates the information into a GIS-based spatial nearshore habitat analysis, and prioritizes specific on-the-ground actions and projects based on biological information, social, political, and economic constraints. The strength of the Skagit Bays Blueprint project lies in the partnerships developed in the feasibility study phase that can lead to on-the-ground projects. The overall methodology includes four phases:

1. Compile and organize existing datasets on nearshore habitat conditions and marine resources in the project area and provide available documentation for each dataset.

2. Inventory the nearshore habitat using oblique shoreline photos (WA Department of Ecology, 2000).

3. Analyze and evaluate habitat conditions based on their ability to support forage fish, juvenile salmonid use of the nearshore habitat, aquatic vegetation, shorebird use of the nearshore, and sediment supply to the nearshore, and apply criteria for prioritizing nearshore habitat restoration and conservation areas.

4. Apply feasibility criteria based on social, political, and economic constraints that identify a short list of possible conservation and restoration projects. These projects are summarized in site-reports that provide rationale for choosing these projects, benefits of these projects, and anticipated "hurdles" to site conservation/restoration actions. People For Puget Sound and the Skagit MRC will present these findings to property owners and land managers to identify and scope at least two projects for conservation or restoration actions in 2004 and 2005.

Description of Project Area

The project area for the Bays Blueprint includes approximately 80 miles of shoreline from the northern Skagit county line, through Samish Bay, around Samish Island, through Padilla Bay, into Fidalgo Bay, along the southern side of Guemes Channel, and Guemes, Saddlebag, Huckleberry, Hat, and Dot Islands. (**Map 1 in Map Book**). This includes tidal waters of these bays as well as adjacent habitats. These shorelines contain a wide variety of beach habitat types, from the rocky headlands of Square Bay to the sandy shores of Camp Kirby to the mudflats of Fidalgo Bay.

For this project, nearshore habitats are defined from a depth of 10 meters (33 feet) below Mean Lower Low Water (MLLW) to Mean Higher High Water (MHHW), including adjacent backshore areas. The lower extent of the nearshore zone (–10 meters MLLW) is based on the upper limit at which healthy benthic vegetation can be found in Puget Sound. The nearshore zone also includes backshore and upland areas in which the strongest intertidal-upland interaction occurs. This is where bluffs provide the sediments that nourish beaches, the upland transition vegetation stabilizes beaches, and the fringing vegetation shades the intertidal zone and contributes insects, leaf litter, and woody debris directly into the aquatic environment (Williams and Thom 2001).

Although this project area does not contain large metropolitan areas, several cities and large communities abut the nearshore habitats. These areas include Bay View, Anacortes, and along the shoreline of Samish Island. A balanced approach to ecosystem protection and industry may allow Skagit County Bays to remain healthy and biologically productive.

Project Organization and Approach

The project approach follows the four specific objectives described above. An overview of the approach is depicted in **Figure 1**. Essential to the success of this project was MRC members and local-level stakeholder participation throughout the process. The group's input and feedback ensured that no important sources were overlooked and provided expertise on the criteria developed to determine high priority restoration and/or conservation areas, as well as on-the-ground feasibility criteria and project selection.

An important component of this project was not only to compile and organize regional and local datasets, but to *add* new information at the local level into a database to be used in a GIS-based spatial nearshore habitat analysis. The nearshore habitat analysis was designed to be adaptive to the MRC and to incorporate new and updated datasets as they become available. The analysis illustrates five different approaches for using the compiled datasets to determine priority restoration and conservation areas. The various approaches used in the habitat analysis reflect the amount of data that is currently available to describe habitat conditions and its relation to the target species and geomorphic processes. Once science-driven priority restoration and conservation areas were identified, specific actions and projects were assessed against social, economic, cultural, and political principles to define the ease of these projects. We can then prioritize our efforts accordingly.

Section I. Inventory

Data Sources Identified and Compiled

Identifying key geographic information systems (GIS) datasets and compiling a database of all datasets characterizing nearshore habitats was the important first step in the Bays Blueprint project. These include data compiled from the Northwest Straits Inventory report (2002) as well as additional datasets made available since then. Sources for available data include state and federal agency surveys and reports, local and county research, tribal research, and university research. State and federal agency publications were culled from Washington Department of Fish and Wildlife (WDFW), Washington Department of Natural Resources (WDNR), Washington Department of Ecology (DOE), Washington Department of Health (WDOH), National Oceanic and Atmospheric Administration (NOAA), National Marines Fisheries Services (NMFS, now NOAA Fisheries), United States Fish and Wildlife Service (USFWS), United States Geological Survey (USGS), and the United States Army Corps of Engineers (USACE) for documents and datasets pertaining to nearshore habitat conditions in the northern Skagit Bays. A summary of the various datasets is provided in **Appendix B** and copies of these datasets can be found on the accompanying CD ROM.

Key regional datasets identified include Washington State's ShoreZone Inventory, WDFW's Priority Habitats and Species Database, Streamnet, the Puget Sound Ambient Monitoring Program's marine mammal and bird distribution (PSAMP), the Puget Sound Environmental Atlas Update, DOE Slope Stability and Drift Cell data, and DOE Oblique Shoreline Photographs (2000). Key county datasets identified include Skagit County Assessor Parcels and Samish Island and March Point Rapid Shoreline Inventory.

New data sets include Department of Ecology 2000 oblique photographs, Digital Airborne Imagery 2001 from Skagit County and © Space Imaging LLC, Drift Cell and Slope Stability digital data from the Department of Ecology Shorelands and Coastal Zone Management Program, and historic shoreline and bathymetry of Fidalgo Bay and Guemes Channel from the WDFW. Identification of local datasets relied on "word of mouth" recommendations from county representatives, environmental consultants, and university professors. A summary of the various datasets is provided in Appendix B. A description of key dataset is given below:

- WDNR's ShoreZone Inventory: this inventory characterizes the geomorphic and biological resources of the intertidal and nearshore habitats of the entire Puget Sound coast, including the Northwest Straits region. Aerial imagery was taken at low tide providing a "snap-shot" in time of habitat conditions. This dataset was used to map substrate, subtidal and intertidal vegetation, and shoreline modifications.

- Priority Habitats and Species Database: this database includes information collected by WDFW based on field surveys, reports from reputable sources, and best professional judgment of their biologists. Datasets contained in this database Nearshore Habitat Inventory include the Marine Resource Division's data on shellfish distributions (crabs, clams, and oysters) and forage fish spawning areas; mapped areas that support diverse, unique, and/or abundant communities of fish and wildlife (i.e., eelgrass); wildlife heritage points including non-game species of concern and state and federal listed species; marbled murrelet distributions; and seabird distributions.

- StreamNet: this database is a cooperative venture among the Pacific Northwest's fish and wildlife agencies and tribes containing statewide anadromous fish distribution information compiled by fish experts from many different agencies and organizations.

- Puget Sound Ambient Monitoring Program: this dataset contains seasonal (summer and winter) sightings of marine bird and mammal species observed during aerial surveys between 1992 and 2000.

- 1992 Puget Sound Environmental Atlas Update: this data source is a compilation of marine resource datasets for the Puget Sound region. Information contained in the atlas includes shellfish distributions (clams and oysters); pinniped haulout sites, marine mammal distributions (whales and porpoises); seabird nesting areas; groundfish distributions; tribal, commercial and recreational fishing areas; and wastewater discharge sites.

- Net Shore-Drift: this dataset depicts the net longshore drift of sediment between two points representing a closed or nearly closed system in areas throughout the Northwest Straits. The Washington Department of Ecology and Western Washington University cooperated in a series of net shore-drift studies of the Washington marine shoreline, including Schwartz's report for the Pacific Ocean and Strait of Juan de Fuca Region and Northern Bays and Straits Region, and Jim Johannessen's report for San Juan, and parts of Jefferson, Island, and Snohomish Counties.

- Slope Stability: These digital maps were originally published as hard copy maps in the Coastal Zone Atlas of Washington between 1978 and 1980. These maps indicate the relative stability of coastal slopes as interpreted by geologists based on aerial photographs, geological mapping, topography, and field observations. This mapping represents conditions observed in the early and mid-1970s.

- 2000 DOE Oblique Shoreline Photographs: this dataset contains oblique aerial photos and a map display for a section of Skagit County's coastline. Beginning in the spring of 2000, the Washington State Department of Ecology began shooting oblique digital photographs of the state's marine shoreline. Each photo is approximately 1000 feet of shoreline, with resolution of 300 pixels per inch. The photos were shot from an airplane flying along the coast at approximately 90-100 ft elevation.

Habitat Characterization Maps

Key habitat features and shoreline configurations were mapped and can be found in the accompanying **Map Book**. These maps are presented to give a general overview of the resource and habitat conditions found throughout the county and are representative examples of the data sources described in Appendix B. Data layers were grouped together in appropriate subsets and displayed separately for clarity. Mapped data layers displayed in each map are listed below:

- Map 2. Shoreline Classification
- Map 3. Drift Cells and Adjacent Slope Stability
- Map 4. Skagit County Tax Assessor Parcels
- Map 5. WDFW Puget Sound Ambient Monitoring Program (Marine Birds)
- Map 6. WDFW Puget Sound Ambient Monitoring Program (Marine Mammals)
- Map 7. WDFW Marine Resources and Species and Streamnet (Forage Fish and Salmonid Bearing Streams)
- Map 8. Northwest Straits Nearshore Habitat Inventory (Juvenile Salmon Habitat Restoration Potential)
- Map 9. March Point Rapid Shoreline Inventory (Potential Forage Fish Habitat Restoration)
- Map 10. Samish Island Rapid Shoreline Inventory Overall Restoration Analysis
- Map 11. USGS Digital Raster Graphics and Digital Orthophoto Quads, and DOE Oblique Photos
- Map 12. Historic NOAA Nautical Chart
- Map 13. Fidalgo Bay Historic and Current Shoreline with Historic Bathymetry
- Map 14. Guemes Island Rapid Shoreline Inventory 2005 Recommendations

Together, the maps characterize the physical, biological, and anthropogenic features that are used to define the habitat conditions in the Northwest Straits region. Maps 9, 10 , 14, and **Appendix A: NPSNHA** were taken from previous reports. For more information contact People For Puget Sound.

The Nearshore Photo Inventory (Armchair RSI)

Well-trained volunteers surveyed shorelines using the Washington Department of Ecology's Shoreline Oblique Photographs from 2000. Each oblique photograph captures a section of shoreline approximately 800 to 1000 feet long during extreme low daytime tides. Each photograph is tied to a specific, geo-referenced beach section represented by a dot on a map and captured in a GIS dataset. The survey data was carefully entered and compiled in a Microsoft Access database and then transferred to a GIS, which displays the data on maps. The GIS was then used to assign values to the data to produce priority areas for voluntary conservation and restoration actions.

Methodology

The Nearshore Photo Inventory (a.k.a., Armchair RSI) was designed to collect accurate, comprehensive data on contiguous sections of Puget Sound shoreline, and to present the results in an organized fashion. In developing this program, great consideration was given to ensure that the data being collected:

- Complemented rather than duplicated existing data sets. The scale at which the Nearshore Photo Inventory program was implemented allowed for a more refined collection of data than is currently available in existing data sets. This inventorying method provided a finer scale look at the health of nearshore habitats. In turn, this detailed information may indicate to resource managers the need for even more meticulous, targeted data collection to be undertaken on-site by biologists, volunteers, or specialized professionals.

- Was accurately collected by trained volunteers or interns. People For Puget Sound recognized that volunteers can be a valuable asset in gathering information that would be cost-prohibitive for agency personnel to collect. However, it was also recognized that collecting certain types of data (such as biological data to the species level), may be best accomplished by professional staff. The data sets presented by this approach were those for which volunteers have proven to be successful in absorbing the requisite training and in implementing the collection of accurate data.

- Provided data geared toward answering specific resource questions: Each data type within the Nearshore Photo Inventory was selected for its direct applicability to shoreline resource management. While there is a tremendous amount of information that would be 'good to know', the Nearshore Photo Inventory was designed to provide resource managers and biologists data that can be directly used to make resource management decisions. For example, the data can provide the baseline information to identify specific shoreline areas that are high priority areas for conservation or for habitat restoration.

The inventory process was divided into three activity areas:

1. Training/setup: All volunteers new to the Nearshore Photo Inventory program completed a training session, comprised of a one on one session with the staff.

2. Implementation: People For Puget Sound staff GIS Analyst assisted and managed volunteers on inventory days. On that day, the GIS Analyst assigned data collectors sections of the shoreline. At the end of the day, the GIS Analyst assured that each assigned section was inventoried and that each form was complete.

3. Data processing/analysis/presentation: Once all shoreline sections have been inventoried, volunteers were trained to enter the data, and their work was reviewed systematically by staff. The data were checked and corrected in table form, and transferred to a Geographic Information System (GIS).

Detailed descriptions of this inventory protocol can be found in **Appendix C**.

Volunteers used a detailed data form, which places data into clear, discrete categories, to collect this information off the oblique photographs (**Figure 2**). The data form limits errors and makes the data as consistent as possible. The inventory data are displayed on 28 maps, providing a visual inventory of resources around this project area. (**Map Book, Maps 15 – 43**).

NEARSHORE PHOTO INVENTORY DATA FORM

Name ____________ Date ____________

County ____________ Bay/Beach Name ____________

Photo ID ____________ Start Time ______ Stop Time ______

Intertidal and Backshore Zones
(Zoom on-screen photo to 150%, look at the lower 1/3 area of photo and locate the backshore/intertidal break)

Vegetation overhanging the backshore or intertidal zone?
☐None ☐Patchy ☐Continuous

Are any of these features present?
Spit ☐Yes ☐No
Bar ☐Yes ☐No
Tombolo ☐Yes ☐No
Intertidal Marsh ☐Yes ☐No
Backshore Marsh ☐Yes ☐No
Driftwood ☐Yes ☐No

Major Streams, Outfalls, and other Discharges
Characterize the 3 most dominant outfalls

Number of visible outfalls ______ or ☐ None

Outfall one:
☐ River (named)
☐ Creek (unnamed)
☐ Seep
☐ Ditch
☐ Pipe or culvert
Associated algal growth? ☐Yes ☐No
Flow? ☐Yes ☐No
Any man-made restriction of vertical flow? ☐Yes ☐No

Outfall two:
☐ River
☐ Creek
☐ Seep
☐ Ditch
☐ Pipe or culvert
Flow? ☐Yes ☐No
Associated algal growth? ☐Yes ☐No
Any man-made restriction of vertical flow? ☐Yes ☐No

Outfall three:
☐ River
☐ Creek
☐ Seep
☐ Ditch
☐ Pipe or culvert
Flow? ☐Yes ☐No
Associated algal growth? ☐Yes ☐No
Any man-made restriction of vertical flow? ☐Yes ☐No

Shoreline Structures
Characterize the 6 most dominate shoreline structures
Number of visible structures ______ or ☐ None
Percentage of the shoreline lined with structures:
☐0-25 ☐26-50% ☐50-75% ☐75-100%

Structure one:
☐ Pier/dock
☐ Bulkhead/seawall
☐ Jetty/groin
☐ Dike/levee
☐ Launch/ramp
☐ Other ______
Made from: ______
Length: ☐0-25 ☐26-50% ☐50-75% ☐75-100%
Any sign of failure? ☐Yes ☐No
Does structure extend in the intertidal zone (verses just in the backshore)? ☐Yes ☐No

Structure two:
☐ Pier/dock
☐ Bulkhead/seawall
☐ Jetty/groin
☐ Dike/levee
☐ Launch/ramp
☐ Other ______
Made from: ______
Length: ☐0-25 ☐26-50% ☐50-75% ☐75-100%
Any sign of failure? ☐Yes ☐No
Does structure extend in the intertidal zone? ☐Yes ☐No

Structure three:
☐ Pier/dock
☐ Bulkhead/seawall
☐ Jetty/groin
☐ Dike/levee
☐ Launch/ramp
☐ Other ______
Made from: ______
Length: ☐0-25 ☐26-50% ☐50-75% ☐75-100%
Any sign of failure? ☐Yes ☐No
Does structure extend in the intertidal zone? ☐Yes ☐No

Structure four:
☐ Pier/dock
☐ Bulkhead/seawall
☐ Jetty/groin
☐ Dike/levee
☐ Launch/ramp
☐ Other ______
Made from: ______
Length: ☐0-25 ☐26-50% ☐50-75% ☐75-100%
Any sign of failure? ☐Yes ☐No
Does structure extend in the intertidal zone? ☐Yes ☐No

Structure five:
☐ Pier/dock
☐ Bulkhead/seawall
☐ Jetty/groin
☐ Dike/levee
☐ Launch/ramp
☐ Other ______
Made from: ______
Length: ☐0-25 ☐26-50% ☐50-75% ☐75-100%
Any sign of failure? ☐Yes ☐No
Does structure extend in the intertidal zone? ☐Yes ☐No

Structure six:
☐ Pier/dock
☐ Bulkhead/seawall
☐ Jetty/groin
☐ Dike/levee
☐ Launch/ramp
☐ Other ______
Made from: ______
Length: ☐0-25 ☐26-50% ☐50-75% ☐75-100%
Any sign of failure? ☐Yes ☐No
Does structure extend in the intertidal zone? ☐Yes ☐No

Bluff/Bank
Is bluff or bank present? ☐Yes ☐No
Vegetation on the bluff or bank?
☐None ☐Patchy ☐Continuous
Un-vegetated scars?
☐None ☐Patchy ☐Continuous
Bulkheading contiguous with un-vegetated scars?
☐None ☐Patchy ☐Continuous
Bedrock at high tide line?
☐None ☐Patchy ☐Continuous

Upland Land Use
Dominant upland land use/vegetations for entire frame? (pick one)
☐ Undeveloped/natural
  ☐ Coniferous trees
  ☐ Deciduous trees
  ☐ Wetland
  ☐ Grassland & Brush
  ☐ Riparian vegetation/Mixed
☐ Buildings or Structures
☐ Paved road or lot
☐ Unpaved road or lot
☐ Railroad
☐ Pasture
☐ Row crops
☐ Lawn

Dominant upland land use **immediately** adjacent to the intertidal? (pick one)
☐ Undeveloped/natural
☐ Buildings or Structures
☐ Paved road, trail or lot
☐ Unpaved road, trail or lot
☐ Railroad
☐ Pasture
☐ Row crops
☐ Lawn

Complete land uses – enumerate or choose all that apply?
Number of buildings ______
Number of other structures (not in the intertidal) ______
Number of paved roads or trails ______
Number of paved lots capable of holding
  < 10 vehicles ______
  > 10 vehicles ______
Number of dirt roads, trails or lots ______
Number of access points (trails, stairs) to the beach ______
Other features present (pick as many as apply)
☐ Undeveloped/natural
  ☐ Grass & Brush
  ☐ Coniferous Trees
  ☐ Deciduous Trees
  ☐ Wetland (Marsh, pond, lake)
☐ Railroad
☐ Pasture (cows and fences)
☐ Row crops
☐ Lawn

Thank you for completing this survey, please check to see that all questions are answered and that your finish time is filled out.

Additional Notes:

Figure 2. Four pages of the data form used by volunteers to collect data off the Oblique Photographs.

Habitat characterizations captured off the oblique photographs focused on the physical, biological, and anthropogenic features of the nearshore that define or affect the condition or function of nearshore habitats. For example, physical features and some biological attributes, such as vegetation, of the nearshore environment define the habitat setting that determines which species occupy an area. Similarly, individual species distributions indicate areas currently meeting the habitat requirements of that species. Furthermore, nearshore modifications including bulkheads, docks, and piers directly affect nearshore processes and the ecology of nearshore species (MacDonald et al. 1994; Thom et al. 1994).

Data Uses

The data are intrinsically valuable as indicators of beach types and as baselines of physical and biological information. The data can show simple correlations between upland and intertidal land use and ecosystem health indicators on the adjoining beach. People For Puget Sound staff, working with nearshore habitat experts, created a system to analyze Nearshore Photo Inventory data and existing GIS datasets in a way that enhances its value. Different "scores" are assigned to different pieces of datum in order to prioritize areas that are appropriate for habitat conservation and restoration actions (see Nearshore Inventory Data Analysis below).

Nearshore Characteristics and Analysis Results

Intertidal/Backshore Zone (Maps 15 through 20)

The intertidal zone, the shoreline between the low and high tide lines, is home to a wide range of flora and fauna — many of which spend their entire lives there, or are dependent on the intertidal for some critical stage of their lives. The Nearshore Photo Inventory captures information from the low tide line to the high tide line where several species of forage fish spawn (**Figure 3**). Two of Puget Sound's three primary forage fish, surf smelt and sand lance, need specific sizes of substrate at or near the top of the intertidal zone in which to lay their eggs: namely, from sand to very small gravel below 4 mm in diameter (Bargmann, 1998). Pacific herring, the third of these three forage fish, attach their eggs to eelgrass and kelp (Bargmann, 1998).

Figure 3: Beds of eelgrass that occur in the lower intertidal and subtidal zones are critical nursery habitat for a variety of species (image courtesy of NOAA).

The backshore is a "splash zone," often a flat area at the top of the beach that collects driftwood and where most of the plants can tolerate occasional salt spray (**Figure 4).** The driftwood and plants in the backshore provide habitat for small invertebrates, which in turn provide food for migrating juvenile salmon (King County Department of Natural Resources, 2001). This zone is often reduced or eliminated when bulkheads are built. High energy beaches with high bluffs may naturally have no backshore present at all.

