



## **Synthesis and Geologic Framework of the US Coastal and Marine Regions; Designing a Template**

US Geological Survey, Coastal and Marine Geology Workshop  
December 12, 2000  
Reston, VA

**Consultation Draft**

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### ***Introduction and Background***

The National Research Council (NRC) recently reviewed the USGS's Coastal and Marine Geology program (CMGP). They urged CMGP to undertake three "Grand Challenges," the first of which is to:

- "Establish the geologic framework of the U.S. coastal and marine regions."

To address the first challenge, the NRC urged CMGP to, "immediately begin planning for a long-term, comprehensive and integrated assessment of the nation's coastal and marine regions" (The NRC report can be found at <http://www.nap.edu/books/0309065844/html/> and the CMG Program webpage is at <http://marine.usgs.gov/>.)

CMGP response to this challenge included identifying the need for an external advisory group (Federal agencies, states, NGO's) to define useful research needs and products, as well as taking steps to initiate several regional syntheses as part of a "Report to the Nation." FY 2001 USGS Prospectus funding was directed toward, "support for workshops and other efforts to identify priority areas for regional/topical assessments, develop protocols and timelines, and standardized product line."

A one-day workshop under this funding was convened in Reston, VA on December 12, 2000 by a national steering committee to obtain broad external and USGS perspective and advice (Appendix A). The workshop sought to formulate a national template for syntheses and assessments of large sectors of the U.S., building toward a national geologic framework for U.S. coastal and offshore regions. Such a framework is a significant effort that might take place over a period of 10 years or more. At the same time, the broad integration of many years of CMGP studies, and those of colleagues, should provide grist for exciting scientific discussions.

The following questions were posed to workshop participants:

- ∑ What issues and content should be addressed in regional or national syntheses?
- ∑ What standard formats for regional and national reports/maps should be used?
- ∑ What should be the geographic extent (and scale) of "regions"?
- ∑ What priority should be given to the different "regions"?
- ∑ What syntheses should be produced cooperatively with other agencies?
- ∑ How should regional synthesis build toward a national geologic framework?
- ∑ (see also workshop website at: <http://woodshole.er.usgs.gov/workshops/synworkshop>)

As a preface to the workshop, the USGS Director's office provided Bureau perspective on the USGS role in synthesis and assessment. The Director's office noted the need for global, national, regional and local coastal perspectives due to rapidly increasing coastal population and development, growing coastal threats. Also noted was the need to provide entities outside the USGS with basic information on the US Exclusive Economic Zone (EEZ), continental margins, Great Lakes and coastal regions. However, the complex nature of coastal and marine ecosystems suggests a geologic system science approach should be taken, which could be a defining future science direction for Bureau budget planning and workforce development. The geologic setting and geologic framework is a basic, yet critical part of the systems science approach to understanding and managing coasts. An expanded national interdisciplinary Bureau coastal program is included in the FY'02 budget request.

The following pages summarize the workshop and discussions with sections on:

- 1) A summary of the key recommendations from the workshop participants (with expanded comments in Appendix A);
- 2) A draft template and approach for products built on workshop input and our discussions;
- 3) Recommendations to management highlighting the funding, staffing, and programmatic implications in the short and long term.

### ***Summary of key recommendations from workshop participants (also Appendix A)***

- ∑ The USGS CMGP should develop regional and national geologic syntheses for the coastal ocean and Great Lakes. These syntheses will serve as a basis for monitoring, research, and management decisions, as well as a basis of outreach communication with the public. The USGS has high scientific standards, technical expertise, and an integrated understanding of coastal systems that will enable it to produce useful products not currently available.
- ∑ The USGS should develop a mechanism to continue the dialog with potential users of geologic syntheses to insure that the format and content meets their needs.
- ∑ The syntheses should systematically cover the entire nation. A national scope for synthesis products is needed to enable comparisons and contrasts between regions. Regional syntheses must cover large co-joining areas to build toward a national framework without gaps. Similarly, a marine geosynthesis should extend onto the shore and be directly related to land-based formatting.
- ∑ The syntheses should be digital and web-based. This will ensure flexibility and broad usage, as well as facilitating updates and widespread, timely distribution. Paper products should be limited to short executive-style summaries and descriptions of the products. Data should be distributed in GIS format. Products should be issued as they are completed.
- ∑ A realistic timetable for products and rudimentary national coverages should be developed.

