Pacific Coast Groundfish Essential Fish Habitat Project
Consolidated GIS Data, Vol. 1: Physical and Biological Habitat

April 2004

Essential Fish Habitat Mandate

In 1996, Congress amended the Magnuson-Stevens Act to require the description and identification of Essential Fish Habitat (EFH) for each life stage of federally managed species. As a result, Regional Fishery Management Councils are responsible for drafting fishery management plans based on the best available science that describe and identify EFH and address adverse effects of fishing on EFH to the extent practicable. In March 2002, a project was initiated to meet the EFH requirements for the Pacific Coast Groundfish Fishery Management Plan.

GIS Supporting the EFH Process

This EFH project launched a major effort to synthesize and generate habitat information previously unavailable at the Pacific Coast scale. The process included integrating data from different regions and variable information content. GIS was an integral tool in this endeavor. Whether creating new GIS data or mining existing data and using it in innovative ways, this EFH process has been the driving force behind compiling disparate habitat data into a single GIS. This GIS is being used to map and model essential fish habitat (EFH), fishing and non-fishing impacts to those habitats, and habitat areas of particular concern (HAPC). Ultimately, GIS will be an invaluable tool for data visualization and regulatory decision-making.

Data on this CD set

The data on this set of CDs, developed specifically for the EFH project, is limited to the layers that were used in the modeling and analytical process to designate EFH for Pacific Coast groundfish. The majority of the data in this GIS were developed by governmental agencies, universities, and private organizations. These data, often available at localized sites up and down the west coast, were homogenized and stitched together by TerraLogic GIS and incorporated into the larger EFH database. This is the first in a series of EFH GIS data CDs to be released. We anticipate future data releases to include data depicting fishing effort and non-fishing impacts to groundfish habitat**.**

The habitat data fall into three general categories: physical habitat, biological habitat, and ancillary data. These layers are briefly described below. For more detail about each layer, please refer to the FGDC metadata files. All data are provided as ESRI shape files and each shape file has been compressed into a ZIP format file.

I. Physical Habitat

A. Marine Gelology:

Benthic Substrate: Marine geology experts developed GIS data delineating bottom-types and physiographic features associated with groundfish habitats. All lithologic and physiographic features were classified according to a deep-water benthic

habitat classification system developed by Greene *et al*. (1999). Detailed documentation about the classification system and mapping methods are included on the CD as source documentation. Benthic habitat data for Washington and Oregon were developed by the Active Tectonics and Seafloor Mapping Lab, College of Oceanic and Atmospheric Sciences at Oregon State University (OSU). Data for California were developed by the Center for Habitat Studies at Moss Landing Marine Laboratories.

Estuaries: Estuaries are known to be important areas for some groundfish species, such as kelp greenling, starry flounder and cabezon. However, specific substrates were generally not mapped by the marine geologists during the initial data consolidation phase of the project. Because of their significance as groundfish habitat, estuaries are included as a separate mapped category of their own, so that they can form part of the area identified as EFH. GIS boundaries for west coast estuaries are from a data set previously compiled during the 1998 EFH process.

Seamounts: Seamounts that occurred within the extent of the benthic substrate layer are mapped within that layer. However, there are some seamounts that are outside of the primary study area. We have included a generalized seamount layer provided by NOAA, National Marine Fisheries Service to show the locations of these important habitat types.

Data Quality:
Because of the wide variety of data sources used in the marine geological mapping, an additional layer indicating the data quality, or level of confidence in the interpretation, has been provided by OSU for the Washington and Oregon data.

B. Bathymetry: Because water depth is a key physical characteristic used to describe west coast groundfish habitat, five regional bathymetric layers were developed with 10-meter depth ranges. The data have been developed from four different data sources and due to their large size, are split into geographic subsets.

C. Latitude: Along the west coast, latitude is another characteristic that correlates to groundfish species distribution. Boxes delineating 10' latitudinal zones have been created and overlaid with bathymetry and benthic habitat data to create a set of unique habitat polygons.

D. Merged geology, estuaries, bathymetry, and latitude: The physical habitat layers have been combined into five regional merged layers. Generally, with the exception of estuaries, the geographic extent of the final merged data was set by the extent or the benthic habitat data, using the shoreline from the benthic habitat dataset.

II. Biological Habitat

Biological organisms play a critical role in determining groundfish habitat use and preference. In some cases, the biological habitat component is the most important feature that makes the habitat suitable for a particular species or life stage.

Kelp: Kelp beds have been shown to be important to many groundfish species, including several rockfish species. GIS data for the floating kelp species, *Macrocytis* spp. and *Nereocystis* sp., have been compiled into a comprehensive data layer for the Pacific Coast.

Seagrass: Another important vegetated habitat is seagrass beds. GIS data delineating seagrass locations has been collected from a large number of sources. Both eelgrass (*Zostera* sp.) and surfgrass (*Phyllospadix* sp.) are included where the data are available.