Very often the two zones were not distinguishable from the photographs. We grouped these two zones on the data forms to capture as much information as possible. Where a backshore feature was distinctly identified in the nearshore zone, we distinguished between intertidal and backshore (e.g., a backshore marsh versus an intertidal marsh).

The Washington DNR ShoreZone dataset was used to capture information on intertidal habitats defined by substrate attributes in the study area. The dominant habitat was sand and gravel beach (25%), followed by mud flat (23%), and sandy flat (11%). Along the water line at low tide, many of the photo sections had substrate that would support eelgrass (sand or sandy mud) (Koch, 2001). Continuous patches of eelgrass were found in 43% of photo sections, while 30% of the photo sections contained patchily distributed eelgrass.

Vegetation that hangs over the intertidal zone is important for shade to protect forage fish spawn (helps to prevent desiccation of the eggs), and as a source of insects that drop into the water thus providing food for juvenile salmon. A majority of sections, 65%, contained at least some vegetation overhanging the intertidal zone. Only 12% of those sections had continuous coverage. Driftwood was present on 82% of the backshores.

Figure 4: Backshore habitat can include driftwood, salt-tolerant vegetation, salt marshes, and sand dunes.

Bluff/Bank Characteristics (Maps 36 through 37)

Bluffs and banks just shoreward of the beach (**Figure 5**) provide a variety of unique habitat niches. Two birds found in marine environments, the kingfisher and the pigeon guillemot, are known to nest in holes in sandy bluffs (Alsop, 2001). Most importantly, sand and gravel that dislodges and slides from bluffs and banks re-supplies fine substrates to the intertidal zone, maintaining the structure and profile typical of beaches from Anderson Island north to Samish Island. Bluffs and banks that provide a steady source of sediment to the shoreline are commonly called "feeder bluffs".

Figure 5: Large and small feeder bluffs are critical sources of sediment for Puget Sound shorelines.

Bluffs or banks, either natural or armored, were present on 70% of the sections. Ninety-six percent of these sections with bluffs, had at least some vegetation coverage. Un-vegetated scars, usually an indication of a recent slide and potential supply of sand to the beach, were continuous for 2% of these sections, while 61% had patchy scars. Eighteen percent of all sections containing bluffs or banks had bulkheads at the base of the bluff or bank.

Adjacent Land Use (Maps 38 through 43)

The ways that land owners build on and maintain the land adjacent to the shoreline can directly impact the quality of nearshore habitat (**Figure 6**). Vegetated riparian buffers act as natural filters, absorbing water from flood events and filtering out toxins and excess nutrients. Clearing trees and shrubs to create views removes shade and food sources on which many species rely (King County Department of Natural Resources, 2001), and lawn and garden fertilizers and pesticides can be washed into the water. Un-managed access points can cause erosion and trampling of shoreline vegetation. Roads and parking lots along the water can increase the runoff of oil, gas, and antifreeze. Agricultural and industrial runoff is not always filtered or treated.

Figure 6: Land use adjacent to the shoreline has an impact on many characteristics of the nearshore environment, including riparian vegetation, aquatic vegetation, erosion, pollutants, and wildlife habitat use.

The dominant upland land cover captured by the photographs was undeveloped (53%), followed by row crops (20%) and lawn (12%). Fifty-seven percent of the *immediately adjacent upland* to the intertidal was predominately undeveloped as of the time of this survey. This relatively moderate number likely related to the fact that much of the residential shoreline development in this area is set well back from the beach, with healthy riparian buffers adjacent the high tide line. The next highest category of immediately adjacent land to the intertidal use was unpaved road, path, or lot at 10%, followed by paved road, path, or lot at 9%, and lawn at 7%. However, several instances of commercial and industrial development were recorded, especially near Anacortes and March's Point.

Streams, Outfalls and Other Freshwater Outflows (Maps 21 through 29)

In many cases, fresh water flowing onto the beach can be an important part of the nearshore ecosystem. Streams and creeks can create deltas or marshes, and can allow fish to move upstream to spawn. But water can also bring pollutants and garbage onto the beach (**Figure 7**). The Nearshore Photo Inventory counted the numbers and types of discharges (which include rivers, creeks, ditches, pipes, and seeps), looked for potential signs of pollution (excessive algal growth), and recorded whether or not the discharge is flowing.

Figure 7: Freshwater discharges entering the nearshore environment can carry excess nutrients or toxic pollutants onto the beach.

Thirty-six percent of sections surveyed contained one or more discharges. A total of 262 discharges were recorded, with 60% being seeps, 20% pipes, 12% creeks, 5% rivers, and 3% ditches. Sections that contained outfalls had an average of 2 per section. Samish Island has a relatively large amount of freshwater seeping onto the beach, and a very low percentage of associated algae. However, the survey area in general showed a moderately high occurrence of algae (continuous or patchy on 45% of sections).

Shoreline Structures (30 through 35)

The Photo Inventory looked for structures built on the shoreline such as bulkheads, docks, ramps, jetties, and levees. Shoreline structures can serve many purposes, from helping protect upland areas from erosion to providing a place to dock or launch boats (**Figure 8**). Some may be un-necessary or in disrepair, with owners that may be un-aware of their potential impacts on nearshore habitat. Bulkheads and jetties can block the flow of sand onto and along the beach, and can force juvenile salmon into deep water, exposing them to predators (Williams and Thom, 2001). Many structures can amplify the energy of waves, which in turn can scour sand from the top of the beach or increase erosion on adjacent or neighboring properties (Shipman, 1995).

Failing structures, especially rip-rap bulkheads, can litter the beach with large materials that cover habitat for clams and other sand-dwelling invertebrates (People For Puget Sound, 2001).

Figure 8: Structures are often intended to prevent erosion or to provide people with access to the shoreline. Both types of structures can negatively impact nearshore habitat, especially as the structures begin to fail.

Nine hundred and nine structures were described during this inventory. Seventy-one percent of the photo section contained structures. Of those sections, the average number of structures was 3. There were no clear majority of one type of structure with 33% bulkheads or seawalls, 19% piers or docks, 9% dikes or levees, 6% launches or ramps, 2% jetties or groins, and 31% for other structure types, such as pilings.

Seventy eight percent of the structures were in good or excellent condition, meaning that they were serving their intended purpose. Twenty two percent were in poor condition, meaning that they were in some stage of obvious failure.

Section II. Analysis

Nearshore Inventory Data Analysis

Habitat inventories contain significant inherent values and descriptions of habitat and can inform habitat conservation decisions when used in geospatial models that define and describe habitat quality. To synthesize all the collected data from both the compiled GIS datasets *and* the Nearshore Photo Inventory, a series of conceptual models were selected from the Rapid Shoreline Inventory (RSI) Analysis and redeveloped to encompass new information gathered by this project. These models also describe the relationship between habitat features and indicators of habitat quality. Like the RSI models, Nearshore Photo Inventory models apply positive values to habitat characteristics perceived to be beneficial to habitat quality. Negative values are assigned to habitat features that impact habitat forming processes (e.g., erosion), are indicators of physical disturbances, or directly impact a species group. The models attempt to define how various measurable characteristics of nearshore habitat affect habitat quality with respect to target biological communities or geophysical processes. The models were chosen because they represent key elements of a functioning nearshore ecosystem typical of Puget Sound.

This methodology is based on the best available science for the relationship between marine nearshore habitats and key ecosystem processes and nearshore-dependent species in Puget Sound. However, scientific study in this area is not abundant. Moreover, the scoring system presented below represents value judgments made by staff scientists based on the scientific literature and other unpublished scoring schemes. These values can be adjusted to reflect other priorities and emerging research. The five models characterized nearshore habitat for:

- Forage fish spawning (species group)
- Juvenile salmonid use of nearshore (species group)
- Aquatic vegetation (species group/ecosystem process)
- Sediment Supply to the nearshore (ecosystem process)
- Birds that depend on Marine Shorelines and Features (species group)

Large amounts of geospatially-referenced species and habitat data are compared and contrasted by these models and the models are designed to assess each geo-referenced photo inventory point for both conservation opportunities and restoration opportunities. The habitat criteria chosen to evaluate the relationship between the species group or ecosystem processes and the current state of the shoreline are derived from the Nearshore Photo Inventory habitat characteristics and the data from the compiled GIS datasets. The justification for choosing the habitat criteria for use in the models are given in **Appendix D.** For each species group and ecosystem process model, a conceptual model, the model equation for how the specific criteria are used to determine the habitat conservation and restoration score, and how each specific habitat characteristic and impact is scored can also be found in Appendix D.

Invited reviewers were given the opportunity to edit and critique the models and the scoring scheme. Table 1 lists the invited professionals under the heading of the specific model they were asked to review:

Table 1. Invited Reviewers who were given the opportunity to critique the models.

Forage Fish
Dan Pentilla (WDFW)

Juvenile Salmon Nearshore Habitat Use
Kurt Fresh (NOAA)
Eric Beamer (Skagit Systems Cooperative)
Colin Levings (Fisheries Oceans Canada)
Charles Simenstad (Wetland Ecosystem Team)

Sediment Supply to Beaches
Hugh Shipman (WDOE)

Aquatic Vegetation
Tom Mumford (WDNR)
Helen Berry (WDNR)

Intertidal Shorebirds
Joe Buchanan (WDFW)

Project Feasibility
Fred Geotz (USACE)
Bernie Hargrave (USACE)
Jeff Dillion (USACE)

*Skagit MRC Bays Blueprint Subcommittee members also made comments on all models

Habitat Conservation Analysis

To find habitat conservation opportunities, the models were used to rate individual 800-ft shoreline sections on a scale of -100 to 100 with higher scores reflecting higher quality habitat. Positive scores were assigned to positive attributes such as riparian vegetation. Negative scores were assigned to habitat impacts such as bulkheads or signs of pollution. The conservation score is then simply the sum of the positive and negative values added for any 800 ft. photo section.

This analysis is helpful for identifying areas of highly functional habitat as well as areas not impacted by invasive organisms or anthropogenic development. While scores vary between the -100 and 100, it is important to recognize that this is a semi-quantitative model that provides a relative indication of site conservation value (sites scoring higher will generally be more favorable) for areas included in this study. The precise scores achieved may have little meaning taken outside the context of this specific analysis.

Habitat Restoration Analysis

The restoration analysis was based on the same scientific literature and data-driven ranking system used in the conservation model. For restoration opportunities, the goal is to identify those sites with a high level of current ecosystem function *and* a significant degree of impairment. This was achieved by multiplying the habitat attribute score and the habitat impact score, and then taking the absolute value of the product of the two numbers. The restoration scores range from zero (sites that have either no current habitat attribute or no obvious habitat impacts) to 10,000 (sites that have both the maximum score in the habitat attributes and impacts present). A site with a high restoration score might have multiple positive habitat attributes such as pea gravel, a spit, eelgrass, and riparian vegetations, but also habitat impacts such as intertidal structures, a boat ramp, and several outfalls.

For the restoration analyses, the scores increase along with increasing attributes and increasing intensity of impact (more impact equals a larger negative number). This results because the impact and attribute values are multiplied instead of added. The implications of this model are that sites with very low habitat attribute or very low habitat impact are not prime targets for restoration. Instead, sites that still have substantial remaining or inherent positive habitat value but also have significant impairment, represent the best opportunity to make significant gains for the ecosystem through restoration.

As with any model analysis, the interpretation of scores requires care and consideration. Since this approach is semi-quantitative, the direction of scores (higher being more favorable than lower) is more important than the specific score or precise difference between scores.

The conservation and restoration scoring scheme does not take into account the quality of immediately adjacent 800 ft. shoreline section, or groups of adjacent sections. In this sense, the study and analysis does not explicitly account for habitat continuity along the shoreline. For example, multiple continuous sections of good to moderate quality habitat might be more important for conservation than one cell of excellent quality habitat in the middle of a larger area of very low quality habitat. While scores for individual sections do not reflect this larger spatial context, viewing groupings of scores on the display maps can help identify important habitat “clusters”.

Model 1. Potential Forage Fish Spawning Habitat

Forage fish, including populations of Pacific Herring (*Clupea harengus*), surf smelt (*Hypomesus pretiosus*), and Pacific sand lance (*Ammodytes hexapterus*), are an essential component of the Puget Sound food web. These three species comprise an essential trophic link within the nearshore environment, and are a major component of the diet of many predatory species like salmonids (Bargmann 1998). While little is know about the adult life stages of forage fish, spawning preferences and requirements are generally understood. This analysis is an extension of surveys that identify forage fish spawn; the model focuses on both current and potential spawning habitat. While forage fish may use the same sites for spawning over long periods of time (Pentilla 1995), a site may be abandoned for no apparent reason only to become used again at some point in the future (Robards et al. 1999).

Shoreline surveys that identify spawning beaches have been conducted by the Washington State Department of Fish and Wildlife since 1972. Based on information obtained during these surveys, surf smelt and sand lance are thought to spawn selectively in shorelines that have deposits of either sand or pea-gravel sized sediment in the upper intertidal zone (Bargmann 1998). In addition to substrate preferences and requirements, forage fish eggs tend to have lower mortality when there is riparian vegetation adjacent to shoreline that can provide shade and moderate temperatures (Robbards et al. 1999). Pacific herring vary slightly from smelt and sand lance in that herring spawns primarily in lower intertidal and shallow subtidal zones, attaching eggs to vegetation such as eelgrass or kelp.

The forage fish analysis focuses on identifying those beaches with conditions that would seem to favor forage fish spawning and spawn survival. Positive attributes for shorelines include appropriate sediment found in the upper intertidal, overhanging vegetation, as well as aquatic vegetation that might be used for spawning. Negative components are primarily those that interrupt or disturb potential spawning areas or the processes that form potential spawning areas. These include artificial outfalls which may supply excessive nutrients or toxic chemicals to the shoreline, bulkheads which alter nearshore hydrography, or piers that shade subtidal vegetation. A conceptual model that describes high potential for forage fish spawning habitat along the nearshore is found in **Figure 9**.

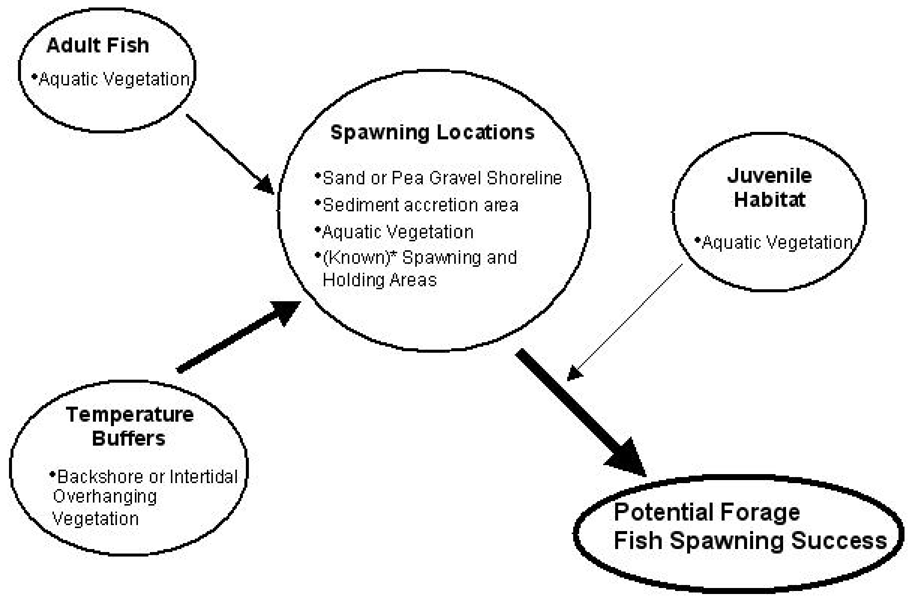

Figure 9. A conceptual model describing the relationship between shoreline characteristics and forage fish spawning success.

The scoring system for each of the forage fish model criteria can be found in Appendix D. The narrative descriptions to determine the habitat conservation and restoration equations are also found at the bottom of this model's description in Appendix D.

Model 2. Potential Nearshore Habitat Use by Juvenile Salmonid

The salmon habitat analysis relies on the assumption that nearshore habitats provide key functions for development and survival of juvenile salmon, such as chum and ocean-type chinook. Nearshore marine habitat may serve as migration corridors, feeding areas, physiological transition zones, refuge from predators, or refuge from high energy wave dynamics (Mason 1970; MacDonald et al. 1987; Thrope 1994; Levings 1994; Spence et al.1996). Most juvenile salmon use the shallow waters of estuaries and nearshore areas as migration corridors to move from their natal streams through Puget Sound to the ocean (Williams and Thom 2001). Estuarine environments provide a gradual transition area for juvenile salmon to adjust physiologically to salt water (Simenstad et al. 1982). With declines in aquatic vegetation that formerly served as feeding grounds and refugia for juvenile salmonid, it is likely that juvenile salmon have shifted their distributions and now use shallow water as an alternate refuge habitat (Ruiz et al. 1993).

This model focuses on evaluating individual sites for their capacity to serve as feeding area, refugia, or migration corridors for juvenile salmon. Emergent vegetation (*Carex lyngbyei*, *Scirpus spp*., etc.) and riparian shrubs and trees have been identified as vital components that provide detritus and habitat for chinook food organisms (Levings et al. 1991, Cordell et al. 2001), and were scored appropriately. Habitat impacts are those features that are known to displace habitat or impede habitat forming processes. These include structures that reduce shallow water nearshore habitat or adjacent land uses that may impact vegetation and upland food sources. A conceptual model that describes potential juvenile salmonid use of nearshore habitat is found in **Figure 10**.

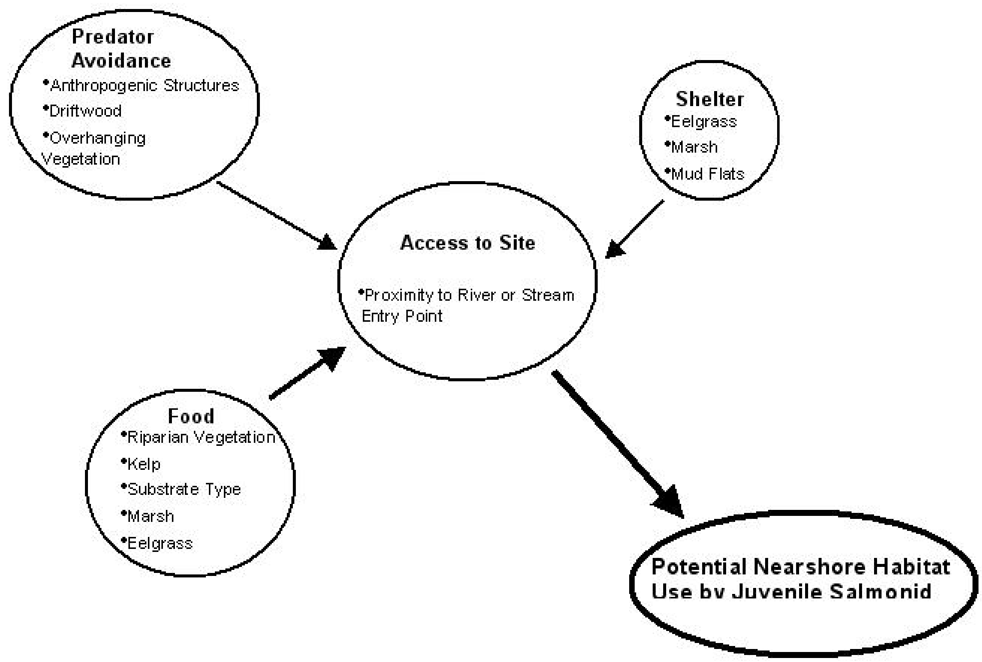

Figure 10. A conceptual model describing the relationship between shoreline characteristics and juvenile salmonid use of nearshore habitat.

The scoring system for each criterion in the juvenile salmonid model can be found in **Appendix D**. The narrative descriptions to determine the habitat conservation and restoration equations are also found at the bottom of this model's description in Appendix D.

Another criterion for juvenile salmon habitat conservation might be the area's proximity to large, chinook-bearing rivers. Recent research in the Skagit River suggests that juvenile chinook can be prematurely forced out of estuaries and into marine shorelines (Beamer et al., 2003), although this has yet to be documented for other sub-estuaries of Puget Sound. Juvenile salmon also use the beach as a migration corridor; the continuity of good habitat was addressed in this report by including proximity of each shoreline section to the mouth of rivers and creeks.

Model 3. Presence of Aquatic Vegetation

Primary production forms the base of any food web, and in the Puget Sound the primary producers are seaweeds, sea grasses, benthic microalage, kelps, marsh macrophytes, and phytoplankton. In Puget Sound, areas of increased algae and seagrass density or biomass, contain more species and a greater abundance of epibenthic invertebrates than do areas of lower vegetative cover or structure (Cheney et al. 1994). With the exception of estuary marsh vegetation, which was formerly widespread in and around the major bays and deltas of the Sound (Bortleson 1980), primary production is limited to a relatively narrow band of habitat as a result of the steep fjord-like character of Puget Sound's nearshore habitat. Any attempt to determine the suitability of certain areas as habitat for submersed aquatic vegetation (SAV) must take into consideration light and parameters that modify light (epiphytes, total suspended solids, chlorophyll concentration, nutrients) (Koch 2001). Anthropogenic nitrogen loads to shallow coastal waters have been linked to shifts from seagrass to algae-dominated communities in many regions of the world (McClelland and Valiela 1998). Propagules of most types of aquatic vegetation are generally a result of either inappropriate habitat for colonization and survival or displacement by another type of aquatic vegetation (Moore et al. 1996).

