

## **Strategic Plan Washington State Seafloor Mapping Program**

March 10, 2009

### **Introduction**

*Objective* – To map the seafloor of all of Washington State’s marine waters, including the outer coast, Strait of Juan de Fuca, and Puget Sound regions, for the purpose of providing bathymetry, benthic substrate, relief, geology, habitat, and other thematic maps to managers of marine resources such as tribes and state and federal agencies. These maps will also be useful for other coastal resource users, academic researchers, ports, non-governmental organizations, policy makers and the public.

*Strategy* – This strategy document lays out the framework and procedures for completing seafloor mapping of Washington State waters.

This document provides a framework to develop partnerships, funding, mapping protocols and standards, mapping data (new and existing), and data archiving and distribution mechanisms in order to create a comprehensive seafloor-mapping program within the State of Washington. This strategic plan is based on the results and recommendations of the Washington State Seafloor Mapping Workshop held in Seattle January 22-23, 2008 (see attached Executive Summary of the workshop; Hennessey et al., 2008). One of the major recommendations of this workshop was to construct a strategic plan for mapping Washington’s marine waters. In addition, this plan is in direct response to actions requested by the *West Coast Governors’ Agreement on Ocean Health* to map the seafloor including bathymetry, benthic substrate, relief, geology, and habitat of the state’s tidelands and submerged lands.. Seafloor mapping is also consistent with recommendations in *Washington’s Ocean Action Plan*.

The components of this plan are outlined below in a rough order of action, although several of the components may be active simultaneously. The strategic actions include the Development of Partnerships, Identification of Potential Funding Sources, Construction of Prototype Maps and Products, Development of Mapping Protocols and Standards, Identification of Existing Mapping Data, Seeking Release of Pertinent Proprietary Data Sets, Establishing Priorities, Performing New Surveys and Producing New Data Products, and Development of a Data Archiving and Distribution System.

In addition, synergy between such groups and organizations as the Puget Sound LIDAR Consortium, Puget Sound Partners, and others will be initiated. This effort will be done to

develop a mapping program that complements and adds value to the work being done by these groups.

### **Development of a Steering Committee and Institutional Framework**

Task: Convene a complementary group of scientists, managers and interested parties that can contribute to the design and implementation of a successful seafloor-mapping program. An initial step toward this task has been accomplished. Organizations, their potential role or interests and contacts are listed below as recommendations for the core group:

<b>Institution or Entity</b>	<b>Role</b>	<b>Possible contact</b>	<b>Representing what interest?</b>
NOAA, OCNMS	User of habitat maps	Ed Bowlby	Ecology
	Creator and user of habitat maps	Nancy Wright	Seafloor mapping
NOAA, NWFC	Data stewardship and distribution	Jeremy Davis	Seafloor mapping
NOAA, NWR	Data availability and application	Steve Copps	Habitats with fish policy/management
NOAA, NWFSC	Data application	Curt Whitmire	Links to fisheries & habitats
WA Dept. of Ecology	Data user, stew. & distribution	Jennifer Hennessey	Nearshore and offshore coastal resources (geology, habitat, biology, coastal processes)
UW, School of Oceanography	Creator, compiler of maps	Mark Holmes	Geology, habitat mapping
	Creator, compiler of maps	Jan Newton	Physical Oceanography
Tombolo/Moss Land. Mar. Labs.	Creator, compiler of maps	Gary Greene	Geology, habitat mapping
USGS, W Coast & Mar. Team	Creator, compiler & distribution	Sam Johnson	Geology, habitat mapping
NWIFC	User of maps	Bruce Jones	Tribal
WA Dept. of Nat. Resources	User, data distri. & stewardship	Tom Mumford	Nearshore, nat. resources
NOAA, Nat. Ocean Survey	Creator, steward., and distribution	Dave Neander	Nautical and habitat mapping
WA Dept. Fish & Wildlife	User, creator and compilation	Wayne Palsson	Bottom fisheries, habitat mapping
NOAA	Compilation, distribution	Bob Pavia	Mapping

This partnership needs to also include decision-makers in government and related organizations to ensure the outcome of this strategic activity is vetted and has significant buy-in from participating entities. The partners convened in February 2009 and has moved ahead in developing further partnerships and tasks. A list of priority surveying sites have been established and the development of rationale for mapping is nearly complete.