- ∑ Many users want information, interpretation and predictive capabilities, such as models. Others want to conduct their own analyses on documented data sets. Suggestions for synthesis “interpretive layers”, many of which might be thought of as layers in a GIS format, include (but are not limited to) the following: morphology (bathymetry), seafloor surficial geology, geologic framework, benthic habitats, coastal features, human/cultural features, coastal vulnerability, geologic hazards, sediment budgets/predictive models, sediment contamination, and sand resources.

### ***Draft Template and Product Approach***

To progress towards the desired scientific products, in light of suggestions from the workshop participants, the steering committee:

- ∑ Decided on boundaries of regions to structure the final National Report;
- ∑ Agreed on a matrix form of work activities that would achieve the scientific products in a reasonable time frame and within our program’s existing decision-making structure.

### ***Definition of regions.***

The steering committee defined regions based on oceanographic and geologic boundaries. The size of regions must be large enough such that data and analyses can be edge-joined to derive a national coverage. For work to be funded as a regional synthesis effort, researchers must agree to cover entire regions, acknowledging that some subject matter will have geographically sparse or patchy data. The coastal zone and the outer edge of the EEZ comprise the inner and outer region boundaries.

The 13 suggested regions are:

- ◇ Alaska
- ◇ Pacific Northwest (Washington, Oregon, N. California)
- ◇ Central California (Cape Mendocino to Pt. Conception)
- ◇ Southern California (Pt. Conception to Mexican border)
- ◇ Pacific Islands
- ◇ U.S. Caribbean Islands
- ◇ Western Gulf of Mexico (Texas)
- ◇ Central Gulf of Mexico (Louisiana, Mississippi, Alabama)
- ◇ Florida (Carbonate platform)
- ◇ South Atlantic Bight (Florida to Cape Hatteras)
- ◇ Middle Atlantic Bight (Cape Hatteras to Cape Cod)
- ◇ Gulf of Maine (Cape Cod to Canadian border)
- ◇ Great Lakes

### ***Developing the national geologic framework and content for regional synthesis***

The steering committee envisions that the work, awarded competitively:

- 1) will be funded in pieces that geographically cover at least one of the proposed regions to produce digital “interpretive layers”
- 2) will include interpretive reports as well as digital map products

3) may be driven by particular issues or disciplines perhaps particularly germane to an area. For example, mapping of seafloor habitats or bottom characterization is considered an interpretive layer (IL) for a region.

The interpretive layers will be built on geologic data layers (DL) such as, bathymetry, morphology, sediment character, earthquake epicenters, and backscatter imagery. For example, the interpreted seafloor surficial geology maps will be supported by GIS layers of seafloor morphology, backscatter imagery, sediment characteristics, onshore geology, and other data. The interpretive structural and stratigraphic layers will be supported by all the above layers plus a deep-seismic data layer. Each underlying data layer may serve multiple interpretive layers and products and in addition, may be valuable products in their own right.

Scientists populating the data layers will need to work in cooperation with the CMGP National Knowledge Bank to insure uniformity in data standards. Maps will be produced in conformance with map standards as agreed by the USGS and consistent with Knowledge Bank protocols. It is acknowledged that these standards will take time and effort to develop.

For the work to be funded, the project chief must agree that the interpretive layer will fully cover one or more of the designated regions. We recognize that the data density and detail will vary greatly within and between regions. Data gaps will be become apparent and their recognition is deemed an important aspect of the synthesis effort.