The focus of this analysis is on direct observations of aquatic vegetation with individual types of aquatic vegetation valued primarily for their ecological "services". Implicit in the scoring of this model is the underlying assumption that each type of aquatic vegetation typically occupies a particular zone in the nearshore environment, from the subtidal to the upper intertidal. Figure 11 shows a conceptual model that describes potential juvenile salmonid use of nearshore habitat.

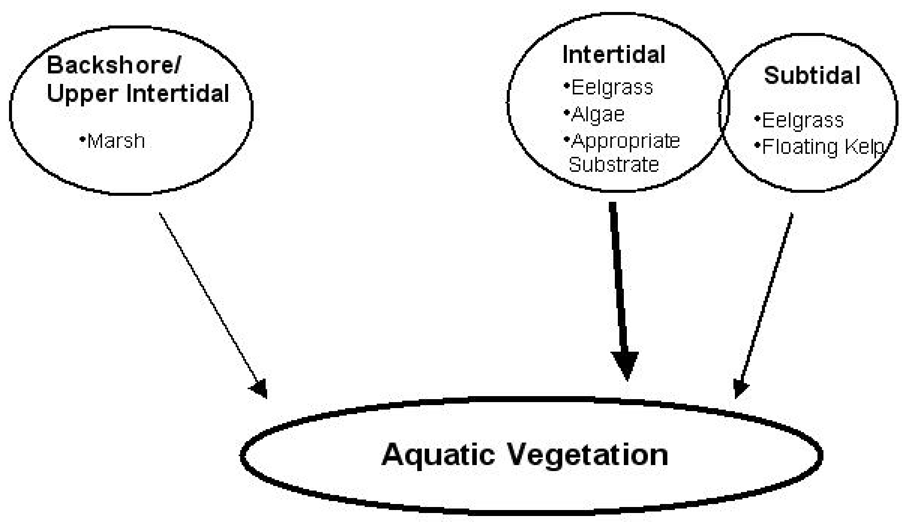

Figure 11. A conceptual model describing the relationship between shoreline characteristics and aquatic vegetation found within the nearshore habitat.

The scoring system for each criterion in the aquatic vegetation model can be found in Appendix D. The narrative descriptions to determine the habitat conservation and restoration equations are also found at the bottom of this model's description in Appendix D.

Model 4. Beach Sediment Supply

Puget Sound's shorelines are composed of hundreds of littoral cells that redistribute sediment along the shoreline. In the relatively protected waters of the Sound, the primary sources of sediment to the shoreline are alongshore and onshore transports, bluff erosion, and beach nourishment. Sediment is lost from the beach as a result of erosion and longshore transport or deposition onto spits (Downing 1983). Shoreline development and armoring actively impact beaches by altering sediment supply and transport processes and by directly modifying and occupying critical habitats (Shipman and Canning 1998, Shipman 1995).

The focus of this analysis is on identifying signs that sediment budget is being filled by looking for evidence of active erosion, in particular bluff faces, and areas of deposition that are found at the end of drift cells such as tombolos and spits. Below is a simplified model of factors affecting sediment supply to beaches using existing geospatially-referenced species and habitat data within Puget Sound. A conceptual model that describes potential sediment supply to the nearshore is found in **Figure 12**.

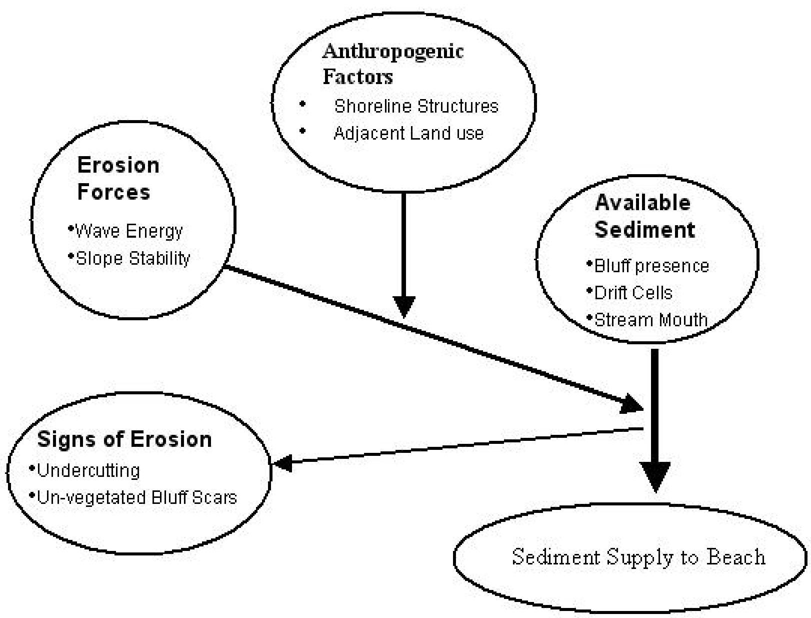

Figure 12. A conceptual model describing the relationship between shoreline characteristics and sediment supply to the nearshore.

The scoring system for each criterion in the beach sediment supply model can be found in Appendix D. The narrative descriptions to determine the habitat conservation and restoration equations are also found at the bottom of this model's description in Appendix D.

Model 5. Marine Bird

Many terrestrial animals spend part or all of their lives within the nearshore environment and have a great impact on the composition and functions of the nearshore ecosystem. An essential component of the nearshore ecosystem is marine birds; specifically the intertidal birds. Marine birds are often the dominant predators along rocky and sandy beaches (Hori and Noda 2001). In addition to being a dominant consumer of animals, most birds are omnivores and play a critical role in structuring both fauna and flora species assemblage in the nearshore ecosystem.

This analysis focuses on habitat components that contribute to the feeding and nesting behaviors exhibited during the breeding season of many intertidal feeding shorebirds. This analysis looks at a variety of shoreline features that are beneficial for a variety of birds that depend on marine shorelines. It awards points for fine sediment where intertidal shorebirds forage and niche habitats where rivers and creeks meet salt water. Negative components are primarily anthropogenic structures that encroach on to nesting and foraging habitats adjacent to and along the shoreline. A conceptual model that describes potential sediment supply to the nearshore is found in **Figure 13**.

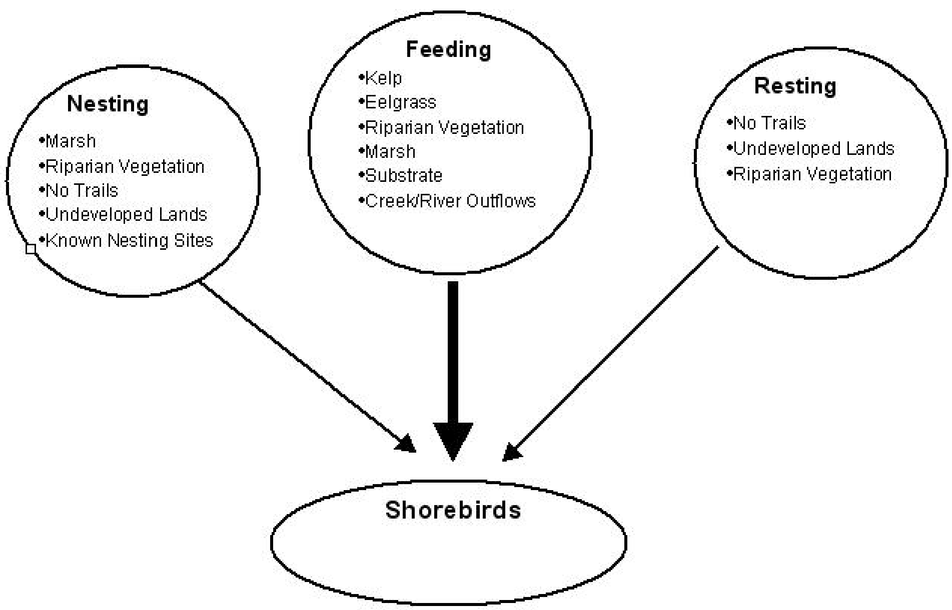

Figure 13. A conceptual model describing the relationship between shoreline characteristics and shorebird use of the nearshore habitat.

The scoring system for each criteria in the marine bird model can be found in Appendix D. The narrative descriptions to determine the habitat conservation and restoration equations are also found at the bottom of this model's description in Appendix D.

Methodology

The data for each model criterion were captured in various GIS datasets and in the Nearshore Photo Inventory database. The information from the GIS datasets were compiled in ArcGIS 9.1® using spatial joins and a script developed to measure the distance between each photo point and features of interest. More information on the GIS and Nearshore Photo Inventory procedures can be found in **Appendix C**. People For Puget Sound compiled all the data into one Microsoft Access database, allowing us the capability to query and organize the data into discrete tables. During the first phase of the Bays Blueprint each model, all data associated with the criteria were captured into separate tables, then analyzed using the open–source software R, developed by The R Development Team©. For the 2005 update the models were coded as SQL queries within the Access database. Each model criteria were scored according to the scoring system described for each model, and compiled into the habitat conservation analysis and the restoration analysis. The output contains the photo point identification number and the habitat conservation and restoration scores for each model and an additional overall conservation and restoration score. The outputs can also be linked to the photo point dataset containing geographic coordinates to be displayed in GIS software. All data and results are displayed using the ESRI ArcGIS 9.1® software.

Analysis Results

The resulting scores for both conservation and restoration calculations of each model are organized and displayed in the data tables found in **Appendix G**. There are 463 photo points that cover the shoreline in the project area. Each photo point is uniquely numbered and chronologically listed. Points identifying each photo section are mapped on the **Key Map** and the subsequent nine maps (**Sheets A – M in Map Book)** can be used as key maps in locating each point along the shoreline. The data tables can be used to view the specific habitat characteristics found at each dot, the scores assigned to these characteristics, the data sources where the characteristics originated, the scoring scheme for each model criteria, and the resulting habitat conservation and restoration scores for each photo point. The information is also spatially linked to a map for referencing via the key maps. Both the maps and the data tables can be used to cross–reference each other.

Section III. Prioritization

Ranking the Analysis Results

The 463 photo points on the maps are associated with the data that make up the conservation and restoration scores described in the analysis section above. Due to this large number of points, it is necessary to organize and display the scores in such a way that helps the user select an appropriate number of points, or sites, to be followed-up with onsite visits, gathering of permits and permissions from property owners, and funding availability.

A percentile-ranking scheme was created to display and present the model results visually, which aided in systematically ranking and prioritizing the analysis results. The scheme provides the process and rationale to identify and select top-scoring sites relative to all other sites. This methodology selects a truncated list of projects, based on biological information, to be followed-up with a feasibility analysis. Conservation and restoration scores were grouped into the following percentile breaks:

- 100% — 96%
- 95% — 91%
- 90% — 86%
- 85% — 81%
- 80% — 71%
- 70% — 51%
- 50% — 0%

The top 20% sites are divided into 5% breaks which yield more separation within the top ranking sites; the 5% breaks highlight high–scoring sites, emphasizing biologically significant areas to select and analyze for project feasibility and implementation.

The resulting data, restoration and conservation scores, and the spatial location of each photo point can be found in the data tables in Appendix G, and are displayed visually in the Map Book. A percentile-ranking scheme was created to display and present the model results visually in **maps 44 through 55**. This aided in systematically ranking and prioritizing the analysis results**.** Each model resulted in both a habitat conservation and restoration map. Because the precise meaning of each individual score is meaningless, it is best to compare sites within a given sampling area. Those sites scoring in the top 10% are likely the most noteworthy sites and should be reviewed for potential conservation or restoration. Overall conservation and restoration values were calculated by averaging the rank orders (between 1 and the maximum number of samples, with 1 being the highest scoring site) of each site for all five models.

This ranking system reveals those conservation and restoration opportunities that would provide the highest value to the living resources — not merely those that are the cheapest or most convenient. While sites identified using this tool are likely to provide ecosystem benefits if they are protected and restored, this ranking scheme only serves as a guide and pre-ranking tool for further detailed site inspections and analysis of site-specific circumstances.

Prioritizing 21 Sites

The overall maps and model maps provide the MRC sub-committee with tools to visually identify areas with the highest biological importance along their shorelines. The conservation maps highlight areas where the habitat features are relatively undisturbed (the largest dots), and should therefore be protected to maintain biological integrity. The restoration maps similarly highlight areas where positive biological aspects currently exist, yet are being disrupted by negative impacts.

The MRC sub-committee was equipped to begin locating sites where actions were needed; determined solely on biological importance. This was accomplished by considering only the overall maps, model maps, and associated biological data. The aerial oblique photos were not used at this time, and an attempt was made to momentarily set aside any known social, cultural, or economic issues, and focus on biological aspects of the sites.

The process began, during the first step of the feasibility phase, by first considering the overall conservation and restoration maps (**Maps 54 and 55 in Map Book)**. The MRC sub-committee determined this to be the best approach, simply because they were interested in all potential projects and not specifically investigating a certain topic, such as forage fish or marine bird habitat. After selecting a single point, or a group of points on the overall map, they then referred to the individual model maps and corresponding data to determine why this area received a high score.

Generally, we found clusters of high-ranking points on both the overall and model maps, as opposed to single high-ranking points. This was not surprising, as the points simply correspond to the aerial oblique photos, and adjacent stretches of shoreline would be expected to have similar or overlapping characteristics. Therefore, a 'site' picked for its overall high-ranking quality, was often composed of several points.

Twenty-one sites were selected from the original 343 points on the maps (prior to the addition of the islands to the GIS). The first six sites were chosen from their high-ranking biological qualities and potential need for conservation. The remaining 15 sites were chosen for their high-ranking quality with regard to restoration needs. A list of these sites was compiled with brief descriptions of the location and immediate area. This list can be found in **Appendix E.**

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Section IV. Project Selection and Evaluation

Proposed Actions and Potential Projects

The MRC sub-committee with the help of People For Puget Sound was able to select 21 sites from the 343 original points to be assessed for potential actions to be taken. The model has shown us that these sites are biologically important, and furthermore it has shown us that each of these sites is in need of restoration or protection on some level. Now, we must determine what that need is. The aerial oblique photographs and other on-the-ground data, such as the Battelle report recommendations and the data results from the models, guided People For Puget Sound in proposing actions to be taken at each site and developing potential projects. Where the data results and the aerial oblique photographs show overlapping conditions or characteristics, actions begin to emerge that will potentially enhance the habitat attributes. For example, a site scored high on the forage fish model due to presence of proper substrate and shade vegetation, yet also had a high restoration score. The photo shows several floating docks along that stretch of beach. The overlap of those two data sources tell us that something should be done about those floating docks.

Similar evaluation of each of the 21 sites led to an average of 3 to 4 proposed actions per site. These actions included removing or redesigning shoreline structures that may impede sediment drift, replanting native vegetation to enhance forage fish habitat, intensive beach clean-up and creosote pilling removal, and education actions targeted at stretches of beach where the cumulative effect of multiple homeowners' actions were degrading intertidal habitats.

The MRC sub-committee then took the People For Puget Sound recommendations for actions and developed them into potential projects. This often involved grouping certain actions into a single project, clarifying the language of the action, or adding additional actions into the scope of the project. Due to the large scope of many of these potential projects and constraints of time and available effort, it is necessary to prioritize. The development and use of a feasibility analysis allowed the MRC sub-committee and People For Puget Sound to do just that.

Feasibility Analysis

Increasing development along the shorelines of Puget Sound increases the pressure on already stressed nearshore habitats and natural processes. Therefore, the implementation of projects to protect and restore habitat and natural processes is necessary. As state and county governments, local municipalities, and Native American tribes continue to explore ways to protect or acquire critical habitats and control land use through planning regulation and public education, prioritizing nearshore protection and restoration projects become critical. To that end, we attempt to model the feasibility of projects once biologically significant sites have been identified (**Figure 14)**.

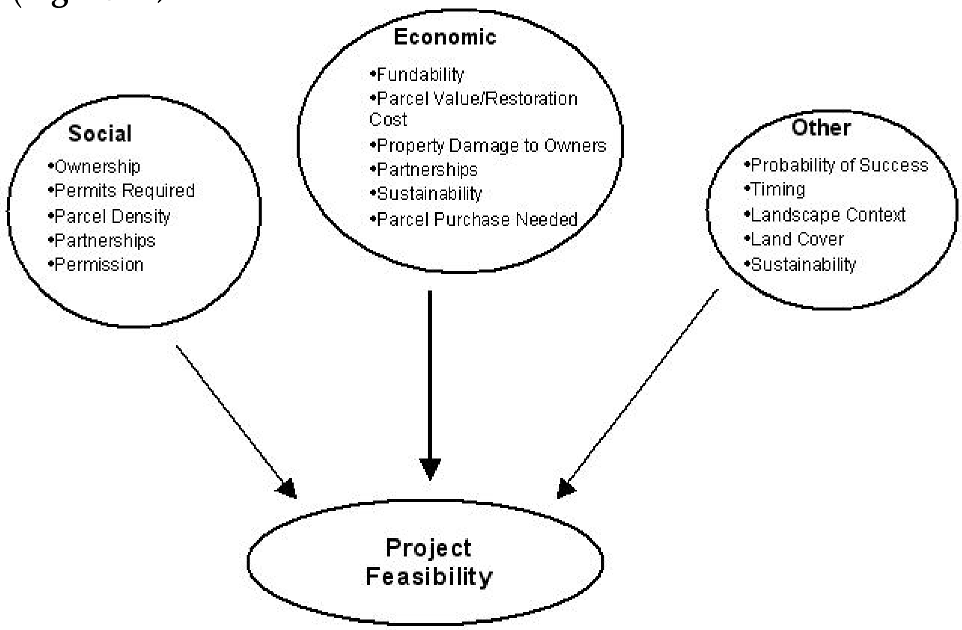

Figure 14. A conceptual model describing the rationale to determine Project Feasibility

Combining the attributes of landscape ecology (Shreffler and Thom 1993) with social, economic, cultural, and political principles, we can define the ease of restoration or conservation projects and prioritize our efforts accordingly. The above criteria were chosen to identify areas where both biologically critical habitats/processes and humans can coexist. In areas where cost is minimal, permission is attainable, and projects easily sustained and monitored, we assign high values. This model does not replace the very important local-level contact and on-the-ground verification steps.

In order to define the elements in the above diagram with local knowledge and site visits, the MRC and People For Puget Sound developed a series of feasibility criteria worksheets. Three worksheets were developed to address the three major types of proposed actions: conservation, restoration, and restoration through education. Examples of each worksheet can be found in **Appendix E.** A brief discussion describing the rationale for each of the feasibility criteria can also be found in **Appendix E**.

The MRC sub-committee met with People For Puget Sound to evaluate the multiple actions proposed at the 21 sites and begin project development. Local knowledge and diverse expertise shared though exchanges between the MRC sub-committee and People For Puget Sound made the process of assigning feasibility scores exceedingly more complete and accurate.

Figure 15. Members of the Skagit MRC Bays Blueprint sub-committee meet to apply the feasibility criteria to determine habitat conservation and restoration opportunities.

People For Puget Sound also instructed the MRC sub-committee in using the information available, such as the data tables, maps, aerial oblique photos, and other outside information to help answer the feasibility criteria questions on the worksheets. With that knowledge, the MRC sub-committee was able to continue through the entire feasibility process for the remainder of the proposed actions, without the direct assistance of People For Puget Sound. At this point, the Bays Blueprint feasibility process became a tool that can be used by any citizen with an interest in nearshore habitat protection and restoration.

Results of MRC Sub-committee meetings

Several of the 21 selected sites had multiple proposed actions, some of which were logically grouped together by the MRC sub-committee to form a single potential project. In some cases, it was determined to be more reasonable that multiple actions at a single site be grouped into more than one potential project. The MRC sub-committee's deliberation of the 21 prioritized sites with multiple proposed actions resulted in 24 potential projects needing further consideration. People For Puget Sound produced Site Reports for each of these potential projects, which can be found in **Appendix F**.

The criteria questions of the feasibility worksheets were designed to result in a discernable difference in the scoring of the potential projects, giving the MRC an additional way of prioritizing projects to be implemented. The MRC sub-committee quickly discovered that it was not possible to fully assess some of the potential projects using the feasibility worksheets. This was generally due to incomplete knowledge of the site at the time of the assessment, or it was not the proper timing or location for the proposed actions. These projects are included in the list of site reports in **Appendix F**, with a notation of why the project was not taken through the feasibility worksheet.

The majority of the potential projects were ranked using the appropriate feasibility worksheet. A brief synopsis of project recommendations was developed by People For Puget Sound for these sites (see section V on the Site Reports in Appendix F). These synopses included information on locating parcel ownership, contact information for various geo-engineers and civil engineers, County and City permitting information, and details on native planting including native plants dealers, local Conservation District chapters, local native plant nurseries, and local chapters of The Native Plant Society.

The ultimate goal of the prioritizing process is to begin implementing potential projects that currently have the highest feasibility. Several of the potential projects fell into this arena. The MRC subcommittee, again using their local knowledge and expertise, selected three sites for further project development. People For Puget Sound elaborated on the brief project recommendations previously supplied by developing scope of work, cost estimates, and potential funding possibilities. We acquired the help of Jim Johannessen, geological engineer of Coastal Geologic Services, Tom Slocum, District Engineer of the Conservation Districts of San Juan, Skagit, and Whatcom Counties, and Daniel Downs in the Skagit County Planning and Permitting Department, to develop the more comprehensive Site Reports. These three expanded Site Reports provides the MRC with a strong foundation to further project development and implementation. These three projects represent areas that are biologically important, require restoration to some degree, and currently have a high feasibility for being beneficial, achievable, and sustainable.