The partners will need support from an institution that can provide a means for official communication and that has an infrastructure to support the group. Further the sponsoring institution should have the capacity to support grant making and fundraising and provide for meaningful governmental initiatives in the future.

### **Identification of Potential Funding Sources**

Identifying and securing funding to support the Washington State Seafloor Mapping Program poses a challenge. Washington State will need to rely upon a variety of funding sources to underwrite its seafloor-mapping program. Therefore, the strategy is to develop a plan that enables the partners to request resources from federal mapping agencies, other similar agencies, and private and tribal groups. All these groups would benefit from a seafloor mapping effort in Washington State. The partners should compile a list of interested agencies, contact information, and descriptions of how the mapping program will benefit each agency. This strategy will require political action on the part of the state, non-federal partners, and tribes in the form of an integrated partnership, that can advocate in unison for a common purpose.

The group estimates that approximately \$30 million is needed to accomplish a comprehensive seafloor mapping effort in the State of Washington that includes multibeam echosounder (MBES) bathymetry and backscatter data collection and processing, groundtruthing and product development (map folios). The estimated cost for collection and processing of the MBES data is \$19 million, for groundtruthing is \$4 million and for product development is \$7 million; these costs do not include the collection of seismic-reflection profiles and the construction of geologic and sediment distribution/thickness maps, which are included for the State of California and have shown value; to provide these projects additional funding will be required. As the cost of collecting seafloor data is increasing daily (due to increasing fuel costs, regulatory expenses, and increase salaries), it is beneficial to undertake the mapping sooner than later. In addition, the cost of not having data to assess potential environmental degradation may end up costing more than the collection and interpretation of the data needed to understand the coastal and marine environments. A comprehensive mapping effort entails collecting new data, developing interpretive maps from that data, as well as compiling and interpreting previously collected useful data. As a general rule the cost ratio for the collection of new data and added-value interpretive products such as a map folio is usually between 3:1 and 4:1. Calculating the cost of the Washington State mapping program will use a similar formula to assure the collection of state-of-the-art

mapping data collected as well as the development of value-added products such as interpretive maps.

### **Construction of Prototype Maps and Products**

In order to obtain support from policy makers, funding agencies, and the public, the partners need to develop materials that illustrate the types of products resulting from the program and their utility. The partners should develop examples of habitat, geology, bathymetry, and other thematic maps for display at public and scientific forums as well as used in presentations for fund-raising. The products developed should showcase the capability of existing collaborations. They should also demonstrate utility to audiences on regional, federal, and international levels..

Following the lead of California (see Kvitek et al., 2006) and to be consistent with the West Coast Governors Agreement for marine habitat mapping, newly collected seafloor mapping products should include:

- seabed geomorphology or relief via digital elevation model (DEM) in color and gray-scale.
- texture (substrate type)
- backscatter draped over bathymetry and interpretive maps
- geology
- three-dimensional perspective views
- sub-bottom seismic-reflection profiles
- sediment isopac maps
- seismicity map
- sediment processes maps

Marine benthic habitat maps constructed for the San Juan Archipelago (see attached Plate 1) can be used to illustrate habitat and geological maps for Washington State waters. These maps were constructed using the same habitat mapping code (derived from varying scales of geological features and biological components; see Greene et al., 1999, 2007) that is presently being used in the California mapping program.

### **Development of Mapping Protocols and Standards**

Mapping protocols and standards including data acquisition, processing, and display methods need to be established to maintain consistency and comparability of map products for the state and region. To achieve this consistency, the partners recommend considering implementation of the protocols and standards similar to those established for the California State Coastal Conservancy mapping program for the Washington State mapping program, either in whole or in part.

Similar to the data quality and resolution that the California mapping program recommended all data acquisition in Washington waters should meet International

Hydrographic Organization (IHO) Order 1 standards if appropriate, and be carried out at the maximum resolution practical using state-of-the-industry tools. In addition, the program the Washington State Mapping Program should considers coverage that includes all state marine waters from the shoreline (Mean Higher High Water) out to at least 3 nautical miles and preferably beyond to include territorial waters to 12 nm to address federal concerns, or to 100 m water depth to address continental shelf issues.