Structure-forming Invertebrates: Similarly, structure forming invertebrates such as sponges, anemones, and corals are an important and potentially vulnerable component of fish habitat. Very little is currently known about the west coast distribution of these species or their potential function as groundfish habitat. Sample data on the presence of these species groups, from West Coast trawl surveys, are available and are plotted as point data.

III. Ancillary Layers

A few additional data layers showing West Coast cities, states, shoreline and the Exclusive Economic Zone (EEZ) have been included on the CD set in order to assist in orientation to the project area. These layers are to be used for viewing and mapping purposes only and no metadata are provided.

Table 1 indicates the data file names, metadata files, source documentation file names, and the CD number on which the data reside.

Data not included in this CD set

A few source data sets were provided for use in the EFH process, but cannot be redistributed to other entities. These data sets include kelp data for Washington and Oregon, and some of the seagrass data for Washington. These data can be requested directly from Washington Department of Natural Resources, Nearshore Habitat Program and Oregon Department of Fish and Wildlife Marine Resources Program. In addition, the final merged data used in the EFH model included seagrass and kelp layers, but due to these same distribution issues and the large size of the final files, we have included the merged physical habitat only. The additional layers are provided on these CDs (with the exceptions noted above), and can be merged, as needed, by the user.

Table 1: Data Sets on the Pacific Coast EFH Consolidated GIS Data CD's, Volume 1: Physical and Biological Habitat

Data Description		Dataset Name (Data folder)	FGDC Metadata (FGDC_meta folder)	Source Documentation (Source_doc folder)	Size MB	CD
I. Physical Habitat						
A.	Benthic Substrate for west coast continental margin	geohab_woc	geohab_woc.meta.txt	*OR/WA*: OR-WA Geo-Hab Maps.doc *CA*: EFH_report.doc Figures.doc Habitat Scheme Explanation. doc Habitat Scheme.doc	176	1
	West Coast estuaries	estuaries	estuaries.meta.txt	nwi_meta.txt caf_full_metadata_d.html	4	1
	Seamounts	seamount	no FGDC metadata, seamount.readme .txt		< 1	1
	Data quality layers for benthic substrate off Oregon and Washington	dataqual_orwa		Tech_Memo.doc	34	1
B.	10-meter bathymetry polygons for Washington	bathpy_wa	bathpy_wa.meta.txt	wsbathy_meta.html	603	2
	10-meter bathymetry polygons for Oregon	bathpy_or	bathpy_or.meta.txt	OR-WA Geo-Hab Maps.doc	278	3
	10-meter bathymetry polygons for northern California	bathpy_nca	bathpy_nca.meta.txt		63	3
	10-meter bathymetry polygons for central California	bathpy_cca	bathpy_cca.meta.txt		84	3
	10-meter bathymetry polygons for southern California	bathpy_sca	bathpy_sca.meta.txt		116	3
C.	10-minute latitude zones	lat10min	lat10min.meta.txt		4	1
D.	Merged geology, estuaries, bathymetry, and latitude for Washington	habdeplat_wa	habdeplat_wa.meta.txt		677	4
	Merged geology, estuaries, bathymetry, and latitude for Oregon	habdeplat_or	habdeplat_or.meta.txt		271	5

Data Description		Dataset Name (Data folder)	FGDC Metadata (FGDC_meta folder)	Source Documentation (Source_doc folder)	Size MB	CD
	Merged geology, estuaries, bathymetry, and latitude for northern California	habdeplat_nca	habdeplat_nca.meta.txt		187	6
	Merged geology, estuaries, bathymetry, and latitude for central California	habdeplat_cca	habdeplat_cca.meta.txt		158	6
	Merged geology, estuaries, bathymetry, and latitude for southern California	habdeplat_sca	habdeplat_sca.meta.txt		165	6
II. Biological Habitat						
	Multi-year canopy kelp beds for California, 1989, 1999, 2002	kelp_ca	kelp_ca.meta.txt	coastwide_kelp_1989.shp.xml dfgkelp_1999_Readme.txt kelp_2002_v1.shp.xml	46	1
	Seagrass compilation for west coast	seagrass_pub	seagrass_pub.meta.txt	*SF Bay*: eelgrass-metadata.htm *Historic SF Bay*: hist-eelgrass-metadata.htm *Alamitos Bay*: eelgrass_polygon.shp.xml *San Diego Bay*: eg2000.shp.xml *San Diego Nearshore*: ktua_veg.shp.xml *Tomales Bay*: tb92eel.txt *Northern Cal*: ncal_esi_metadata.pdf *Southern Cal*: scal_esi_metadata.pdf *SF Bay*: sfb_esi_metadata.pdf *Oregon Estuaries*: habs.htm *South Slough*: ssnerr.doc *Tillamook Bay*: IMAGE EELGRASS.htm *Hood Canal*: fa1_fa7 metadata.htm	33	1
	Structure Forming Invertebrates – Point Locations from RACEBASE	invert_race	invert_race.meta.txt		< 1	1
III. Ancillary Layers						
	Major Cities	city_wcefh			< 1	1
	Western States and NOS Shoreline	stateswc			4	1
	Exclusive Economic Zone – Line	eezwc_ln			< 1	1
	Exclusive Economic Zone – Polygon	eezwc_py			5	1