Conclusions

PPS and MRC are very pleased with the process and outcome of the Northern Skagit County Bays and Shoreline Habitat Conservation and Restoration Blueprint. This project arose from the need for a large–scale, spatial analysis of biological information. Bays Blueprint improved upon that need by determining the most important and feasible sites for on–the–ground conservation and restoration actions. Although it was developed based on rigorous, scientific methodology, the model outcomes are understandable and useable by any citizen with an interest in the health of the nearshore environment.

Building on the Blueprint

Adding new data

As the science and understanding of nearshore habitats increase, new data will become available to include into the Bays Blueprint. Datasets such as new forage fish spawning data, bird surveys, and juvenile salmonid use of the nearshore, more detailed drift cell analyses, new oblique aerial photographs, and new county data arising from Shoreline Master Plans (SMP) updates should be included. Availability of new datasets usually come from word of mouth knowledge from scientists doing the analyses, meetings or conferences where constituents share new information, regional scientific journals, and the websites of city, county, and state agencies, universities and professors. All new datasets should be incorporated into the biological model analysis component of the Bays Blueprint by trained GIS analysts.

Updated parcel ownership, site-specific inventories (RSI) and reports such as the Battelle Report (Antrim et al., 2003), and plans such as updated SMP are some of the resources to be used by the MRC to determine potential projects or actions and aid in project feasibility analysis. One of the most useful pieces of information for the MRC is the updated oblique photographs to view sections of the shoreline. The oblique photographs are taken every five years by the Washington Department of Ecology.

Technical collaboration

The habitat conservation and restoration results drive the project feasibility analysis component of the Bays Blueprint. Just as the evaluation of project feasibility is a group effort, the compiling datasets in to a GIS and modeling important species groups and biological processes also require a collaborative effort. A technical team comprised of scientists, GIS modelers and analysts, and computer developers would develop a more powerful and efficient modeling tool that produces biologically significant results from which to build the feasibility component. Peer review, critical review, and model sensitivity tests are just a few examples of how to build up the validity of this project.

People For Puget Sound

Spreading the word

This important tool should be used as a public education tool, and the Skagit MRC can help by presenting the Bays Blueprint to other MRC groups, local stakeholders, politicians, and tribal entities. People For Puget Sound staff presented preliminary results to the Northwest Straits Commission and the Whatcom, San Juan and Island County MRC's during development of the project. People For Puget Sound also presented this project at the 2004 Restore America's Estuary National Conference to address the scientific community.

The Future of Bays Blueprint

People For Puget Sound is interested in expanding the Northern Skagit County Bays and Shoreline Habitat Conservation and Restoration Blueprint to the rest of Puget Sound basin and the Northwest Straits. This will likely be accomplished on a county by county basis, possibly prioritized by the deadlines of Shoreline Master Program updates. This effort will require collaboration with interested local stakeholders, scientists, and the public.

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Map Book

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Map Book Contents

Adjacent Land Use

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Map39	Dominant Land Cover Immediately Adjacent to Intertidal
Map40	Number of Buildings in the Upland Area
Map41	Number of Structures other than Buildings in the Upland
Map42	Number of Roads, Trails, or Lots in the Upland Area
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Analysis

Map44	Aquatic Vegetation Conservation Analysis
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Photo Numbers

Key Map	Key Map
SheetA	Photo Point Location and Numbers
SheetB	Photo Point Location and Numbers
SheetC	Photo Point Location and Numbers
SheetD	Photo Point Location and Numbers
SheetE	Photo Point Location and Numbers
SheetF	Photo Point Location and Numbers
SheetG	Photo Point Location and Numbers
SheetH	Photo Point Location and Numbers
SheetI	Photo Point Location and Numbers
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SheetK	Guemes Island Photo Point Location and Numbers
SheetL	Guemes Island Photo Point Location and Numbers
SheetM	Guemes Island Photo Point Location and Numbers

Appendix A

North Puget Sound Nearshore Habitat Assessment (NPSNHA)

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Guemes Island Analysis

In December of 2005 US Fish and Wildlife Service and People for Puget Sound completed a study entitled the North Puget Sound Nearshore Habitat Assessment to improve and describe our understanding of the relationship between nearshore habitat characteristics and the distribution of marine bird populations in order to identify nearshore conservation actions.

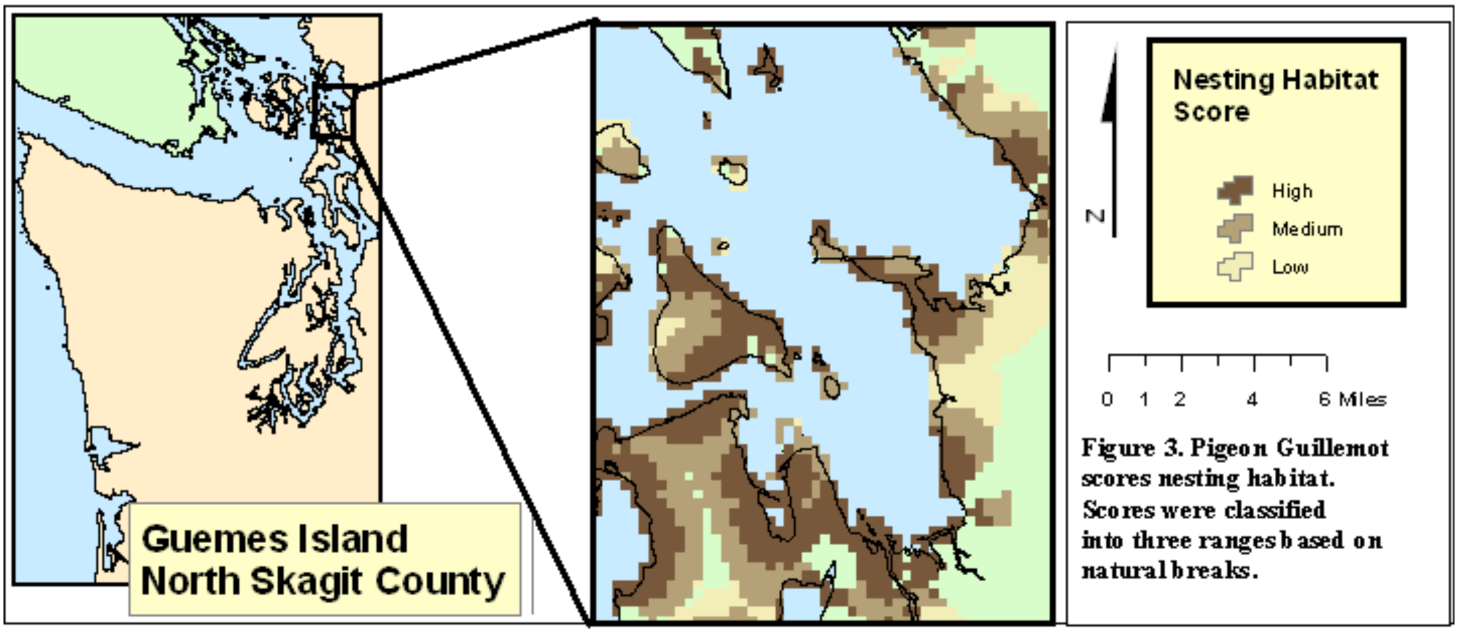


Figure 3. Pigeon Guillemot scores nesting habitat. Scores were classified into three ranges based on natural breaks.

Three species of marine birds were chosen for study: the Pigeon Guillemot, representing diving birds; the American black Oystercatcher, representing shoreline birds; and the Great Blue Heron, representing wading birds. Conceptual models that describe the interactions between species and their habitat were developed with attention to both the natural features and human modifications. These models were then used to analyze available spatial datasets to identify high quality habitat for each species. The results of the analysis were then compared to existing survey data and data from field studies for validation. Correlations between the model and habitat data were high for the Great Blue Heron model, the forage habitat model for the Pigeon Guillemot, and nesting habitat model where American Oystercatcher nest on small islets.

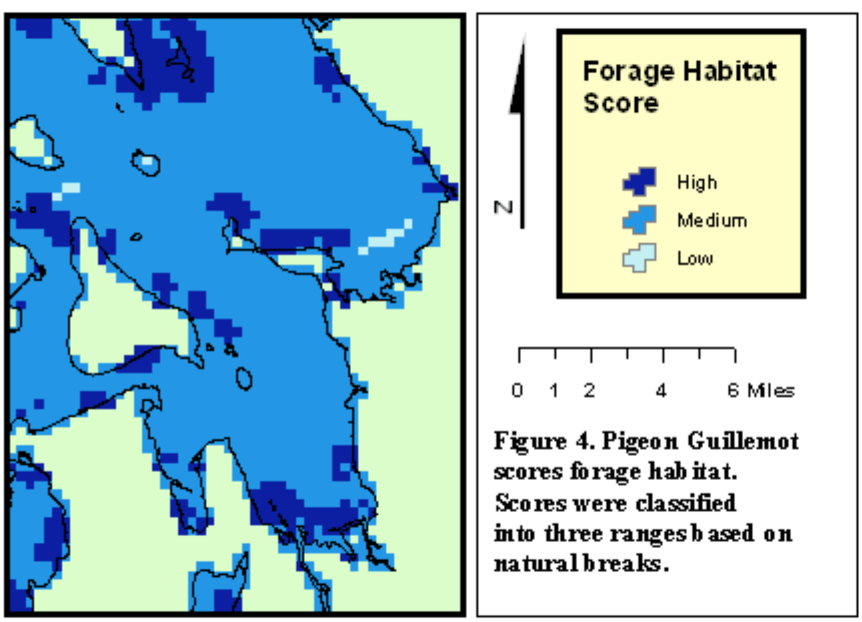
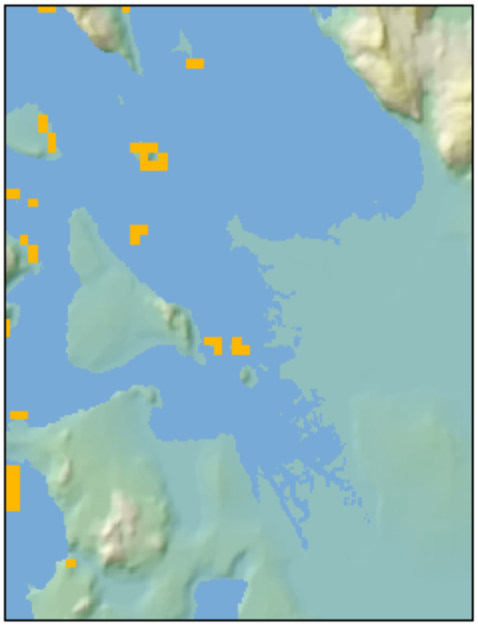


Figure 4. Pigeon Guillemot scores forage habitat. Scores were classified into three ranges based on natural breaks.

The final goal of the study was to apply the findings to the planning and prioritization process, using our habitat information to identify potential conservation sites for Guemes Island.



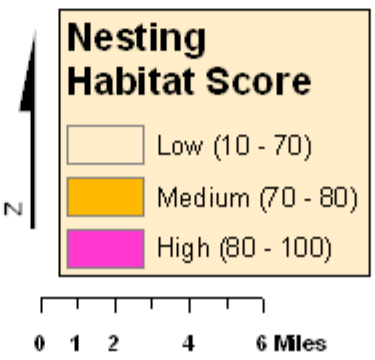
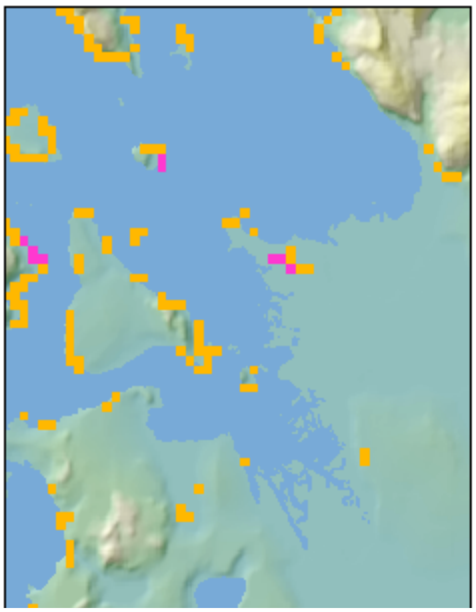


Figure 5. American black oystercatcher scores nesting habitat. Scores were classified into three ranges based on natural breaks.



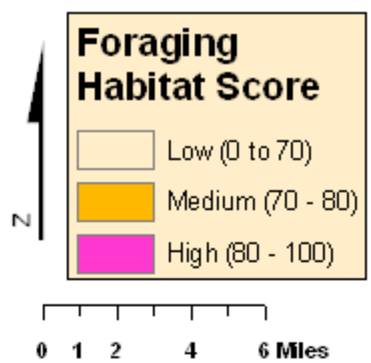
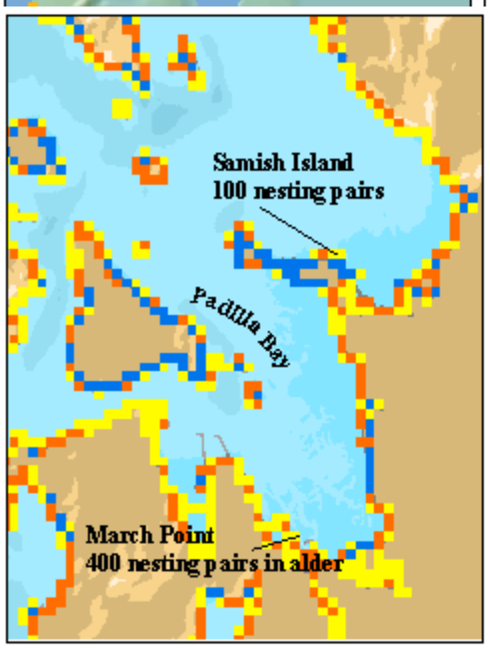


Figure 6. American Black Oystercatcher scores for foraging habitat. Scores were classified into three ranges based on natural breaks.



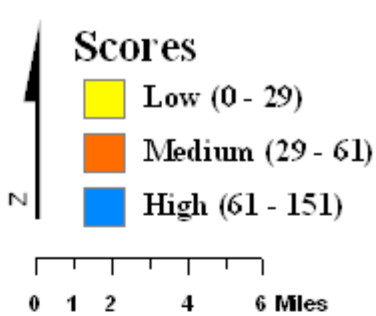


Figure 7. Scores for eelgrass, land cover, and shoreline modification combined. Scores were classified into three ranges based on natural breaks.

Pigeon Guillemot

The highest scoring sites for nesting were on the southwestern side of the island from the ferry terminal to the west beach sand bluffs, including Kelly's Point where nests have been observed (pers. obs. DeLorey 2005). The Northern bluff area of north beach also scored high for nesting. The Northwestern side of Guemes Island and its nearby islands scored high for forage habitat, except for the bluff area of north beach. Dot Island, Saddlebag Island, and Huckleberry Island are the sites of known Pigeon Guillemot colonies. Pigeon Guillemots prefer the deeper water off the west coast of Whidbey Island, and this may support the preference for deeper water foraging as well (pers. Com. Francis Wood).

American Black Oystercatcher

Results

Guemes Island did not score well for nest habitat, however nearby Huckleberry Island and Saddlebag Island did score moderately well . Moderate forage scores were found at: Yellow bluff/Kelly's point, west beach bluff, Holiday Hideaway, Clarks Point the rocky areas of North Beach, Seaway Hollow, and the small surrounding islands (Hat Island, Huckleberry Island, and Saddlebag Island).

Great Blue Heron Results

Much of Guemes Island scored high for Great Blue Heron overall habitat due to its extensive eelgrass beds and natural land cover. Hat and Saddlebag Island also scored moderate to high for overall habitat.

Discussion

The 2005 Marine bird model calculates conservation scores for forage and nesting habitat of three species using Puget Sound wide datasets. The original Marine Bird model developed for the 2003 Bays Blueprint is a synthesis of information which utilizes more habitat attributes and information about human impacts, but does not distinguish species and nesting habitat. The Bays Blueprint also calculates restoration scores using the information about structures and human impacts. The Bays Blueprints marine bird model is better suited for identifying habitat for wading birds, and hunting birds (Kingfisher), rather then diving birds (Pigeon Guillemot), and rocky shore birds (Oystercatcher). Overall, the results from the Bays Blueprint model resemble the results for the Great Blue Heron section of the 2005 analysis. We recommend that the new models be added to the Blueprint to better represent diving birds and rocky shore birds, and further modeling and analysis may bring out needs for higher resolution on other species of concern

Recommendations

Conservation recommendations for Guemes Island focused on offshore islets that show high quality habitat and important foraging areas close to the island, such as eelgrass beds. The full report is available from People For Puget Sound (www.pugetsound.org) and the US Fish and Wildlife Service.

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Appendix B

Summary of Existing Datasets

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County Specific Data

Source Publication Title	File Name	Layer Name	Data set description	Study Area
1995 Compact Airborne Spectrographic Imager Grayscale Raster, Whatcom County Area, WA.	band2_8.*	Compact airborne spectrographic imager grayscale raster	Data consists of a grayscale raster image, wavelength range from 540-560 nm. It is a single layer from the original multispectral data set. The multispectral data were acquired by the compact airborne spectrographic imager sensor.	Whatcom county area, WA
1996 Compact Airborne Spectrographic Imager Gray Scale Raster, Skagit County and Northern Whidbey Island, WA	band2_96	Compact airborne spectrographic imager gray scale raster 1996	Data consists of a grayscale raster image, wavelength range from 540-560 nm. It is a single layer from the original multispectral data set. The multispectral data were acquired by the compact airborne spectrographic imager sensor.	Skagit county and northern Whidbey Island, WA
1995 Intertidal Shoreline Characteristics, Whatcom County Area, WA	shor1995.*	Intertidal shoreline characteristics inventory 1995	This layer delineates intertidal shoreline characteristics in the Skagit County area, classified according to "A Marine and Estuarine Habitat Classification System for Washington State" (Dethier 1990). Polygon attributes include feature identifiers, features measurements.	Whatcom county area, WA
1995 Intertidal Shoreline Characteristics, Skagit County and Northern Whidbey Island, WA	shor1996*	Intertidal shoreline characteristics inventory 1996, Skagit County and nothern Whidbey Island, WA	This layer delineates intertidal shoreline characteristics in the Skagit County area, classified according to "A Marine and Estuarine Habitat Classification System for Washington State" (Dethier 1990). Polygon attributes include feature identifiers, features measurements.	Skagit county and northern Whidbey Island, WA
Distribution of habitats and summer standing crop of seagrasses and macroalgae in Padilla Bay, Washington	veg89	Seagrasses and macroalgae in Padilla Bay	Contains polygons and labelpoints which represent intertidal habitats in Padilla Bay in 1989. Seagrasses and macroalgae are attributed with species type and estimates of percent cover. Sand and mud flats are identified as sparse/unvegetated or as Ruppia.	Padilla Bay, Skagit County, WA

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Eelgrass Survey 2000: A Survey of Shoreline Property Owners of Island County in June 2000	Upmidlow	Eelgrass discovery map: upper, middle, lower beach areas	Data consists of eelgrass coverage in areas of Island County discovered by shoreline owners during specific low tide days.	Island County shoreline
Intertidal Habitat Inventory Study Area 1995	stdyarea	Intertidal habitat inventory study area 1995	Dataset consists of a polygon coverage representing the geographic area of the 1995 intertidal habitat inventory.	Whatcom county area, WA
Intertidal Habitat Inventory Study Area 1996, Skagit County and Northern Whidbey Island, WA	stdyarea96	Intertidal habitat inventory study area, 1996, Skagit County and northern Whidbey Island, WA	Dataset consists of a polygon coverage representing the geographic area of the 1996 intertidal habitat inventory.	Skagit county and northern Whidbey Island, WA
Intertidal Vegetation Inventory 1995, Whatcom County Area, WA.	iveg1995.*	Intertidal vegetation inventory 1995	The raster layer delineates nearshore vegetation types in the Whatcom County area. Vegetation types are classified according to the Nearshore Habitat Program's protocol. A spatial mask was used to remove the uplands and deep water areas before classification.	Whatcom county area, WA
Intertidal Vegetation Inventory 1995, Whatcom County Area, WA.	iveg95vc.*	Generalized intertidal vegetation inventory 1995	Dataset consists of a polygon coverage representing eight intertidal vegetation types, classified according to Nearshore Habitat Program's vegetation mapping procedures. Data set was generalized from a more detailed raster dataset.	Whatcom county area, WA
Intertidal Vegetation Inventory 1996, Skagit County and Northern Whidbey Island, WA	iveg1996.*	Intertidal vegetation inventory 1996, Skagit County and northern Whidbey Island, WA	The raster layer delineates nearshore vegetation types in the Skagit County and northern Whidbey Island. Vegetation types are classified according to the Nearshore Habitat Program's protocol. A spatial mask was used to remove the uplands and deep water areas.	Skagit county and northern Whidbey Island, WA