Comprehensive mapping will require the application of multiple acquisition sensors including acoustic (e.g. multibeam echo sounder [MBES], side-scan sonar) and optical (e.g. LIDAR, hyperspectral, multispectral systems). In regard to geospatial accuracy and geodesy, the mapping program should consider using the best available positioning instrumentation (e.g. high-precision kinematic GPS), and that a common vertical datum be agreed on and used, such as bathymetric and topographic surveying on the ellipsoid (e.g. ITRF or WGS84), thereby facilitating more accurate tidal corrections, data fusion and conversion to other datums. These standards need to be specified to meet agencies' and public needs.

The Washington State Mapping Program should also include:

- Adequate groundtruthing (e.g. via video or physical samples) of acoustic and optical remote sensing data used to create the DEM and surface texture data sets to verify the classifications.
- Subsurface structure (sediment thickness and stratigraphy via subbottom seismic reflection profiles and grab sampling), where appropriate and possible.
- Standard method for habitat characteristics and symbology (see Greene et al. (2007). This method is also in use in Oregon, Canada and the San Juan Islands.

### **Identification of Existing Mapping Data**

The Washington State Seafloor Mapping Workshop identified initial mapping data gaps (see attached Plate 2). Although extensive seafloor mapping has been done in Washington State waters, it is possible that not all of the data collected will be of a high-enough resolution to benefit the seafloor mapping program. Therefore, the next steps are to: 1) develop criteria for data resolution and data quality; 2) evaluate existing data sources against the criteria and refine the data gap map and 3) investigate locations for new mapping efforts, including potential priorities areas.

### **Establishing Priorities**

The workshop participants felt that setting priorities would be detrimental to a comprehensive mapping effort and recommended a focus on comprehensively mapping the all of the state's marine waters and adjacent waters. In reality, priorities of what should be mapped first will emerge. Therefore, this strategy will seek to evaluate geographic areas and priority management needs to determine areas that are most in need of mapping and that meet multiple missions of partners. This prioritization endeavor should also incorporate current or proposed mapping efforts in order to leverage

resources and maximize efficiency. An initial attempt to establish these priorities was accomplished and is reflected in the table below: (insert of Sam Johnson's task)

### **Performing New Surveys and Producing New Data Products**

Funding will be sought to undertake the collection of new MBES bathymetry and backscatter, bathymetric and terrestrial LiDAR, air photos, seafloor video and sediment sampling, and towed fix camera slide data. These new data will be collected in areas determined from the regional priority list included above and where distinct data gaps occur. In addition, funds sought will cover not just the collection of new data, but will cover the expense of the production of new data products such as interpretive maps (e.g., habitat maps) and if possible cover the expense of producing a map folio.

### **Development of an Archiving and Distribution System**

The Washington State Seafloor Mapping Program will make all data collected and compiled, including value-added (interpretive) products publicly available and easily accessible. To accomplish this the group must find a central depository for raw data such as NOAA's National Geophysical Data Center (NGDC) or some other entity. A state agency or federal agency might be the best place to disseminate interpretive products. In particular, the Department of Ecology manages the state's coastal atlas, which serves up a variety of coastal data sets collected by many state and federal agencies. This would be a useful place to make products available as GIS layers (e.g. bathymetry, habitat classifications, fault locations). It is critical that all base data and map products be served up to the public in a timely manner, within a year or two of actual data collection or compilation. The use of Google Earth or Google Ocean might also be a mechanism for communicating and disseminating data and products to the public. Information pertinent to resource managers and key decisions should be supplied quickly and, if possible, prior to public disclosure.

### **Time Lines (Milestones)**

To be determined

### **Accomplishments – Successful Release of Pertinent Proprietary Data Sets**

During the Washington State Seafloor Mapping Workshop, participants discussed proprietary data sets (e.g., held by the US Navy, NOAA) which could be useful for mapping efforts in Washington State waters. The participants recommended the state work to influence NOAA and the U.S. Navy on removing a security policy in place for over twenty years. Due to security concerns, the U.S. Department of Defense (US Navy) and NOAA were operating under a MOU that prohibited the distribution of high-resolution bathymetric data in Washington's marine waters deeper than 50 meters. This restriction limited the ability to utilize existing data sets and partner with NOAA on