Challenges Encountered While Compiling EFH GIS

Compiling comprehensive datasets covering the range of West Coast Groundfish has proven to be an enormously complex and time-consuming task. Listed below are the issues and constraints encountered repeatedly while developing the data layers.

- Locating Quality Data
  Every GIS undertaking of this magnitude faces longstanding challenges to data sharing and integration. Compiling a GIS for a 822,000 square km study area requires navigating a complex web of federal, state and local agencies in an effort to locate the best available data. Ideally, data sets sought out for inclusion were comprehensive for the west coast where possible, already in GIS format, free, readily available, and redistributable. However, more often than not, meeting all these criteria proved impossible. Balancing cost and time requirements to meet the EIS schedule, it is important to note the data incorporated does not always represent the best data, but the best data available to the project in the timeframe dictated.

- Uniting Disparate Data Sets
  Reconciling data from disparate sources into a unified, coherent database presents a multitude of technical challenges, requiring decisions about seemingly arcane, yet critical, details. Almost all EFH data was available only as geographic subsets to the study area. Ideally, these data would be "stitched" together at their edges using straightforward GIS commands. In practice, however, combining these geographic subsets into one comprehensive GIS layer required additional processing including:

  1. modifying attribute definitions to make them identical,
  2. eliminating overlapping areas by determining which subset has priority,
  3. filling in data gaps between subsets,
  4. understanding and reconciling different source scales and spatial extents,
  5. validating coding,
  6. updating coding as new information is provided, and
  7. projecting data to a common west coast projection.

  During these procedures, the goal has been to remain as consistent as possible with the intent of the source data while also creating comprehensive data coverage for the area of interest. To facilitate this process, automated procedures were used in lieu of more time-consuming manual editing procedures.

- Scale and Detail Exceed Software Capacity
  The large spatial extent of this project combined with the need for highly detailed GIS data has resulted in the creation of GIS datasets that exceed the capacity of essential software algorithms. To address this issue, alternative processing procedures were required to process and recompile these datasets into usable a format.

Credits and Acknowledgements

The development of these data have benefited from a large number of contributors. In addition to the people who have directly contributed data, financial support, or project support, we have benefited from many data collection efforts and research cruises that occurred long before the inception of the EFH process. These wide-reaching contributions to this database have allowed us to create a robust, functional, groundfish habitat GIS that can be used to answer specific analytical and policy questions that have never before been possible to answer.

Cooperators and funders who contributed to development of these data, include Pacific States Marine Fisheries Commission, and National Marine Fisheries Service, Northwest Fisheries Science Center, Southwest Fisheries Science Center, Northwest Region, and Southwest Region.

Organizations that developed or contributed data sets to this project include:

- Active Tectonics and Seafloor Mapping Lab, College of Oceanic and Atmospheric Sciences
- Center for Habitat Studies at Moss Landing Marine Laboratories
- NOAA, National Marine Fisheries Service, Alaska Fisheries Science Center, RACE Division
- Washington Department of Fish and Wildlife
- California Department of Fish and Game
- Oregon Department of Fish and Wildlife
- United States Fish and Wildlife Service
- Morro Bay National Estuary Program
- Merkel and Associates
- NOAA, National Marine Fisheries Service, Restoration Center, Santa Rosa, California
- NOAA, National Marine Fisheries Service, Southwest Region
- Wetlands Support
- U.S. Navy SWDIV Naval Facilities Engineer Command
- Port of San Diego
- KTU+A
- San Diego Association of Governments (SANDAG)
- California Coastal Conservancy
- NOAA, National Ocean Service, Office of Response and Restoration
- Ecotrust
- Oregon Department of Land Conservation and Development
- South Slough National Estuarine Research Reserve

- Earth Design Consultants
- Tillamook County, Oregon
- King County, Washington
- Battelle Marine Sciences Lab
- Washington Department of Natural Resources
- Point No Point Treaty Council
- Puget Sound Action Team

Finally, although it is impossible to list all the individuals who have contributed something to this project, we would like to specifically acknowledge the support provided by Waldo Wakefield, Mary Yoklavich and Steve Copps. Without their vision and ongoing championing of groundfish habitat mapping and GIS, this project would not be successful and these data sets would not be publicly available in this synthesized format.