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Intertidal Vegetation Inventory 1996, Skagit County and Northern Whidbey Island, WA	iveg96vc.*	Generalized intertidal vegetation inventory 1996, Skagit County and northern Whidbey Island, WA	Dataset consists of a polygon coverage representing eight intertidal vegetation types, classified according to Nearshore Habitat Program's vegetation mapping procedures. Data set was generalized from a more detailed raster dataset.	Skagit county and northern Whidbey Island, WA
San Juan County Rapid Shoreline Inventory	SJ*.	Rapid shoreline inventory	Data describes intertidal, backshore, and upland habitats as well as identifying invasive species and characterizing structures and outfalls. Wildlife and vegetation species are identified during the course of the survey.	Small section of San Juan County
San Juan County Rapid Shoreline Inventory 2001	Esnd*.	Rapid shoreline inventory	Data describes intertidal, backshore, and upland habitats as well as identifying invasive species and characterizing structures and outfalls. Wildlife and vegetation species are identified during the course of the survey.	Small section of San Juan County
Skagit County Rapid Shoreline Inventory	Skagit*.	Rapid shoreline inventory	Data describes intertidal, backshore, and upland habitats as well as identifying invasive species and characterizing structures and outfalls. Wildlife and vegetation species are identified during the course of the survey.	Section of Skagit County around March Point
Whatcom County Rapid Shoreline Inventory	Whatcom*.	Rapid shoreline inventory	Data describes intertidal, backshore, and upland habitats as well as identifying invasive species and characterizing structures and outfalls. Wildlife and vegetation species are identified during the course of the survey.	Small section of Whatcom County

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Videographic Eelgrass Survey of Island County Selected Areas: Final Report	OakHarbor	Videographic eelgrass survey map of Oak Harbor	Autocad map of actual video taped eelgrass beds in priority areas of Island County incorporating real time GPS data on location.	Oak Harbor
Videographic Eelgrass Survey of Island County Selected Areas: Final Report	PennCove	Videographic eelgrass survey map of Penn Cove	Autocad map of actual video taped eelgrass beds in priority areas of Island County incorporating real time GPS data on location.	Penn Cove
Videographic Eelgrass Survey of Island County Selected Areas: Final Report	SkagitBay	Videographic eelgrass survey map of Skagit Bay	Autocad map of actual video taped eelgrass beds in priority areas of Island County incorporating real time GPS data on location.	Skagit Bay
Videographic Eelgrass Survey of Island County Selected Areas: Final Report	Utsaladay	Videographic eelgrass survey map of Utsaladay Bay	Autocad map of actual video taped eelgrass beds in priority areas of Island County incorporating real time GPS data on location.	Utsaladay Bay
Wetlands in Padilla Bay, WA Watershed 1993	wet93	Wetlands	Wetland coverage of Padilla Bay, WA	Padilla Bay, Skagit County, WA
Department of Ecology Shorelands and Coastal Zone Management Program	Skagit_slope	Slope Stability	From 1979 Coastal Zone Atlas	Skagit County
Department of Ecology Shorelands and Coastal Zone Management Program	010411_121*.jpg	Oblique Photographs	DOE oblique photos of approximately 600 foot nearshore habitat taken 2000.	Skagit County
Historic Nearshore Habitat Change Analysis: Fidalgo Bay and Guemes Channel	Shore_1891	Historic shoreline of Fidalgo Bay and Guemes Channel.	USCGS 1891 historic charts	Fidalgo Bay and Guemes Channel
Historic Nearshore Habitat Change Analysis: Fidalgo Bay and Guemes Channel	Bathy_1891	Historic bathymetry of Fidalgo Bay and Guemes Channel.	USCGS 1891 historic charts	Fidalgo Bay and Guemes Channel
Skagit County GIS Services	DAIS_2001	Digital Airborne Imagery of Skagit County (2001)	High resolution orthophotos of Skagit County	Skagit County

Regional Level Data

Source Publication Title	File Name	Layer Name	Data set description	Study Area
1992 Washington State Salmonid Stock Inventory	SASI	Anadromous fish stock status	This dataset contains anadromous fish stock status. This data is from the Salmonid Stock Inventory (SaSI) report and appendices published by WDFW in 1992. SaSI documents the results of an initial stock status inventory that was part of a statewide effort	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
1992-2000 PSAMP Aerial Surveys	s92-99line	Summer flight transects 1992-99	Flight transect lines used to complete aerial surveys detailing marine bird, waterfowl, and marine mammal distributions in Puget Sound.	Puget Sound shoreline
1992-2000 PSAMP Aerial Surveys	s92-99point	Summer marine bird and mammal observations 1993-99	Marine bird species and mammal species observed during the summer aerial surveys 1992-99.	Puget Sound shoreline
1992-2000 PSAMP Aerial Surveys	w93-00line	Winter flight transects 1993-2000	Flight transect lines used to complete aerial surveys detailing marine bird, waterfowl, and marine mammal distributions in Puget Sound.	Puget Sound shoreline
1992-2000 PSAMP Aerial Surveys	w93-00point	Winter marine bird and mammal observations 1992-2000	Marine bird species and mammal species observed during the winter aerial surveys 1993-2000.	Puget Sound shoreline
2000 Annual Inventory of Commercial and Recreational Shellfish Areas in Puget Sound	*2000g	Commercial shellfish growing area classifications	WDOH is responsible for certifying that shellfish harvested commercially are safe for human consumption. These designations are displayed in this layer.	Puget Sound
2000 Annual Inventory of Commercial and Recreational Shellfish Areas in Puget Sound	Rec*_pt83	Public recreational shellfishing beaches	State-owned beaches, including those on WDNR property, and county-owned beaches open to recreational shellfish harvesting are displayed.	Puget Sound

Source Publication Title	File Name	Layer Name	Data set description	Study Area
2000 Annual Inventory of Commercial and Recreational Shellfish Areas in Puget Sound	Stp_pt83	Sewer Treatment Plant Outfalls	Dataset depicts shoreline location of sewer treatment plant outfalls, does not depict exact offshore location of outfall if applicable.	Puget Sound
Atlas of Seal and Sea Lion Haulout Sites in Washington.	seals	Seal and Sea Lion Haulouts	Contains information on haulout sites for harbor seals, steller sea lions, California sea lions, and Northern elephant seals located in Washington waters.	Washington waters
Building a seamless digital elevation model of the Puget Sound Basin	october	Digital elevation model	Integrated elevation and bathymetry data	Puget Sound
Canopy-forming Kelp Inventory 1996	kelp1996	Kelp Inventory 1996	Canopy-forming Kelp Inventory 1996	Strait of Juan de Fuca and outer northern Washington Coast
Catalog of Washington Seabird Colonies	seabirds	Washington Seabird Colonies	The seabird colony database contains a digitized version of locations surveyed for breeding seabirds as documented by Speich and Wahl (1989).	Coast and interior marine waters of Washington
GIS Rocky Reef Data	rock93-96_state	Density of rockfish	Density of rockfish derived from underwater video surveys of rocky reef areas.	Puget Sound
Priority Species and Habitat Database	ABALONE	Abalone	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	CLAM	Manila clams	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	CLAMHARD	Intertidal hard shelled clams	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Priority Species and Habitat Database	CLAMSUBT	Sub-tidal clams	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	CRAB	Dungeness crab	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	CRAB_C	Pacific coast areas commercially harvested crabs	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	CRAB_C sport	Pacific coast areas fished for sport crab	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	CRABLINE time	Offshore dungeness crab fishing distribution and timing	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	GEODUCK	Geoduck	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	HERRHOLD	Herring pre-spawn holding areas	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	HERRSPWN	Herring spawning grounds	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Priority Species and Habitat Database	hrtgpts	Wildlife Heritage points	Contains information on documented point observations of non-game species of concern, state and federal listed species including those designated as endangered, threatened, sensitive, candidate, and monitor.	Washington State
Priority Species and Habitat Database	mamusect	Marbled Murrelet polygons	Consists of a polygon coverage containing marbled murrelet detection sections. A detection section is defined as any section where a murrelet has been detected, regardless of status (occupancy or presence).	Washington State
Priority Species and Habitat Database	OYSTER	Oysters	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	oyster native	Native or Olympia oysters in the pacific coast areas	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	OYSTER_C pacific	Pacific or Japanese oyster (introduced) in the pacific coast areas	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	phspoly	Priority Habitats and Species	Consists of polygons or points that describe occurrences of priority habitats and species. All priority species mapped areas represent known use areas; they are not potential habitats. Priority habitats are areas that support diverse, unique and/or abundant	Washington State

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Priority Species and Habitat Database	RAZRCLAM	Pacific coast razor clams	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	ROCKSOLE spawn	Rocksole spawning beaches	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	SANDLANZ	Sand lance spawning beaches	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	SHRMPPAN	Water column dwelling shrimp	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	SMELT spawn	Smelt spawning beaches	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Priority Species and Habitat Database	URCHIN	Red and green sea urchins	A collection of information concerning marine fish and shellfish resources in the coastal and inland marine waters of Washington.	The coastal and inland marine waters of Washington
Puget Sound Environmental Atlas Update 1992	clamhard2	hardshell clam species	The known distribution of commercially or recreationally important clams occurring in intertidal or subtidal ranges is represented. The hard-shell clams include: horse clams (Tresus nuttalli, T. capax), butter clams (Saxidomus giganteus), cockles (Clinocardium nutalli), native littleneck clams (Protothaca staminea), & Manila lams (Venerupis japonica).	Puget Sound

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Puget Sound Environmental Atlas Update 1992	Clamsoft	Softshell clam	The known distribution of the soft-shell clam, (Mya arenaria).	Puget Sound
Puget Sound Environmental Atlas Update 1992	Clamsubt	Subtidal Clam species	The known distribution of commercially or recreationally important clams occurring in intertidal or subtidal ranges is represented. Contact the Washington Dept. Of Fisheries for further definition of soft-shell clam species.	Puget Sound
Puget Sound Environmental Atlas Update 1992	Geoduck2	Geoduck	Locations of goeduck (Panopea generosa) beds.	Puget Sound
Puget Sound Environmental Atlas Update 1992	Gfdemrsl	Demersal Groundfish	The known distribution of demersal (bottom-dwelling) fish species.	Puget Sound
Puget Sound Environmental Atlas Update 1992	Gfpelagc	Pelagic Groundfish	The known distribution of pelagic groundfish species that may migrate and experience conditions throughout the region.	Puget Sound
Puget Sound Environmental Atlas Update 1992	Gfreef	Reef Dwelling Groundfish	The known distribution of reef dwelling groundfish species which reside in the same vicinity most of the time and are most vulnerable to changing conditions within a specific area.	Puget Sound
Puget Sound Environmental Atlas Update 1992	Haulout	Pinniped haul-out sites	The known locations of the haul out sites of harbor seals (phoca vitulina), northern elephant seals (Eumetopias jubatus), and California sea lions (Zalophus californianus) in Puget Sound.	Western Washington
Puget Sound Environmental Atlas Update 1992	NPDES	National Permit Discharge Elimination System Sites	NPDES Permit sites	Washington, Idaho, and Oregon

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Puget Sound Environmental Atlas Update 1992	Oyster2	Oysters	The known distribution of three oyster species has been mapped : Olympia oyster (Ostrea lurida), The Pacific Oyster (Crassostrea gigas), and European flat oyster (Ostrea edulis).	Puget Sound
Puget Sound Environmental Atlas Update 1992	Porpdall	Dall's Porpoise siting Concentration Area	Areas where Dall's Porpoise (Phocoenoides dalli) have been observed most frequently. The data set contains updated information from the1987 Atlas.	Puget Sound
Puget Sound Environmental Atlas Update 1992	PorpHarb	Harbor Porpoise siting concentration areas	Areas where the harbor porpoise (Phocoena phocoena) has been observed most frequently. The data set is updated from the1987 Atlas, including data from recent surveys of harbor porpoise (Calambokidis et al., 1992).	Puget Sound
Puget Sound Environmental Atlas Update 1992	Salmcmrc	Commercial salmon fishing areas	The areas considered by WDF to be fished commercially more than other areas in Puget Sound. Salmon are harvested recreationally and commercially in all areas of Puget Sound.	Puget Sound
Puget Sound Environmental Atlas Update 1992	Salmsprt	Recreational salmon fishing areas	The areas considered by WDF to be fished recreationally and commercially in all areas of the Sound.	Puget Sound
Puget Sound Environmental Atlas Update 1992	Seabird	Seabird nesting areas and beaches	Nesting sites and beaches in Puget Sound; the following marine seabirds are represented: glaucous winged gull (Larus glauescens), double-crested cormorant (Phalacrocorax auritus), pelagic cormorant (P. pelagicus), pigeon guillemot (Cepphus columba), etc.	Puget Sound

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Puget Sound Environmental Atlas Update 1992	Tribes	Tribal usual and accustomed fishing areas	Puget Sound waters of interest to western Washington treaty tribes are mapped. Numerous court determinations have concluded that these tribes possess treaty fishing rights in or near the indicated waters.	Puget Sound
Puget Sound Environmental Atlas Update 1992	WDIS	Wastewater discharge sites	Contains mostly current, major dischargers, but some minor or non-active dischargers may be included.	Puget Sound
Puget Sound Environmental Atlas Update 1992	Whgray	Gray whale siting concentration areas	Gray whale sitings in Puget Sound	Puget Sound
Puget Sound Environmental Atlas Update 1992	Whkiller	Killer whale siting concentration areas	Killer whale sitings in Puget Sound	Puget Sound
Puget Sound Environmental Atlas Update 1992	Whminke	Minke whale siting concentration areas	Minke whale sitings in Puget Sound	Puget Sound
StreamNet Database	anadpres	Anadromous fish distribution	This dataset is a record of the distribution of anadromous fish based upon the best professional judgement of local fish biologists. This data was collected by biologists at the state fish and wildlife agencies of Washington (WDFW), Oregon (ODFW), and Idaho.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
StreamNet Database	anadrear	Anadromous fish rearing	This dataset contains known rearing areas for anadromous fish.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
StreamNet Database	anadspawn	Anadromous fish spawning	This dataset contains known spawning areas for anadromous fish.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana

Source Publication Title	File Name	Layer Name	Data set description	Study Area
StreamNet Database	banks	Banks hydrography	Contains double-banked streams and rivers, the shorelines of lakes and reservoirs, and the boundaries of glaciers displayed on 1:100,000 scale USGS quadrangle maps.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
StreamNet Database	barriers	Fish Barriers	This dataset contains known anadromous fish barriers by distance up stream from the outlet or confluence.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
StreamNet Database	bullchar	Dolly Varden/Bull Trout	This dataset contains Dolly Varden/Bull trout status information and distribution.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
StreamNet Database	facilities	Production Facilities	Contains data on production facilities, including hatcheries and off-site rearing and staging areas.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
StreamNet Database	lakes	Lakes and Reservoirs	Contains statewide information for lakes and reservoirs.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
StreamNet Database	phsfish	Priority Habitat and Species fish	This dataset contains Priority Habitat and Species fish distribution from WDFW's Priority Habitat and Species database.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
StreamNet Database	resfish	Resident fish	The resident fish layer was based on processes and data types that were originally used in the Pacific Northwest Rivers Assessment Study.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana

Source Publication Title	File Name	Layer Name	Data set description	Study Area
StreamNet Database	str100	Base hydrography	This hydrography layer serves as the base for StreamNet. It is a digital reproduction of the rivers and streams on the 1:100,000 scale US Geological Survey quadrangle maps.	All rivers and streams appearing on the 1:100,000 scale USGS quadrangle maps in Oregon, Washington, Idaho and Montana
unknown	MPA_WDFW	WDFW Marine Protected Area designations	Proposed and current Marine Protected Area (MPA) designations	Washington State waters
unknown	Sediment	Offshore surficial sediment	Marine sediments from NOAA bathymetric survey data	Strait of Juan de Fuca and Pacific Coast of Washington to 48.5d Lat, 125d Long.
unkown	MPA_TEXT	Marine Protected Area Text	For use complementary with MPA_WDFW in Arc/View, to enable placement of MAP and/or WAC and status text. One point is placed for each MPA	Washington State waters
Washington State Shorezone Inventory	szlineth	ShoreZone linear unit theme	An inventory of Washington State's saltwater shorelines using the ShoreZone Mapping System. Physical and biological resources are described, along with information on the inventory data collection. The majority of the spatial data is line data.	Washington State's saltwater shoreline
Washington State Shorezone Inventory	szpoly	ShoreZone polygon unit features	An inventory of Washington State's saltwater shorelines using the ShoreZone Mapping System. Physical and biological resources are described, along with information on the inventory data collection. The majority of the spatial data is line data.	Washington State's saltwater shoreline

Source Publication Title	File Name	Layer Name	Data set description	Study Area
Washington State Shorezone Inventory	szpt	ShoreZone point unit features	An inventory of Washington State's saltwater shorelines using the ShoreZone Mapping System. Physical and biological resources are described, along with information on the inventory data collection. The majority of the spatial data is line data, with some polygons and points.	Washington State's saltwater shoreline
Department of Ecology Shorelands and Coastal Zone Management Program	merge_ps_drift	DOE drift cell	Drift cell information from several 1980-1990's M.S. theses and contract reports.	Puget Sound

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Appendix C

Nearshore Photo Inventory and the GIS Inventory Protocol

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Nearshore Photo Inventory
Program Protocol

PROGRAM SUMMARY

The Nearshore Photo Inventory is designed to collect accurate, comprehensive data on contiguous sections of Puget Sound shoreline, and to present the results in a timely fashion. In developing this program, great consideration was given to ensure that the data being collected:

1. Complements rather than duplicates existing data sets. The scale at which the Nearshore Photo Inventory program is implemented allows for a more refined collection of data than is currently available in existing data sets. This inventorying method provides a finer scale look at the health of nearshore habitats. In turn, this detailed information may indicate to resource managers the need for even more meticulous, targeted data collection to be undertaken on site by biologists, volunteers, or specialized professionals.

2. Can be accurately collected by trained volunteers or interns. People For Puget Sound recognizes that volunteers can be a valuable asset in gathering information that would be cost-prohibitive for agency personnel to collect. However, it is also recognized that collection of certain types of data (such as biological data to the species level), may be best accomplished by professional staff. The data sets presented in the by this approach are those for which volunteers have proven to be successful in absorbing the requisite training and in implementing the collection of accurate data.

3. Provides data geared toward answering specific resource questions: Each type of data within the Nearshore Photo Inventory has been selected for its direct applicability to shoreline resource management. While there is a tremendous amount of information that would be 'good to know', the Nearshore Photo Inventory is designed to provide resource managers with data that can be utilized directly for making resource management decisions. For example, the

data can provide the baseline information to identify specific shoreline areas that are high priority areas for conservation or for habitat restoration.

The process is divided into three activity areas:

- Training/setup: All volunteers new to the Nearshore Photo Inventory program will complete a training session, comprised of one classroom session or one on one training.
- Implementation: People For Puget Sound staff GIS Analyst will assist and manage volunteers. The GIS Analyst will assign data collectors sections of shoreline. Volunteers may work from home from a computer and send data forms electronically or work directly with the GIS Analyst. All forms are quality controlled by a staff member
- Data processing/analysis/presentation: Once shoreline sections have been inventoried, the GIS Analyst will organize the forms for data processing and analysis. Staff train and supervise volunteers to enter the data into the database, and staff review data entry on every 20th form. Once the data is entered, the Data Analysts transfers the data to a Geographic Information System and review the data for gaps and anomalies. Field staff review the data forms and data entry to resolve questions about the data. The Data Analysts then creates standard and customized displays of the data, in consultation with the resource managers, and staff generate a project report based on the original data goals for the project.

PROGRAM DETAIL

Planning

Data Preparation and GIS Setup:

People For Puget Sound will collect and implement existing GIS data into a GIS document containing Ortho rectified base maps and WA DOE oblique photos (2000). A hyperlink will be created that attaches each oblique photo to a GPS point; these points are dispersed at 600 to 800 feet intervals along the shoreline and overlays onto the base maps. This process allows the user to click on a GPS point that brings up the oblique photograph of the shoreline section. From the photograph, an inventory characterizing the nearshore habitats will be made and compiled into a GIS database ready for data analysis.

Training/setup

Volunteer recruitment:

People For Puget Sound will recruit and manage citizen volunteers and GIS interns for Nearshore Photo Inventory. People For Puget Sound will assume responsibility for communicating and organizing from the pool of previously trained Rapid Shoreline Inventory (RSI) volunteers and GIS interns.

Creation of forms/gathering datasets: Once the datasets have been collected and inserted into an ArcGIS map document, data forms should be created and inventory supplies gathered. Staff should create a master form for each inventory day by filling in the date and shoreline section with corresponding photo point numbers.

Training implementation: All volunteers participating in the blueprint analysis must complete a training session, conducted by People For Puget Sound staff (and/or other qualified staff) or be trained individually. The training format is as follows:

- Program description. Includes program background, description of the inventory process, and discussion of the commitment necessary to be a volunteer.
- Presentation on the Puget Sound ecosystem and threats to nearshore and estuary habitat.
- Basics of Puget Sound shoreline ecology, including the vocabulary necessary to conduct the inventory.
- Presentation on GIS and basic ArcMap use.
- Thorough, interactive part-by-part examination of the data form, including areas of possible confusion, allowable and unallowable data choices, and what-if scenarios.
- Demonstration of GIS techniques and determination of necessary shoreline distinctions (i.e., break between backshore and intertidal zones, how to estimate bank/bluff height).

Once volunteers have completed the training series, they are considered 'certified' and qualified to implement Nearshore Photo Inventories on Puget Sound shorelines. Volunteers can work from home computers or when available, work in the offices of People For Puget Sound.

Implementation

After volunteers are trained in reading the aerial photos and entering data, the GIS Analyst will perform quality control and data form review.

A quality control check includes:

- Ensuring that the data form is complete with no areas left blank.
- Ensuring that only allowable entries are listed for each data question.
- Identifying and clarifying any areas of discrepancy or questionable data.
- Initialing each data form as a signal to the data entry staff that the form has received a quality control check
- Answering questions and clarifying any areas of confusion for data collectors.