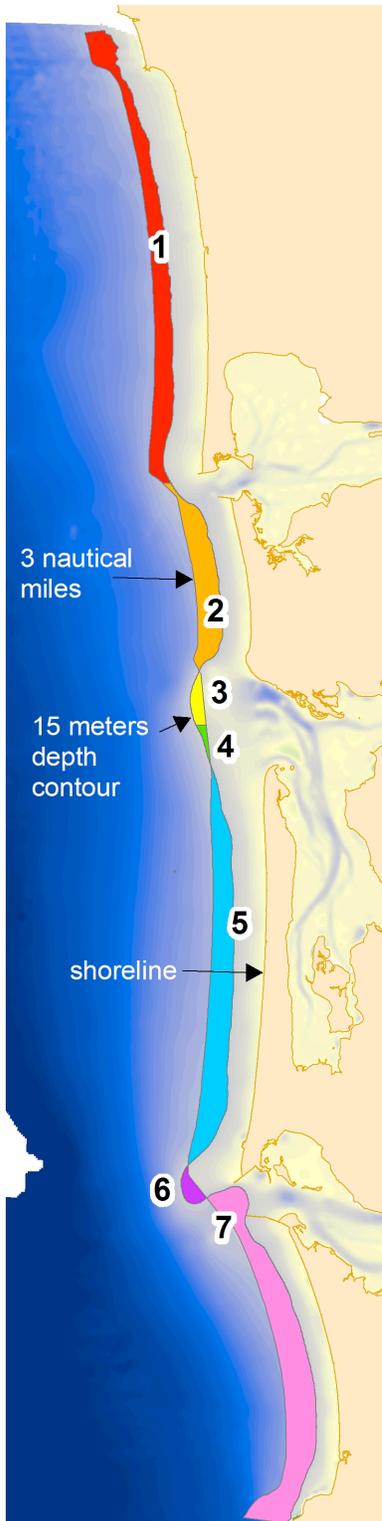
future data collection efforts. However, the Governor of Washington sent a letter to Navy and NOAA requesting a review of the policy and for the repeal or reduction of the security policy. This was also supported by a letter from the Workshop Steering Committee. As a result, the Navy rescinded the security restriction on this data collected by NOAA. NOAA can now share existing high resolution data and partner more fully with the state on future mapping efforts.

### **References Cited:**

Greene, H.G., Bizzarro, J.J., O'Connell, V.M., and Brylinsky, C.K., 2007. Construction of digital potential marine benthic habitat maps using a coded classification scheme and its Application. *In* Greene, H.G. and Todd, B.J., eds., *Mapping the Seafloor for Habitat Characterization*, Geological Association of Canada Special Paper 47, p. 141-155.

Hennessey, J., Greene, H.G., Palsson, W., Bowlby, E., Davis, J., Dzinbal, S., Johnson, S., Mumford, T., and Pavia, R., 2008. *Washington State Seafloor Mapping Workshop Proceedings*, Washington State Dept. Ecology, Olympia, WA, 69 p.

Kvitek, R., Bretz, C., Cochrane, G., and Greene, G., 2006. *Final Report, Statewide Marine Mapping Workshop*, California State University, Monterey Bay and California Coastal Conservancy, Seaside, CA, 108 p.



**Figure 1.** Seafloor areas along the Columbia River littoral cell in northwest Oregon and southwest Washington between 15 m water depth and 3 nm offshore. Along southwest Washington, the 15 m depth contour is on average 2.1 nm from the shoreline, thus only a strip of seafloor about 1 nm wide would be mapped, and this strip would span water

depths of only about 15 to 20 m. The mapping would also be discontinuous across the mouth of Willapa Bay (areas 3 and 4) and the mouth of the Columbia River (area 6) where 3 nm offshore is only about 7 m deep.

## Workshop Executive Summary

On January 22-23, 2008, a group of state and federal natural resource and science agencies, along with private industry partners convened the Washington State Seafloor Mapping Workshop in Seattle.<sup>1</sup> This workshop, attended by over 120 scientists, managers, and policy makers, highlighted seafloor mapping technology and products, discussed status of mapping efforts, determined data gaps and priorities and developed partnerships and next steps to advance comprehensive mapping of Washington State's marine waters. Current technologies can accurately map bottom depths and seafloor geology that are as detailed as terrestrial maps of forests, grasslands, and mountains. Like on land, seafloor maps have great potential to inform scientists, managers, and citizens when making decisions on developing, protecting, or restoring the marine environment. Seafloor mapping data can be used to:

1. Improve navigation and commerce.
2. Characterize benthic habitats.
3. Manage fisheries, plan resource surveys, and designate marine protected areas.
4. Monitor environmental change such as sea level impacts.
5. Predict sediment and contaminant transport, load and other coastal processes.
6. Manage sediments and coastal erosion.
7. Evaluate sites for nearshore or offshore infrastructure such as alternative energy.
8. Assess earthquake and tsunami hazards.
9. Model circulation and inundation from storm surge or tsunamis.
10. Understand geologic history and change.