The majority of staff/volunteers participating in the inventory are data collectors. Data collectors are responsible for:

- Completing data collection for their assigned sections.
- Clarifying with staff any areas of uncertainty or confusion regarding their assigned sections.
- Ensuring that each of their data forms receives a quality control check while they are standing in that section.

Data processing, analysis and presentation

All data gathered using this protocol is public and easily available. At a minimum, any agencies, businesses, or organizations who use this protocol must agree in writing to follow the training and Q/C procedures, to process and analyze the data in a timely fashion, to make the data available to the public, and to deliver the data to People For Puget Sound.

Data entry. Once the inventory has been completed, People For Puget Sound will take possession of the data forms for entry into the Nearshore Photo Inventory database (unless other arrangements for data entry have already been made). The database uses Microsoft Access and Excel as the base software to ensure optimal compatibility with ArcView and ArcInfo GIS software. People For Puget Sound staff and/or volunteers enter all data into the database.

Perform quality control. Volunteers should be instructed to review each form against its computer record to ensure that the record accurately reflects the information collected on the data form. Staff review data entry for each volunteer's first five forms, and then for every 20^{th} form.

Analyze/present data. Data is transferred into People For Puget Sound's GIS system for analysis and presentation. The type of analysis and reporting will vary based on the needs of the resource manager involved in a particular inventory. At a minimum, People For Puget Sound will generate maps presenting the following data sets:

- Shoreline structure presence/absence
- Outfall presence/absence
- Adjacent Land uses

NEARSHORE PHOTO INVENTORY DATA FORM

STANDARDS AND TRAINING PROCEDURES

During the "form training", the trainer should walk through the entire form from top to bottom, explaining every section and each question in detail. Each participant should have a paper copy of the form in front of them. Be sure to include participants in the training process by asking questions and providing ways for them to be engaged throughout the session. The form training is accompanied by transparencies showing each part of the form in full, and slides depicting the different features covered throughout the form. It is also accompanied by a drawing depicting one survey section along the beach indicating the different locations on the beach (i.e. intertidal, backshore, etc.) as well as an explanation of how to call up each oblique survey photo within the ArcGIS software. The trainer will call to attention to beach section overlaps depicted in each photo and to verify that the photo is placed correctly on the coastline. A rectified Orthophoto or digital topographic map will be used as the base map, anchoring the oblique photos to the coastline.

Standards and Definitions

Dominant: That which is 50% or more of the total.

Patchy: Multiple areas of coverage, with space in-between patches. When answering substrate questions, a "patch" should, at minimum, dominate your view looking straight down from a standing position.

Continuous: Any continuous line of coverage *running parallel* to the beach for the entire section. This is a linear measure, not a spatial measure.

Data Form Use Training Procedures

This document gives trainers a guide for instructing the proper use of the data form. It also represents the standards by which we collect data.

Header

Photo Point ID number

- Participant must record the photo point ID number associated with each on screen point. Trainers will emphasize that a systematic approach be used; start at a known end point and begin working down the coast line (from north to south) , clicking at each photo point and recording data along the way.

Steward Name

- Make note that the participants name and the section number needs to appear on every form they turn in.

<u>*Date/Start and End Time*</u>

- We ask for this information so that we can go back and compare the data that was recorded with others participants to avoid overlaps or gaps.
- Make special note of the End Time as it is easily over-looked.

<u>Part 1: Intertidal and Backshore Zone</u>

<u>Intertidal Zone</u>

- Point out that this entire part of the form (as marked in the thick black line at the top of the part) is focused on both the intertidal and backshore zones. Make note that every part of the form is labeled in the same manner (i.e. "Intertidal & Backshore Zones," Bluff/Bank," etc.)

<u>Vegetation Overhanging the Intertidal OR Backshore Zone?</u>

- We are looking for vegetation overhanging the intertidal *or* backshore zone. Distinguish between the two on the form and classify as "none", "patchy", or "continuous".

<u>Are Any of These Features Present?</u>

- Define what spits, bars, tombolos, dunes, driftwood and marshes are. Marshes are defined here as vegetated, and most often represent a "bench," or physical feature (as opposed to a small patch of vegetation on the slope of a beach).
- Emphasize that either "yes" or "no" must be checked for each feature.

<u>Part 2: Streams, Outfalls, and other Discharges</u>

• Note that this data is collected throughout the *Entire Section.*

<u>Number of Outfalls</u>

- Must check either the "Number" box or the "None" box. If there are outfalls in the section then write the *total* number for the entire section on the blank line next to "Number."

<u>Please Provide Details for the Three of the Most Dominant Outfalls:</u>

- *"Most active"* is not the same thing as the *"largest".* By "most active" we mean that we are looking for information about the three outfalls that are producing the most discharge or have the most associated properties.

Type of Outfall

- Run through the list of outfall types and describe each one.

<u>Outfall Associations</u>

- Must check "yes" or "no" for each one.
- Only mark "yes" if the feature is clearly associated with the outfall.
- *Flow* is not speculative, it means at the time of observation.
- *Algae growth* should be attached and obviously related.

- Note that this data is collected throughout the *Entire Section.*

Number of Structures

- Emphasize that this part of the form is used to collect data about *man made* structures that are affecting the shoreline habitat in some way.
- Must either write the number of structures observed or check the "None" box.
- If there are structures in the section, participants should write the total number of structures present in their section on the blank line next to the box labeled "Number".

Provide Data for the Three Largest Structures

- By *largest*, we are looking for the three most dominant and functional structures in the section.

Type of Structure

- Define all structures listed. Most can be defined by their function, and almost every shoreline structure can be put into these categories without using *other*.
- *Piers and docks* tend to be on pilings or floating. The function is to keep structures or passages in place and above the water.
- *Bulkheads and seawalls* sit adjacent to or on the beach, and run parallel to the shoreline. The function is to keep upland sediment from eroding onto the beach.
- *Jetties and groins* also sit on the beach, and run perpendicular to the beach. The function is to trap sand or otherwise prevent the lateral transport of sediment. Large jetties are also built to protect harbors from wave action.
- *Launches and ramps* slope down to the beach. The function is to provide access to the water for boats.
- *Other* is intended for large, often derelict structures sitting on the beach. Be sure to fill in the blank. Mobile debris should not be recorded.

Structure Made From

- Review all of the common material from which shoreline structures are made (i.e. rip rap, wood, concrete, plastic, etc.) Encourage participants to use general categories.

Structure Length

- For all shoreline structures, this is the measurement that runs parallel to the shoreline. Again, this may seem counter-intuitive for some shoreline structures.

Structure Condition

- In deciding on a structure's condition we encourage participants to think about whether or not the structure is still performing its function, and how well it is doing so. Admit that this is a bit of a judgment call on the part of the participant.

- *Fail* means that a portion of the structure within the section is poor, such as rip rap on the beach, erosion from behind a bulkhead, collapsed surface of pier or ramp, etc.
- *Not failing* means that the structure is functioning, with no failure inside the section, but is showing signs of wear, stress or potential failure. These could include cracked concrete, patched/repaired structures, or debris on top of ramps or piers that suggests a lack of use or maintenance.

Part 4: Bluff/Bank

If There is No Bluff or Bank in This Section, Please Check "No" for "Bluff or Bank Present" and Move On to Part 4.

- Define Bluff or Bank. Explain that man made structures such as bulkheads, seawalls, dikes and levees are included in this section. The minimum height for a Bluff or Bank to be considered such, is roughly the height of one's knee (approx. 2 ft.).
- Point out that Bluff/bank data is collected throughout the *Entire Section.*

Is Bluff or Bank Present?

- Must check either "yes" or "no."

Vegetation On the Bluff or Bank

- Classify as "none," "patchy," or "continuous."
- This classification should *not* include algae covering a shoreline structure.

Unvegetated Scars

- Unvegetated scars are areas along the bluff or bank where vegetation is not growing because of erosion (i.e. landslides) or other influences (other than erosion and undercutting.) This does not include naturally occurring rock faces.
- Must classify scars as "none," "patchy," or "continuous." A single scar that is large enough to constitute a "patch" is adequate to classify the section as patchy.

Bottom of Bluff

- Look at the base of the bluff/bank and determine whether or not there are any obvious areas where the bluff/bank is eroding away.

Part 5: Upland Use

- Note that this data is collected throughout the *Entire Section*

Dominant Adjacent Land Use

- Emphasize that the focus is on the *Dominant* land use (over 50%).
- Clearly explain what is meant by *Adjacent.* For this survey we are following the standard definition of *adjacent* as being *that which is immediately next to* the beach. When a bluff is immediately adjacent to the shoreline the adjacent land use classifies what is happening on top of the

bluff. For banks, the adjacent land use includes the face of the bank, up to 200 feet from the shoreline.

- Characterizing the dominant adjacent land use can be fairly subjective and participants are encouraged to consider the dominant *function* of the land adjacent to the beach. It helps to explain that we are looking for how the land located immediately next to the beach is affecting the shoreline.
- Emphasize that only one box can be marked for the first two questions of this section. The last question should be filled out as much as possible with as much detail as possible (numbers, descriptions, etc.)
- Define all land uses listed on the form.
- Distinguish between coniferous and deciduous trees.
- The difference between, *industrial*, *commercial*, or *residential* structures is not always clear. If you can't tell, make your best guess and move on.
- *Crops* and *Pasture*: An easy way to tell the difference between "pasture" and "crops" is that presence of row crops or cultivated soil typically indicates cropland and the presence of large animals or a fenced, grazed field is indicative of pasture land.
- *Lawn:* This classification includes such things as managed parks, picnic areas, etc.
- *Undeveloped/natural* sometimes includes damaged areas overrun with invasive species such as Himalayan blackberries, Scot's broom, etc.

NEARSHORE PHOTO INVENTORY DATA FORM

Name ____________________ **Date** ____________________

County____________________ **Bay/Beach Name** ____________________

Photo ID ____________________ **Start Time** _______ **Stop Time** _________

Intertidal and Backshore Zones
(Zoom on-screen photo to 150%, look at the lower 1/3 area of photo and locate the backshore/intertidal break)

Vegetation overhanging the backshore or intertidal zone?
❑None ❑Patchy ❑Continuous

Are any of these features present?
Spit ❑Yes ❑No
Bar ❑ Yes ❑ No
Tombolo ❑ Yes ❑ No
Intertidal Marsh ❑ Yes ❑ No
Backshore Marsh ❑ Yes ❑ No
Driftwood ❑ Yes ❑ No

Major Streams, Outfalls, and other Discharges
Characterize the 3 most dominant outfalls

Number of visible outfalls _________ or ❑ None

Outfall one:
❑ River (named)
❑ Creek (unnamed)
❑ Seep
❑ Ditch
❑ Pipe or culvert
Associated algal growth?
❑Yes ❑No
Flow? ❑Yes ❑No
Any man-made restriction of vertical flow? ❑Yes ❑No

Outfall two:
❑ River
❑ Creek
❑ Seep
❑ Ditch
❑ Pipe or culvert
Flow? ❑Yes ❑No
Associated algal growth?
❑Yes ❑No
Any man-made restriction of vertical flow? ❑Yes ❑No

Outfall three:
❒ River
❒ Creek
❒ Seep
❒ Ditch
❒ Pipe or culvert
Flow? ❒Yes ❒No
Associated algal growth? ❒Yes ❒No
Any man-made restriction of vertical flow? ❒Yes ❒No

Shoreline Structures
Characterize the 6 most dominate shoreline structures
Number of visible structures __________ or ❒ None
Percentage of the shoreline lined with structures:
❒0-25 ❒26-50% ❒50-75% ❒75-100%

Structure one:
❒ Pier/dock
❒ Bulkhead/seawall
❒ Jetty/groin
❒ Dike/levee
❒ Launch/ramp
❒ Other ____________________
Made from: __________________
Length: ❒0-25 ❒26-50%
❒50-75% ❒75-100%
Any sign of failure? ❒Yes ❒No
Does structure extend in the intertidal zone (verses just in the backshore)? ❒Yes ❒No

Structure two:
❒ Pier/dock
❒ Bulkhead/seawall
❒ Jetty/groin
❒ Dike/levee
❒ Launch/ramp
❒ Other____________________
Made from: __________________
Length: ❒0-25 ❒26-50%
❒50-75% ❒75-100%
Any sign of failure? ❒Yes ❒No
Does structure extend in the intertidal zone? ❒Yes ❒No

Structure three:
❒ Pier/dock
❒ Bulkhead/seawall
❒ Jetty/groin
❒ Dike/levee
❒ Launch/ramp
❒ Other ____________________
Made from: __________________
Length: ❒0-25 ❒26-50%
❒50-75% ❒75-100%
Any sign of failure? ❒Yes ❒No
Does structure extend in the intertidal zone? ❒Yes ❒No

Structure four:
❒ Pier/dock
❒ Bulkhead/seawall
❒ Jetty/groin
❒ Dike/levee
❒ Launch/ramp
❒ Other ____________________
Made from: __________________
Length: ❒0-25 ❒26-50%
❒50-75% ❒75-100%
Any sign of failure? ❒Yes ❒No
Does structure extend in the intertidal zone? ❒Yes ❒No

Structure five:
❒ Pier/dock
❒ Bulkhead/seawall
❒ Jetty/groin
❒ Dike/levee
❒ Launch/ramp
❒ Other ____________________
Made from: ___________________
Length: ❒0-25 ❒26-50%
❒50-75% ❒75-100%
Any sign of failure? ❒Yes ❒No
Does structure extend in the intertidal zone? ❒Yes ❒No

Structure six:
❒ Pier/dock
❒ Bulkhead/seawall
❒ Jetty/groin
❒ Dike/levee
❒ Launch/ramp
❒ Other ____________________
Made from: ___________________
Length: ❒0-25 ❒26-50%
❒50-75% ❒75-100%
Any sign of failure? ❒Yes ❒No
Does structure extend in the intertidal zone? ❒Yes ❒No

Bluff/Bank

Is bluff or bank present? ❒Yes ❒No

Vegetation on the bluff or bank?
❒None ❒Patchy ❒Continuous

Un-vegetated scars?
❒None ❒Patchy ❒Continuous

Bulkheading contiguous with un-vegetated scars?
❒None ❒Patchy ❒Continuous

Bedrock at high tide line?
❒None ❒Patchy ❒Continuous

Upland Land Use

Dominant upland land use/vegetations for entire frame? (pick one)
- ❒ Undeveloped/natural
  - ❒ Coniferous trees
  - ❒ Deciduous trees
  - ❒ Wetland
  - ❒ Grassland & Brush
  - ❒ Riparian vegetation/Mixed
- ❒ Buildings or Structures
- ❒ Paved road or lot
- ❒ Unpaved road or lot
- ❒ Railroad
- ❒ Pasture
- ❒ Row crops
- ❒ Lawn

Dominant upland land use **immediately** adjacent to the intertidal? (pick one)

- ❒ Undeveloped/natural
- ❒ Buildings or Structures
- ❒ Paved road, trail or lot
- ❒ Unpaved road, trail or lot
- ❒ Railroad
- ❒ Pasture
- ❒ Row crops
- ❒ Lawn

Complete land uses – enumerate or choose all that apply?

Number of buildings_______________

Number of other structures (not in the intertidal) ____________

Number of paved roads or trails _______________

Number of paved lots capable of holding

< 10 vehicles_________________

> 10 vehicles_________________

Number of dirt roads, trails or lots____________

Number of access points (trails, stairs) to the beach _________

Other features present (pick as many as apply)

- ❒ Undeveloped/natural
  - ❒ Grass & Brush
  - ❒ Coniferous Trees
  - ❒ Deciduous Trees
  - ❒ Wetland (Marsh, pond, lake)
- ❒ Railroad
- ❒ Pasture (cows and fences)
- ❒ Row crops
- ❒ Lawn

Thank you for completing this survey, please check to see that all questions are answered and that your finish time is filled out.

Additional Notes:

Automated GIS Survey for the Bays Blueprint 2005

December 2005 the Bays Blueprint GIS Survey was partially automated to save time and improve precession and consistency.

The survey looks for two different kinds of data for each of the photo points: Proximity data which is answered by ranges, and text data (Ex: type of substrate, Patchy, Continuous). All of these data can be obtained by using ArcMaps Spatial Join, which can join the nearest features of interest to the photo points and record the distance. There are 11 layers with features of interest, in both shapefile and coverage form. To speed things up farther a model in ArcTools has been developed to calculate the distance for the 6 proximity data features. This reduces the number of datasets to be spatially joined to 4, leaving only one layer to be analyzed manually.

The only question this procedure does not answer is presence or absence of stream in the 800 ft section. A factor in the stream data that distinguishes shoreline from a stream must be found to finish the automation procedure. The research has not been done on the str100 coverage to determine how it can be automated yet, however it is known that the national hydrological dataset does have a field for distinguishing that question. Guemes Island only has one stream so it was entered manually.

Procedure:

1. Compile datasets into one mxd, projecting as needed. The majority of the data was in NAD27 State Plane South, so the project was completed in this projection. It was found that to project NAD83 Harn to NAD27, the feature needed to be first converted to NAD83 from Harn, then to NAD27.

2. Spatially Join the photo points shapefile to the following datasets

    Shore Zone Dataset
    Shorline Substrate, Eelgrass, Kelp, Algae, and Beach Energy can be calculated from the szlineth arc, using the fields BCname, Bio_Unit, and ExpClass. Spatially join the photo points shapefile to the szlineth coverage in ArcMap. The Shore Zone dataset is full of data that could be tapped more in future models.

    WA DOE (Drift Cell) Dataset
    The field CELL_TYP in merge_ps_drift was used to determine drift cell type.

    WA DOE (Slope Stability) Dataset
    The field SLP_CLASS in Skagit_sp slope was used to determine slope stability.

    Parcel Data
    The field OWNAGTNM in the Aqueous Parcels dataset was used to determine beach ownership. The Skagit County Assessor's Office also has a dataset. To use that dataset with this method the beach ownership would have to be separated by the land to ensure that the points were spatially joined only to the beach data.

3. Clean the fields in excel to remove unwanted field, reorder fields, and rename the distance fields created by the joins

4. Run the BBP Proximity tool. This will calculate the distance between each photo point and its closest feature in question. The datasets/features calculated are: Herring Holding grounds, Herring Spawning grounds, Salmon bearing stream, Sand Lance, Smelt, and Birds Nest proximity.

5. Import to the Access database GIS_Photo Inventory. Once imported to the GIS Photo Inventory Database the GIS data can be added to the form collected Photo Inventory data and run through Analysis. A set of macros have been created within the database for analysis and table creation. The 'BBP 2005' group has the macros, queries-(both in chronological order)- tables, and forms needed for the general analysis. More tools are available in the database for editing of the analysis code, and validation. A Word file with the analysis code is also available for editing ease. For more information on editing the code and automation contact Starla DeLorey.

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Appendix D

The Analytic Models

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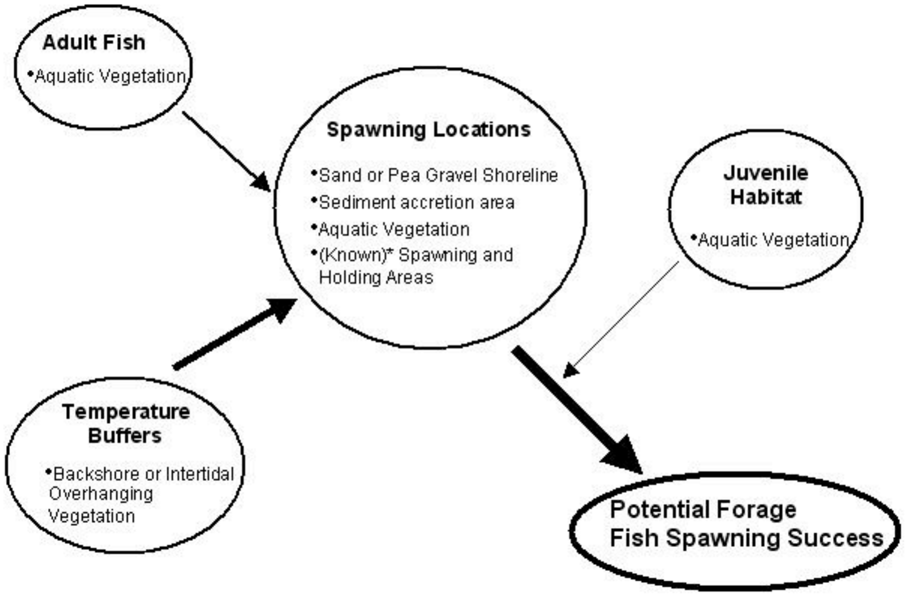
Model 1. Potential Forage Fish Spawning Habitat

Conceptual Model:



Forage fish, including populations of Pacific Herring (*Clupea harengus*), surft smelt (*Hypomesus pretiosus*), and Pacific sand lance (*Ammodytes hexapterus*), are an essential component of the Puget Sound food web. These three species comprise an essential trophic link within the nearshore environment, and are a major component of the diet of many predatory species like salmonids (Bargmann 1998). While little is know about the adult life stages of forage fish, spawning preferences and requirements are generally understood. This analysis is an extension of surveys that identify forage fish spawn; this model focuses on both current and potential spawning habitat. While forage fish may use the same sites for spawning over long periods of time (Pentilla 1995), a site may be abandoned for no apparent reason only to become used again at some point in the future (Robards et al. 1999).

Shoreline surveys that identify spawning beaches have been conducted by the Washingtone State Department of Fish and Wildlife since 1972 (known areas*). Based on information obtained during these surveys, surf smelt and sand lance are thought to spawn selectively in shorelines that have deposits of either sand or pea-gravel sized sediment in the upper intertidal zone (Bargmann 1998). In addition to substrate preferences and requirements, forage fish eggs tend to have lower mortality when there is riparian vegetation adjacent to shoreline that can shade the shoreline and moderate temperatures (Robbards et al. 1999). Pacific herring vary slightly from smelt and sand lance in that herring spawn primarily in lower intertidal and shallow subtidal zones, attaching eggs to vegetation such as eelgrass or kelp (Pentilla, *pers. comm.* 2001).

The forage fish analysis focuses on identifying those beaches with conditions that would seem to favor forage fish spawning and spawn survival. Positive attributes for shorelines include appropriate sediment found in the upper intertidal, overhanging vegetation, as well as aquatic vegetation that might be used for spawning. Negative components are primarily those that interrupt or disturb potential spawning areas or the processes that form potential spawning areas. These include artificial outfalls which may supply excessive nutrients or toxic chemicals to the shoreline, bulkheads which alter nearshore hydrography, or piers that shade subtidal vegetation.

Model Analysis: *Forage Fish Analysis*

Conservation Score = (Shoreline Substrate + Spit + Bar + Tombolo + Marsh + Driftwood + Creek/River Mouth + Herring Holding Areas + Herring Spawning Areas + Eelgrass + Kelp + Algae + Overhanging Vegetation + Bluff/Bank) + (Dominant Upland Cover + Shoreline Structures + Length of Shoreline Structures + Bedrock at High Tide)

Restoration Score = (Shoreline Substrate + Spit + Bar + Tombolo + Marsh + Driftwood + Creek/River Mouth + Herring Holding Areas + Herring Spawning Areas + Eelgrass + Kelp + Algae + Overhanging Vegetation + Bluff/Bank) * (Dominant Upland Cover + Shoreline Structures + Length of Shoreline Structures + Bedrock at High Tide)

People For Puget Sound

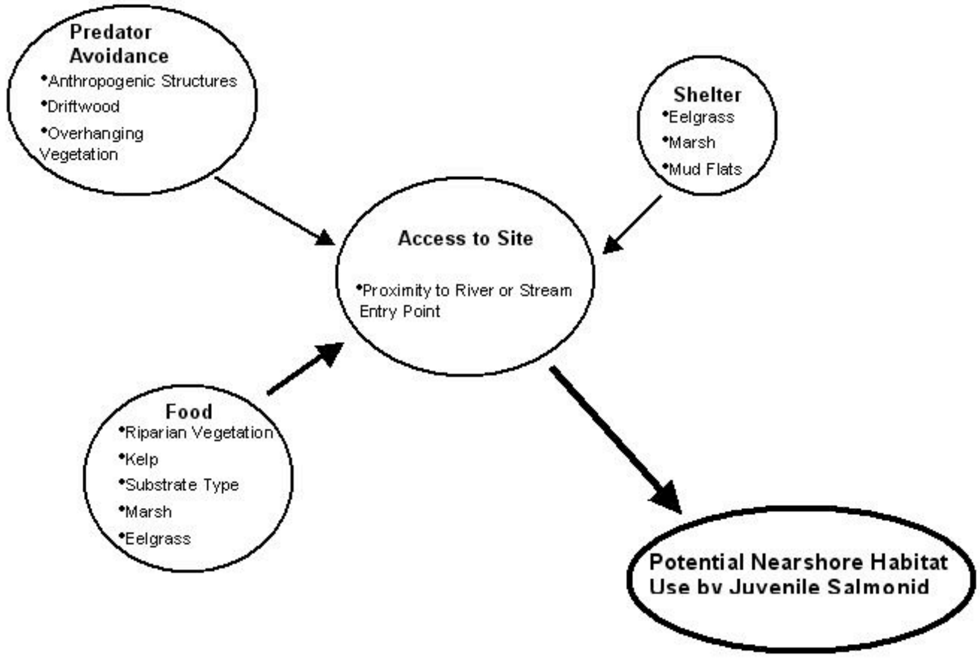
Model 1: Forage Fish Model Breakdown

Habitat Attribute	Habitat Quality Value	Data Source
Geophysical Characteristics		
Shoreline Substrate	(0 to 15)	ShoreZone (WDNR)
Rock cliff	0	
Rock platform	0	
Rock with sand and gravel beach	3	
Rock with gravel beach	3	
Rock with sand beach	3	
Gravel beach	5	
Gravel flat	5	
Sand with gravel beach	15	
Sand and gravel flat	15	
Sand beach	5	
Sand flat	5	
Channel	5	
Estuary wetland	10	
Mud flat	5	
Man-made	0	
Intertidal Habitat Features	(0 to 10)	Oblique Photo (WA DOE)
Spit	10	
Bar	5	
Tombolo	10	
Marsh (Intertidal or Backshore)	5	
Driftwood	5	
Creek/River Mouth	5	
Proximity Herring Holding Areas	(0 to 10)	Streamnet (WDFW)
< 100 ft	10	
100 – 1500 ft	5	
> 1500 ft	0	
Proximity Herring Spawning Areas	(0 to 10)	Streamnet (WDFW)
< 100 ft	10	
100 – 1500 ft	5	
> 1500 ft	0	
Vegetation Characteristics		
Eelgrass	(0 to 10)	ShoreZone (WDNR)
None	0	
Patchy	10	
Continuous	10	
Kelp	(0 to 10)	ShoreZone (WDNR)
None	0	
Patchy	5	
Continuous	10	
Algae	(0 to 10)	ShoreZone (WDNR)
None	0	
Patchy	5	
Continuous	10	

Model 1 (cont.): Forage Fish Model Breakdown

Overhanging Vegetation	(0 to 10)	Oblique Photo (WA DOE)
None	0	
Patchy	8	
Continuous	10	
Bluff/Bank Presence	(0 *or* 5)	Oblique Photo (WA DOE)
Habitat Impact	**Habitat Quality Value**	**Source**
Anthropogenic Characteristics		
Upland Land Use	(-20 to 10)	Oblique Photo (WA DOE)
Undeveloped/natural	10	
Pond/lake	10	
Buildings/structures	-20	
Unpaved road/lot	-10	
Paved road/lot	-20	
Railroad	-20	
Pasture	-10	
Agricultural, or Row crops	-10	
Lawn	-10	
Golf course	-10	
Shoreline Structures	(0 to -20)	Oblique Photo (WA DOE)
Pier/dock	-10	
Bulkhead/seawall	0	
Jetty/groin	-10	
Dike/levee	-10	
Launch/ramp	-20	
Other	-5	
Bedrock	(0 to -20)	Oblique Photo (WA DOE)
None	0	
Patchy	-10	
Continuous	-20	
Shoreline Development		
Proportion of Structure	(0 to -40)	Oblique Photo (WA DOE)
1-25%	-10	
26–50%	-20	
51–75%	-30	
76–100%	-40	

Conceptual Model:



The salmon habitat analysis relies on the assumption that nearshore habitats provide key functions for many juvenile salmon development and survival, such as juvenile chum and ocean-type chinook. Nearshore marine habitat may serve as migration corridors, feeding areas, physiological transition zones, refuge from predators, or refuge from high energy wave dynamics (Mason 1970; MacDonald et al. 1987; Thrope 1994; Levings 1994; Spence et al.1996). Most juvenile salmon use the shallow waters of estuaries and nearshore areas as migration corridors to move from their natal streams through Puget Sound to the ocean (Williams and Thom 2001). Estuarine environments provide a gradual transition area for juvenile salmon to adjust physiologically to salt water (Simenstad et al. 1982). With declines in aquatic vegetation that formerly served as feeding grounds and refugia for juvenile salmonid, it is likely that juvenile salmon have shifted their distributions and now use shallow water as an alternate refuge habitat (Ruiz et al. 1993).

This model focuses on valuing individual sites for their capacity to serve as feeding area, refugia, or migration corridors for juvenile salmon. Emergent vegetation (*Carex lyngbyei*, *Scirpus* spp., etc.) and riparian shrubs and trees have been identified as vital components that provide detritus and habitat for chinook food organisms (Levings et al. 1991, Cordell et al. 2001), and were scored appropriately. Habitat impacts are those features that are known to displace habitat or impede habitat forming processes. These include structures that reduce shallow water nearshore habitat or adjacent land uses that may impact vegetation and upland food sources.

Model Analysis: *Juvenile Salmon Analysis*

Conservation Score = (Shoreline Substrate + Spit + Bar + Tombolo + Marsh + Driftwood + Creek/River Mouth + Salmon Bearing Streams + Eelgrass + Kelp + Overhanging Vegetation + Vegetation on Bluff/Bank) + (Dominant Upland Cover + Shoreline Structures + Length of Shoreline Structures)
Restoration Score = (Shoreline Substrate + Spit + Bar + Tombolo + Marsh + Driftwood + Creek/River Mouth + Salmon Bearing Streams + Eelgrass + Kelp + Overhanging Vegetation + Vegetation on Bluff/Bank) * (Dominant Upland Cover + Shoreline Structures + Length of Shoreline Structures)

Model 2: Salmon Habitat Model Breakdown

Habitat Attribute	Habitat Quality Value	Certainty Rating of Habitat Value	Data Source
Geophysical Characteristics			
Shoreline Substrate	(0 to 15)		ShoreZone (WDNR)
Rock cliff	0	L	
Rock platform	3	L	
Rock with sand and gravel beach	3	L	
Rock with gravel beach	2	L	
Rock with sand beach	2	L	
Gravel beach	3	L	
Gravel flat	6	M	
Sand with gravel beach	3	L	
Sand and gravel flat	7	L	
Sand beach	5	L	
Sand flat	11	M	
Channel	15	H	
Estuary wetland	12	H	
Mud flat	15	H	
Man-made	3	L	
Intertidal Habitat Features	(0 to 10)		Oblique Photo (WA DOE)
Spit	5	L	
Bar	5	L	
Tombolo	5	L	
Marsh (Intertidal or Backshore)	10	H	
Driftwood	10	L	
Creek/River Mouth	10	H	
Proximity Salmon Bearing Streams	(0 to 15)		Streamnet (WDFW)
< 100 ft	15	H	
100 – 1500 ft	10	H	
1500 ft – 5000 ft	5	H	
> 5000 ft	0	H	
Vegetation Characteristics			
Eelgrass	(0 to 15)		ShoreZone (WDNR)
None	0	M	
Patchy	7	H	
Continuous	15	H	
Kelp	(0 to 5)		ShoreZone (WDNR)
None	0	H	
Patchy	3	H	
Continuous	5	H	
Overhanging Vegetation	(0 to 20)		Oblique Photo (WA DOE)
None	0	L	
Patchy	15	M	
Continuous	20	M	

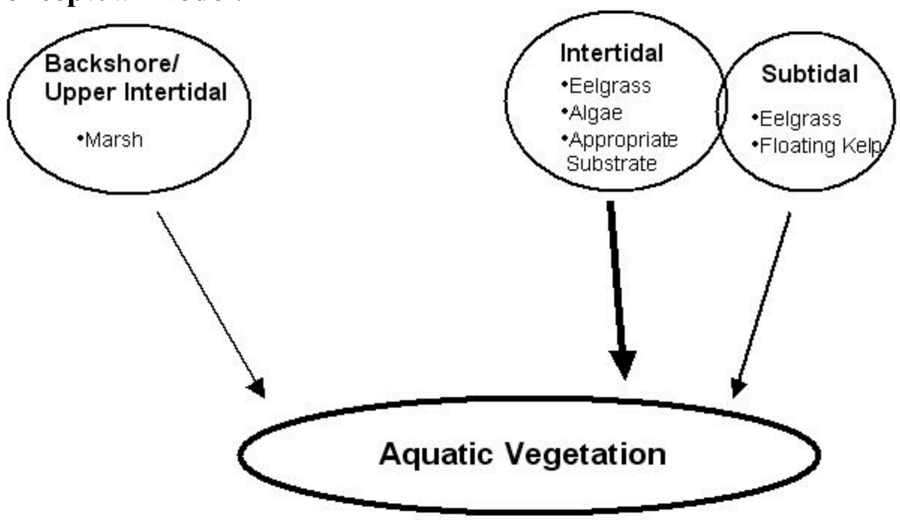
Bluff/Bank Vegetation	(0 to 5)		Oblique Photo (WA DOE)
None	0	M	
Patchy	3	H	
Continuous	5	H	

Model 2 (cont.): Salmon Habitat Model Breakdown

Habitat Impact	**Habitat Quality Value**	**Certainty Rating of Habitat Value**	**Source**
Anthropogenic Characteristics			
Upland Land Use	(-30 to 10)		Oblique Photo (WA DOE)
Undeveloped/natural	10	L	
Pond/lake	10		
Buildings/structures	-30	L	
Unpaved road/lot	-10	L	
Paved road/lot	-30	L	
Railroad	-30	L	
Pasture	-10	L	
Agricultural, or Row crops	-15	L	
Lawn	-20	L	
Golf course	-10	L	
Shoreline Structures	(0 to -30)		Oblique Photo (WA DOE)
Pier/dock	-30	M	
Bulkhead/seawall	0	L	
Jetty/groin	-10	M	
Dike/levee	-20	L	
Launch/ramp	-20	L	
Other	-5		
Shoreline Development			
Proportion of Structure	(0 to -40)		Oblique Photo (WA DOE)
1-25%	-10	L	
26–50%	-20	L	
51–75%	-30	L	
76–100%	-40	H	

<u>Model 3. Presence of Aquatic Vegetation</u>

Conceptual Model:



Primary production forms the base of any food web, and in the Puget Sound the primary producers are seaweeds, sea grasses, benthic microalage, kelps, marsh macrophytes, and phytoplankton. In Puget Sound, areas of increased algae and seagrass density or biomass, contain more species and a greater abundance of epibenthic invertebrates than do areas of lower vegetative cover or structure (Cheney et al. 1994). With the exception of estuary marsh vegetation, which was formerly widespread in and around the major bays and deltas of the Sound (Bortleson 1980), primary production is limited to a relatively narrow band of habitat as a result of steep fjord-like character of Puget Sound's nearshore habitat. Any attempt to determine the suitability of a certain areas as habitat for submersed aquatic vegetation (SAV) must take into consideration light and parameters that modify light (epiphytes, total suspended solids, chlorophyll concentration, nutrients) (Koch 2001). Anthropogenic nitrogen loads to shallow coastal waters have been linked to shifts from seagrass to algae-dominated communities in many regions of the world (McClelland and Valiela 1998). Propagules of most types of aquatic vegetation are generally a result of either inappropriate habitat for colonization and survival or displacement by another type of aquatic vegetation (Moore et al. 1996).

The focus of this analysis is on direct observations of aquatic vegetation with individual types of aquatic vegetation valued primarily for their ecological "services". Implicit in the scoring of this model is the underlying assumption that each type of aquatic vegetation typically occupies a particular zone in the nearshore environment, from the subtidal to the upper intertidal. Species and multi-species assemblage scores are largely based in the ecological services they provide and the number of zones they occupy. Factors affecting light availability and nutrient loading are assessed as detractors in this model.

Model Analysis: *Aquatic Vegetation Analysis*

Conservation Score = (Vegetation Matrix*) + (Shoreline Structures + Length of Shoreline Structures)

Restoration Score = (Vegetation Matrix*) * (Shoreline Structures + Length of Shoreline Structures)

Model 3: Aquatic Vegetation Model Breakdown

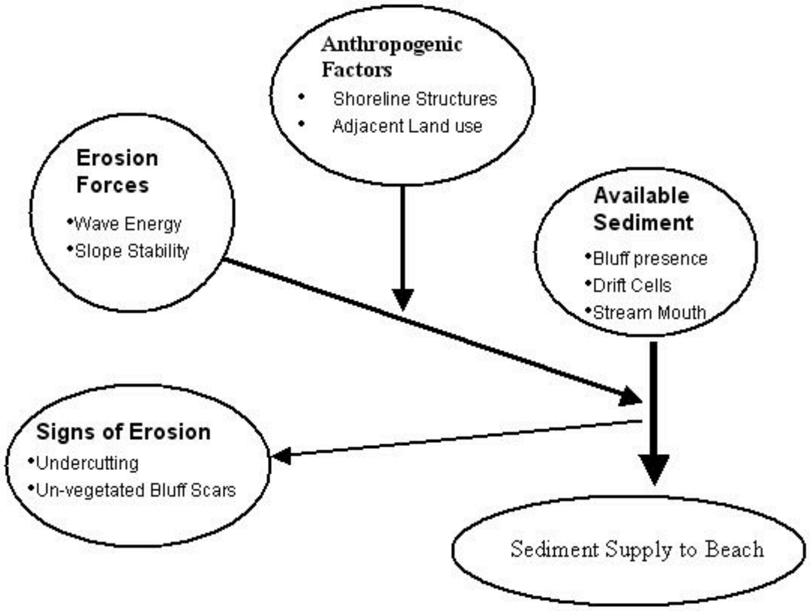
Habitat Attribute	Habitat Quality Value	Data Source
Vegetation		
Eelgrass	***See Matrix Below***	ShoreZone (WDNR)
None		
Patchy		
Continuous		
Kelp	***See Matrix Below***	ShoreZone (WDNR)
None		
Patchy		
Continuous		
Algae	***See Matrix Below***	ShoreZone (WDNR)
None		
Patchy		
Continuous		
Marsh	***See Matrix Below***	Oblique Photo (WDOE)
Habitat Impact	**Habitat Quality Value**	**Data Source**
Shoreline Structure	(0 to -20)	Oblique Photo (WA DOE)
Pier/dock	-20	
Bulkhead/seawall	0	
Jetty/groin	0	
Dike/levee	-20	
Launch/ramp	-10	
Other	-5	
Shoreline Development		
Proportion of Structure	(0 to -40)	Oblique Photo (WA DOE)
1-25%	-10	
2 –50%	-20	
51–75%	-30	
76–100%	-40	

*Aquatic Vegetation Matrix

Eelgrass (Patcy or Continuous)	Kelp (Patchy or Continuous)	Algae (Patchy or Continuous)	Marsh (Intertidal or Backshore)	Score
x	x	x	x	100
x	x		x	90
x		x	x	90
x			x	85
	x	x	x	70
	x		x	60
		x	x	60
x	x			50
x		x		50
x	x	x		60
			x	40
x				40
	x	x		30
	x			20
		x		20
				0

Model 4. Beach Sediment Supply

Conceptual Model:



Puget Sound's shorelines are composed of hundreds of littoral cells that redistribute sediment along the shoreline. In the relatively protected waters of the Sound, the primary sources of sediment to the shoreline are alongshore and onshore transports, bluff erosion, and beach nourishment. Sediment is lost from the beach as a result of erosion and longshore transport or deposition on the spits (Downing 1983). Shoreline development and armoring actively impact beaches by altering sediment supply and transport processes on shorelines and by directly modifying and occupying critical habitats (Shipman and canning 1998, Shipman 1995).

The focus of this analysis is on identifying signs that sediment budget is being filled by looking for evidence of active erosion, in particular bluff faces, and areas of deposition that are found at the end of drift cells such as tombolos and spits. Above is a simplified model of factors affecting sediment supply to beaches using existing geospatially-referenced species and habitat data within Puget Sound.