Some of Washington's waters have already been mapped with high-resolution Multibeam Echosounder sonar bathymetric (MBES) and backscatter imaging. The Center for Habitat Studies of Moss Landing Marine Labs (California State University) partnered with the Canadian Geological Survey to map marine benthic habitats in the San Juan Islands. This project collected and interpreted the complex seafloor MBES data of the San Juan Archipelago and resulted in detailed seafloor maps that identified rockfish, lingcod, and sand lance habitats as well as potential geological hazards. Other sections of Puget Sound and the Washington coast have also been mapped by NOAA, the US Geological Survey, Army Corps of Engineers, and the University of Washington. Many of these efforts are project-specific investigations or have specific missions that guide the use of the data. As a result, the data is not integrated nor coordinated to best facilitate availability and wide use by managers, scientists and citizens. Existing data, if collected at an appropriate resolution and made publicly available, could assist in producing comprehensive maps for Washington.

The US Navy, through an agreement with NOAA, restricts the distribution of high-resolution seafloor data and resulting maps or data products collected or funded by NOAA. This data restriction greatly impairs the ability of Washington to form

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<sup>1</sup> Participants on the steering committee included: Tombolo Institute; U.S. Geological Survey; National Oceanic and Atmospheric Administration (NOAA); Olympic Coast National Marine Sanctuary; and the Washington Departments of Fish and Wildlife, Natural Resources, and Ecology.

partnerships with NOAA and other organizations that will effectively advance high-resolution seafloor mapping and release data to resource managers and the public. Even if this existing data was made available, many of Washington's waters have not been mapped at all or were surveyed long ago with less accurate techniques. These areas will require new or increased mapping efforts.

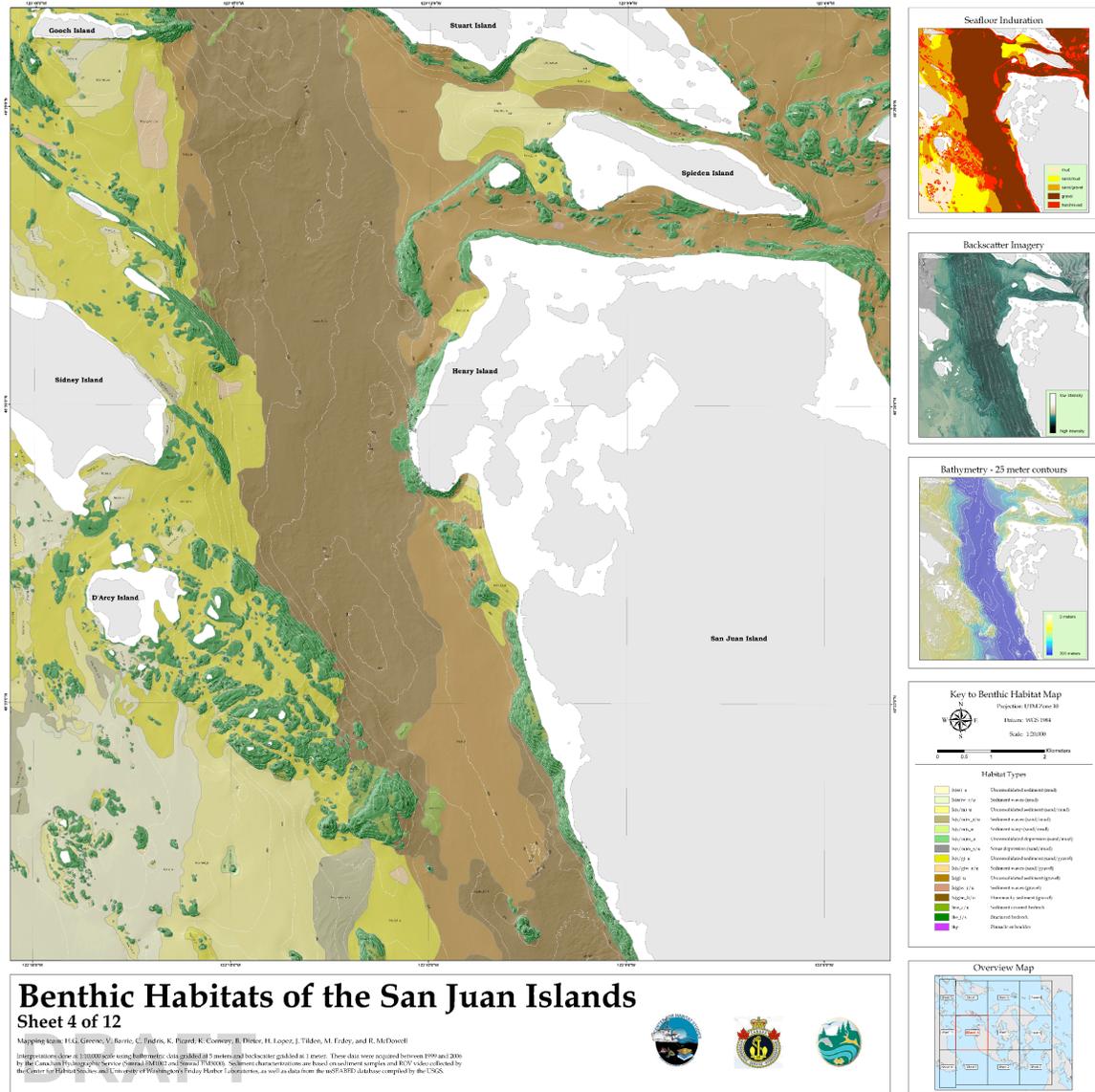
Since mapping provides a critical foundation for ocean and coastal management, completing seafloor maps for state waters of California, Oregon, and Washington is a priority of the West Coast Governors' Agreement on Ocean Health. California established a consortium of partners and is already mapping its marine waters using high-resolution sonar. Meanwhile, Washington and Oregon are investigating what it would take to advance seafloor mapping. In Washington, the workshop attendees suggested a consortium of agencies, organizations, and governments would be needed to develop a shared strategic plan that will leverage activities and acquire the \$20-30 million dollars estimated cost for mapping state waters.

During the workshop, participants divided into two work groups: one for Puget Sound and one for Washington's outer coast. These groups discussed uses for data; status and gaps in data; planned data collection efforts; criteria for prioritizing data collection; and partnerships and opportunities for leveraging mapping. The following provides a brief summary of their discussions:

- **Data Uses:** Many important needs drive the need for seafloor mapping data: ecosystems, hazards, baselines, understanding processes, sea level rise impacts, and predictive models of coastal evolution. Mapping data will also assist with prioritizing future or additional research. For example, delineating hard substrate versus other bottom types can help fisheries managers focus additional research on particular habitats.
- **Prioritizing Data Collection:** The outer coast group suggested establishing priority areas for mapping by tying the data to particular management needs, which will help drive data collection for specific areas. However, participants also recognized the need to have comprehensive, complete data. For Puget Sound, the group's possible prioritization criteria were urban areas and threatened ecosystems. Both groups recognized that it is more cost-effective to map deeper waters versus the nearshore, shallow waters. The groups suggested that balancing importance with costs for initial efforts and that a combination of approaches will be needed to advance comprehensive mapping.
- **Partnerships and Leveraging:** Federal and state agencies, tribes, non-government organizations, academic institutions, and foundations can all play a role in forming a strong partnership to advance mapping. Partnerships should examine gaps in data collection and overall programs of various agencies; align resources and priorities to advance a joint effort. Online resources and data portals can assist in leveraging planned federal mapping activities and in disseminating information. Regionally, all three states should leverage proposed activities for

offshore areas as a way to obtain necessary data (e.g. alternative energy). The states can utilize the West Coast Governors' Agreement as a way to coordinate regionally. Navy restriction on distribution of NOAA and NOAA-funded data prevents free exchange of information collected in waters deeper than 50 meters. It prevents the scientific and resource management community from adequately meeting their missions and goals including: protecting society and property from coastal hazards and climate change impacts; assessing and managing the sustainability of marine resources and ecosystems; restoring damaged marine and coastal habitats, species, and processes; and properly siting the uses and development of ocean and coastal resources.

**Plate 1** – Example of habitat map to be produced from the Washington State Seafloor Mapping Program



**Plate 2** – Map of known mapping data existing for Washington State and adjacent Water