Model Analysis: ***Sediment Supply Analysis***

Conservation Score = (Beach Energy + Slope Stability + Unvegetated Scars + Bluff Bulkhead Scars + Drift Cells + Bluff/Bank + Creek/River Mouth) + (Shoreline Structures + Length of Shoreline Structures)

Restoration Score = (Beach Energy + Slope Stability + Unvegetated Scars + Bluff Bulkhead Scars + Drift Cells + Bluff/Bank + Creek/River Mouth) * (Shoreline Structures + Length of Shoreline Structures)

Model 4: Beach Sediment Supply Model Breakdown

Habitat Attribute	**Habitat Quality Value**	**Data Source**
Erosion Forces		
Beach Energy	(0 to 20)	ShoreZone (WDNR)
Very protected	0	
Protected	7	
Semi-protected	14	
Semi-exposed	20	
Exposed	20	
Very exposed	20	
Slope Stability	(0 to 20)	WA DOE
Modified	0	
Stable slope	0	
Intermediate	0	
Unstable slope	10	
Unstable-old	20	
Unstable-recent	20	
Signs of Erosion		
Bluff Scars	(0 to 20)	Oblique Photo (WA DOE)
None	0	
Patchy	10	
Continuous	20	
Bluff Bulkheaded	(0 to 20)	Oblique Photo (WA DOE)
None	0	
Patchy	10	
Continuous	20	
Available Sediment		
Drift Cells*	(0 to 20)	WA DOE
Divergence Zone	20	
Left to Right	10	
Right to Left	10	
No Appreciable Drift	0	
Bluff Presence	0 *or* 20	Oblique Photo (WA DOE)
Presence of Stream	0 *or* 20	Streamnet (WDFW) and Oblique Photo (WA DOE)
Habitat Impact	**Habitat Quality Value**	**Data Source**
Shoreline Development		
Shoreline Structure	(0 to -20)	Oblique Photo (WA DOE)
Pier/dock	-5	
Bulkhead/seawall	0	
Jetty/groin	-20	
Dike/levee	0	
Launch/ramp	-20	
Other	-5	

Model 4: Beach Sediment Supply Model Breakdown (continued)

Proportion of Armoring	(0 to -40)	Oblique Photo (WA DOE)
1-25%	-10	
26–50%	-20	
51–75%	-30	
76–100%	-40	
Upland Land Use	(10 to -20)	Oblique Photo (WA DOE)
Buildings/structures	-20	
Unpaved road/lot	-15	
Paved road/lot	-20	
Railroad	-20	
Pasture	-10	
Agricultural, or Row crops	-10	
Lawn	-10	
Golf course	-10	
Undeveloped/natural	+10	
Pond/lake	+10	

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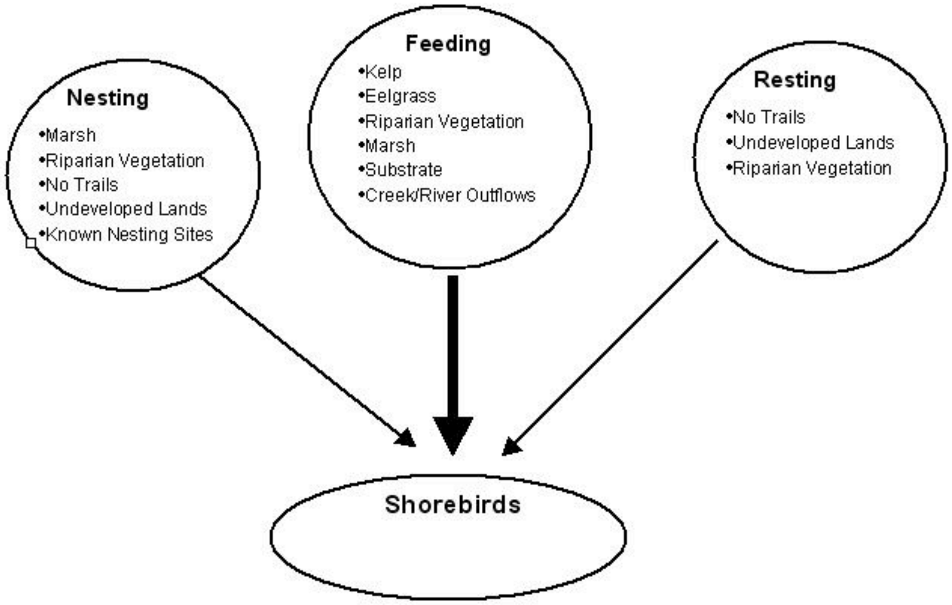
Model 5. Marine Bird

Conceptual Model:



Many terrestrial animals spend part or all of their lives within the nearshore environment and have a great impact on the composition and functions of the nearshore ecosystem. An essential component of the nearshore ecosystem is marine birds; specifically the intertidal birds. Marine birds are often the dominant predators along rocky and sandy beaches (Hori and Noda 2001). In addition to being a dominant consumer of animals, most birds are omnivores and play a critical role in structuring both fauna and flora species assemblage in the nearshore ecosystem.

This analysis focuses on habitat components that contribute to the feeding and nesting behaviors exhibited during the breeding season of many soft intertidal feeding shorebirds. This analysis looks at a variety of shoreline features that are beneficial for a variety of birds that depend on marine shorelines. It awards points for fine sediment where intertidal shorebirds forage and niche habitats where rivers and creeks meet salt water. Negative components are primarily anthropogenic structures that encroach on to nesting and foraging habitats adjacent to and along the shoreline.

Model Analysis: *Marine Bird Analysis*

Conservation Score = (Shoreline Substrate + Spit + Bar + Tombolo + Marsh + Driftwood + Creek/River Mouth + Eelgrass + Kelp + Algae + Overhanging Vegetation + Vegetation on Bluff/Bank + Nesting Location) + (Dominant Upland Cover + Shoreline Structures + Length of Shoreline Structures + Number of Trails)

Restoration Score = (Shoreline Substrate + Spit + Bar + Tombolo + Marsh + Driftwood + Creek/River Mouth + Eelgrass + Kelp + Algae + Overhanging Vegetation + Vegetation on Bluff/Bank + Nesting Location) * (Dominant Upland Cover + Shoreline Structures + Length of Shoreline Structures + Number of Trails)

Model 5: Intertidal Shorebirds Model Breakdown

Habitat Attribute	Habitat Quality Value	Data Source
Geophysical Characteristics		
Shoreline Substrate	(0 to 20)	ShoreZone (WDNR)
Rock cliff	0	
Rock platform	0	
Rock with sand and gravel beach	0	
Rock with gravel beach	0	
Rock with sand beach	0	
Gravel beach	8	
Gravel flat	8	
Sand with gravel beach	8	
Sand and gravel flat	8	
Sand beach	12	
Sand flat	12	
Channel	20	
Estuary wetland	10	
Mud flat	20	
Man-made	0	
Intertidal Habitat Features	(0 to 10)	Oblique Photo (WA DOE)
Spit	5	
Bar	5	
Tombolo	5	
Marsh	10	
Driftwood	5	
Creek/River Mouth	10	
Vegetation Characteristics		
Eelgrass	(0 to 10)	ShoreZone (WDNR)
None	0	
Patchy	5	
Continuous	10	
Kelp	(0 to 5)	ShoreZone (WDNR)
None	0	
Patchy	3	
Continuous	5	
Algae	(0 to 5)	ShoreZone (WDNR)
None	0	
Patchy	3	
Continuous	5	
Overhanging Vegetation	(0 to 15)	Oblique Photo (WA DOE)
None	0	
Patchy	7	
Continuous	15	
Bluff/Bank Vegetation	(0 to 5)	Oblique Photo (WA DOE)
None	0	
Patchy	7	
Continuous	15	

Site Location		
Proximity Known nesting location	(0 to 20)	Seabird Colony (WDFW)
> 3000 ft	0	
1000 – 3000 ft	10	
< 1000 ft	20	

Habitat Impact	**Habitat Quality Value**	**Source**
Anthropogenic Characteristics		
Upland Land Use	(-30 to 10)	Oblique Photo (WA DOE)
Undeveloped/natural	10	
Pond/lake	10	
Buildings/structures	-30	
Unpaved road/lot	-10	
Paved road/lot	-30	
Railroad	-30	
Pasture	5	
Agricultural, or Row crops	5	
Lawn	-10	
Golf course	3	
Shoreline Structures	(0 to -20)	Oblique Photo (WA DOE)
Pier/dock	-20	
Bulkhead/seawall	0	
Jetty/groin	-20	
Dike/levee	-10	
Launch/ramp	-20	
Other	-5	
Shoreline Development		
Proportion of Structure	(0 to -40)	Oblique Photo (WA DOE)
1-25%	-10	
26–50%	-20	
51–75%	-30	
76–100%	-40	
Trail Presence	(0 *or* -10)	

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Proposed Assessment Criteria for Analyses

I. GeoPhysical Characteristics	**Justification**
Spit, Bar, or Tombolo	Substrate source in area Indicates sediment deposition
Upper Intertidal Substrate	Indicates habitat use (i.e., Sand/Pea gravel bed use as spawning area)
Bluff (patchy/continuous)	Substrate source in area
Bluff with scar	Substrate source in area
Driftwood	Habitat for prey resource; refugia Indicates sediment deposition
Creek or River Mouth	Habitat for prey resource; migration corridor; physiological transition zone
Proximity to documented Herring Holding Areas	Link for Herring that spawn near holding areas
Proximity to Salmonid Bearing Stream	Migration corridor
II. Vegetation Characteristics	
Eelgrass	Spawning medium; prey resource Salmon/forage fish refugia
Kelp & Intertidal algae	Spawning medium; prey resource Salmon/forage fish refugia
Overhanging Vegetation	Shades spawn; prey resource (insects)
Backshore/Intertidal Marsh	Provides prey resource; shelter
Riparian Vegetation	Habitat for prey resource; refugia; Shade; nesting
Bluff/Bank Vegetation	Habitat for prey resource; nesting
III. Anthropogenic Characteristics	
Undeveloped or Natural Adjacent Land use	Undeveloped areas represent lack of disturbance and likely to have native flora
No intertidal structures	Nearshore hydrography likely intact

IV. Habitat Impact

Intertidal Structures	Structures impact nearshore hydrography and sediment transport
Shoreline Armoring	Removes refugia; removes prey resource; Ceases erosion of fine sediments; removes Sediment sources
Upland Land use	Potential or actual impacts to shoreline, Water quality, light, noise; no adjacent vegetation
Boat Ramp	Potential for continual damage through use and potentially altered nearshore hydrography
Potentially polluted outfalls	Signs of pollutants and/or excess nutrients

Appendix E

The Feasibility Criteria
and Worksheets

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- Site 1- The shoreline extending from the North county line down to the outlet of Harrison creek (McIlroy Slough). This entire stretch came out in the top tier of the Conservation ranking. This high overall score was due to high Conservation scores on the Forage Fish model, Juvenile Salmon Habitat model, and Marine Bird Habitat model. A quick look at the overall Restoration map showed a single point within the stretch that was ranked high. The data showed that this was due to the dock at Taylor Shellfish Farm. Ivar Dolph, MRC sub-committee, mentioned that the oyster growers would be interested in conservation actions in this area.

- Site 2- East side of Samish Island at the Church camp lagoon. It was agreed upon by the MRC sub-committee that this site would be good for conservation actions since the landowners are already interested.

- Site 3- A section of shoreline along Guemes channel at the North end of Fidalgo Island. Jeanne Robinette, MRC Sub-committee, pointed out that this is a low-density residential area under new development, and this would be a good time to start conservation actions there.

- Site 4- Short stretch of shoreline North of Bayview State Park. This site had high Conservation scores for marine bird habitat and juvenile salmon habitat, and median scores for forage fish and beach sediment supply.

- Site 5- South end of March Point, near the bluffs.

- Site 6- Northwest point of Samish Island. This site ranked high for beach sediment supply, forage fish, and juvenile salmon habitat. It was mentioned by the MRC sub-committee that this site has feeder bluffs that should be conserved.

- Site 7- Southwest end of Samish Island at Camp Kirby. This site scored similar to Site 6. It also features public property, which is a plus.

- Site 8- Northeast point of Samish Island. This site scored high for restoration on the Aquatic Vegetation, Forage Fish, and Juvenile Salmon Habitat models, and median on the Marine Bird Habitat model.

- Site 9- The North entrance to the Swinomish Channel. This site scored high for restoration in all 5 models.

- Site 10- Joe Leary Slough outlet. This site also scored high on all the models. It was mentioned by Lori Kyle, MRC sub-committee, that this large slough historically hosted a salmon run, but has not in several years.

- Site 11- Alice Bay at the SE end of Samish Island. This site scored high for restoration on all 5 models. Jeanne Robinette, MRC sub-committee, mentioned that there is considerable community awareness in the area, but there is a need for improvement in septic systems.

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- Site 12- North Shore of Samish Island. This site scored in the first and second highest tiers in the restoration analysis for forage fish, aquatic vegetation, and juvenile salmon habitat. There is a considerable amount of soft armoring along this shoreline. It was mentioned that beach nourishment projects have been done in this area for sediment enhancement.

- Site 13- Bayview shoreline. This area is just south of the site pointed out in the Conservation model. It came up high for restoration in the Forage Fish and Marine Bird Habitat models, and median on the Juvenile Salmon Habitat model.

- Site 14- Stretch of shoreline from 34th Street in Anacortes to Weaverling Spit. This is the site for the Tommy Thompson Trail. This area was not highlighted in the Restoration (or Conservation) analysis, and only 2 or 3 points were ranked above the lowest tier. This is likely due to the lack of data in areas of heavy industrial/residential, such as this. The site was still chosen since the proposed planting action along the trail is already in existence, and Paul Dinell, MRC sub-committee, has found viable forage fish eggs in the riprap along the shore.

- Site 15- Northeast tip of Fidalgo Island at Cap Sante. This site scored in the top tier for beach sediment supply restoration, and median tiers for marine bird habitat, forage fish, and juvenile salmon habitat.

- Site 16- Guemes Ferry dock/Kiwanis Park/Old Cannery. This site scored high in the Forage Fish, Marine Bird Habitat, and Beach Sediment Supply models. It had a median score on the Juvenile Salmon Habitat model. Lori Kyle, MRC sub-committee, mentioned that there are old pilings from the canneries that should be removed. Everyone agreed that this area is re-developable property and should have building standards in place.

- Site 17- Old Anacortes Veneer/ Plywood mill. This site ranked high for aquatic vegetation, forage fish, beach sediment supply, and juvenile salmon habitat restoration. It was mentioned that this site is privately owned, but could be restored.

- Site 18- West side of March's Point above Crandall Spit. This site scored in the top two tiers for restoration under the Marine Bird Habitat and Forage Fish models. And in the median tiers in the Beach Sediment Supply and Juvenile Salmon Habitat models.

- Site 19- East side of March's Point. This site scored similarly to Site 18. People For Puget Sound has proposed an adaptive management approach to beach nourishment to the MRC at this site.

- Site 20- East side of Fidalgo Bay, across from Weaverling Spit.

- Site 21- Crandall Spit.

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Feasibility Criteria Worksheet for Conservation Priority

Feasibility Criteria	*Value*	Information Source	Weight?	Site Score
1. Is the area/project threatened?				
Yes	0			
Maybe	2			
No	4			
2. Ownership?				
Private	0			
Public	4			
3. Level of Interest?				
Low	0			
Medium	2			
High	4			
4. Timeliness				
Ok to delay	0			
Act	2			
Act Now	4			
	(0-16)			**Total**

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Feasibility Worksheet for Education Priority

Feasibility Criteria	*Value*	Information Source	Weight?	Site Score
1. Ownership		GIS		
Private?	4			
Public?	0			
2. Parcel Density (# per defined area)		GIS		
> 10	4			
10 – 7	3			
6 – 4	2			
3 - 2	1			
1	0			
3. Partnerships				
Low Opportunities	0			
Medium Opportunities	2			
High Opportunities	4			
4. Impact of Cultural Aspects on Action				
Impedes	0			
No Effect	2			
Enhances	4			
5. Potential funding?				
Few Sources	0			
Moderate	2			
Many	4			
6. Damage or Risk to Owners				
High Risk	0			
Moderate Risk	2			
Low Risk	4			
7. Probability of Success of Proposed Action				
Low/Unknown	0			
Moderate	2			
High/Guaranteed	4			
8. Timing (funding, local interest, etc)				
Bad	0			
Moderate	2			
Good	4			
9. Self-Sustaining?				
Low	0			
Medium	2			
High	4			
				Total
	(0-36)			

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Feasibility Criteria Worksheet for Restoration Priority

Feasibility Criteria	*Value*	Information Source	Weight?	Site Score
1. Ownership		GIS		
Private?	0			
Public?	4			
2. Permits Required				
USCOE + HPA + Shoreline?	0			
HPA + Shoreline?	2			
No Permits?	4			
3. Parcel Density (# per defined area)		GIS		
> 10	0			
10 – 7	1			
6 – 4	2			
3 - 2	3			
1	4			
4. Partnerships				
Low Opportunities	0			
Medium Opportunities	2			
High Opportunities	4			
5. Permission				
No	0			
Maybe/Partial	2			
Yes	4			
6. Impact of Cultural Aspects on Action				
Impedes	0			
No Effect	2			
Enhances	4			
7. Potential funding?				
Few Sources	0			
Moderate	2			
Many	4			
8. Parcel Purchase Required				
No	4			
Yes	0			
9. Parcel Purchase Cost				
Expensive	0			
Moderate	2			
Low	4			
10. Damage or Risk to Owners				
High Risk	0			
Moderate Risk	2			
Low Risk	4			
11. Probability of Success of Proposed Action				
Low/Unknown	0			
Moderate	2			
High/Guaranteed	4			
12. Adjacent Land Cover		GIS		
Impervious	0			
Semi-impervious	2			
Pervious	4			
13. Adjacency to Public Lands		GIS		
> 1500 ft	0			
100 – 1500 ft	2			
< 100 ft	4			
14. **Timing (funding, local interest, etc)**				
Bad	0			
Moderate	2			
Good	4			
15. Self-Sustaining?				
Low	0			
Medium	2			
High	4			
				Total
	(0-60)			

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Feasibility Criteria

Each feasibility worksheet contains criteria to evaluate and prioritize habitat conservation, education, and restoration opportunities.

Criterion 1: Is the area or site threatened?
This question tries to capture any knowledge about the site, property, or community that may affect the proposed project. Is the property up for sale? Is there a development plan underway for that property? This question pertains to the conservation worksheet.

Criterion 2: Ownership
Property ownership is a key component in evaluating project feasibility. If the property is privately owned, the willingness of the owner to cooperate or participate in the proposed project often presents a time–consuming hurdle. This question can be found on all three worksheet.

Criterion 3: Level of Interest
What is the level of interest from the surrounding community, native tribes, local city and county agencies, other partner organizations, funding sources, and the local MRC members in pursuing the proposed project? The proposed project may be stymied if there is resistance shown by a key group. This question can be found in the conservation worksheet.

Criterion 4: Timeliness
This criterion focuses on timing in terms of how outside factors such as political climate, community mind-set, funding availability, partnership formation, and opportunity influences the proposed action. If all of these factors are all in-line, the "Act Now" category should be selected. This question can be found in the conservation worksheet.

Criterion 5: Parcel Density
Permission has to be granted by landowners for the proposed project to move forward. The more landowners involved, the more difficult it is to reach an agreement. With multiple owners, the costs associated with purchasing or conservation easements increase. This criterion was included in both the education and restoration worksheets.

Criterion 6: Partnerships
The ease of implementing and sustaining projects increases with multiple partner organizations, agencies, or individuals. Opportunities for team–building are evaluated in both the education and restoration worksheets.

Criterion 7: Impact of Cultural Aspects?
Cultural aspects such as native burial grounds, anthropologic artifacts, historic homestead sites, etc. may impede, have no affect, or enhances the proposed project. This criterion was included in both the education and restoration worksheets.

Criterion 8: Potential Funding?
Multiple opportunities may exist to push the project to towards completion, and money is an important factor. The more sources of funding available, the more likely the project will actually be funded. Leveraging one funding source against another is often a great way to build partnerships. This criterion was included in both the education and restoration worksheets.

Criterion 9: Damage or Risk to Owners

The proposed action may have some risks involved. Removing a bulkhead from a shoreline property can compromise the integrity of the property, and endanger the home or building, actions such removing a dock may devalue the property, or a beach nourishment project may result in unwanted sediment build–up under piers or other structures. This criterion gauges, subjectively, the risk project by project. This criterion was included in both the education and restoration worksheets.

Criterion 10: Probability of Success
This criterion examines a project's probability of success based on demonstrated restoration techniques used in the marine or shoreline environment. Projects based on established techniques such as creosote pilling removal, would be more reliable than unknown or inconsistent techniques such as beach nourishment. This criterion was included in both the education and restoration worksheets.

Criterion 11: Self-Sustaining?
This criterion evaluates the amount of on-going monitoring, funding, maintenance involved in the up-keep or operation of the proposed action. If the opportunities are there, the project is self-sustaining. This criterion was included in both the education and restoration worksheets.

Criterion 12: Permits
The permitting process is often lengthy and slow. The more permits required to allow project implementation, the less likely the project will occur. The project may be located in an area where multiple jurisdictions coincide. This criterion was included in the restoration worksheet.

Criterion 13: Permission
Permission has to be granted by landowners for the restoration action to move forward. Some landowners may be more likely to grant the permission if they are directly engaged and connected to the proposed project. This criterion was included in the restoration worksheet.

Criterion 14: Parcel Purchase Required?
Some property may be available for purchase. If the purchasing property is required in order for the project to be implemented, the expense, effort, and time obstructs the momentum. This criterion was included in the restoration worksheet.

Criterion 15: Parcel Purchase Cost
Expensive property burdens the project with high costs and budgetary nightmares. This criterion was included in the restoration worksheet.

Criterion 16: Adjacent Land Cover
Where the land is paved or developed, restoration actions are expensive and time-consuming. Impervious areas include buildings, roads, driveways, and parking lots. Agricultural areas may present a few more restoration opportunities, while previously logged or farmed area that has become overgrown with noxious weed may present many more restoration opportunities. This criterion was included in the restoration worksheet.

Criterion 17: Adjacency to Public Lands
This criterion defines the extent to which a proposed project provides habitat connectivity to other habitat areas in the form of public parks and open spaces. A habitat restoration opportunity along a stretch of degraded shoreline near state parkland could enhance connectivity to adjacent areas of higher habitat quality.

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Appendix F

Site Reports

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Site Reports

Applying the Bays Blueprint methodology in Skagit County has occurred in two stages. Compiling existing datasets and creating the GIS occurred in 2003, followed by inventory and analysis of the Skagit County mainland shoreline in 2004. This first stage captured the shoreline area from the Whatcom/Skagit border through Samish Bay, Padilla Bay, Fidalgo Bay across the top of Fidalgo Island. The site reports were created during this first stage.

In fall of 2005 Guemes, Saddlebag, Huckleberry, Hat, and Dot Islands were surveyed adding another 120 points to the original 343 points, for a total of 463 points surveyed. Data inventoried from these Islands was included in the larger Skagit County GIS and the entire area was re-analyzed for conservation and restoration priorities. No additional sites were selected and studied for feasibility. The inclusion of the islands into the survey area changed the conservation and restoration priorities in two ways. The additional points added to the total number of points in each rank category and shifted the ranking of certain points to a lower or higher priority. This shifting of rank was most apparent in the conservation scores, due to the high conservation potential of Guemes Island's shorelines, and lowered the ranking of some of the mainland sites. Secondly, the improvements to the model have also changed the resulting scores.

The following tables have the 2005 updated ranked scores for each of the points within the reported sites. Some sites have multiple points and multiple recommendations, these are also included in the table.

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Appendix G

Model Data Tables