Envisioning the work as a matrix of tasks leading to completion of a national geologic framework, the different layers are aligned along the horizontal axis, and the regions along the vertical axis. The matrix will be filled as projects are proposed and completed

Table 1. Example of conceptual matrix

	Region 1	Region 2	Region 3	Region 4, etc.
<i>Surficial geology interpretative layer</i>	–	–	–	–
morphology data layer	--	--	--	--
sediment character data layer	--	--	--	--
sonar imagery data layer	--	--	--	--
etc.				
<i>Sediment contamination interpretative layer</i>	–	–	–	–
sediment texture data layer	--	--	--	--
sediment composition data layer	--	--	--	--
sediment transport pathways data layer	--	--	--	--
etc.				
<i>Sediment budget/predictive models interpretative layer</i>	–	–	–	–
sediment texture data layer	--	--	--	--
morphology data layer	--	--	--	--
suspended-sediment distribution data layer	--	--	--	--
current measurements data layer	--	--	--	--
etc.				

<i>Tectonic hazards interpretative layer</i>	—	—	—	—
subbottom structural/stratigraphic data layer	--	--	--	--
morphology data layer	--	--	--	--
earthquake epicenters data layer	--	--	--	--
etc.				

With this scheme, the most important issues, themes, or interpretive layers will become the scientific products completed first. As the synthesis progresses, funding attention will be drawn to holes in the matrix, particularly those with scientific or societal interest. Using this strategy, it will become apparent what needs to be done to complete the Report to the Nation, and this visibility will enhance its completion in a timely fashion.

We rejected the work strategy that might be called the “stovepipe” model wherein all layers are completed for a given region followed by a final regional report. Instead we envision populating the matrix in any way that makes sense in terms of vital scientific or societal issues and availability of scientific skills and data. This will result in the whole matrix being filled unevenly but simultaneously. As the interpretive layers, derived from nationally standardized data layers plus regional and issue-specific data, and studies begin to fill out the geologic framework of the regions, the regions will become better documented, described, interpreted, and understood in terms of their geologic framework.

We suggest yearly work proposals on synthesis and framework be judged, not only on scientific quality, budget feasibility, etc., but also by how they address the needs of the National CMGP Geologic Framework Synthesis. For this to succeed, a strong working relationship must be established between the Knowledge Bank and Regional Synthesis projects. Standards for each interpretive layer will be established and used by each project to develop the final digital product. A yearly meeting of customers and federal agency scientists and managers who are potential users or scientific partners is strongly recommended.

The format favored by customers and ourselves is web-based reports, backed up by CD-ROM where indicated by data density. A hard copy executive summary of each interpretive layer also needs to be published as it is completed. PDF file formats, available on the web, are favored for longer detailed reports and normal rigorous peer review is assumed.

Based on our data holdings, scientific and societal importance, and customer interests, we believe the following interpretive layers are the most important to include in regional synthesis (or national) reports:

- ✓ Seafloor surficial geology (a geological description of the water-bottom interface);
- ✓ Geologic framework (Shallow and deep geologic structure, sedimentary stratigraphy);
- ✓ Benthic habitat characterization (Geologic characteristics of the sea floor environments and their importance to various fisheries and marine life);
- ✓ Coastal vulnerability (Long-term shoreline change, vulnerability to coastal flooding, erosion, and long-term sea level rise);
- ✓ Sediment budget and predictive models (Sediment transport pathways, areas of sediment accumulation and erosion, rates of transport, capability to predict transport of sediment particles)
- ✓ Holocene sediment thickness and accumulation rates (sedimentation since sea-level rise)
- ✓ Tectonic hazards (likelihood of earthquakes on active faults, submarine landslides)

- ✓ Sediment contamination (Geologic processes related to contaminants in surficial sediments)

Below are some data layers that would support the above interpretive layers. (Some are also to some degree “interpretive”):

- ✓ Bathymetry and coastline
- ✓ Seafloor backscatter imagery
- ✓ Sediment texture
- ✓ Sediment composition
- ✓ LIDAR and other imagery of coastal zone and beach changes
- ✓ Rates of coastal accretion or erosion
- ✓ Current measurements
- ✓ Earthquake epicenters
- ✓ Onshore geology

## ***Recommendations to Management***

The steering committee believes this work will provide a national focus for CMGP in the years ahead. The steering committee encourages initiation of at least three pilot studies to begin the nationwide engagement of CMGP scientists. The process of standards development is perhaps the most critical aspect of this work in the early stages. Strong national leadership and multi-agency coordination will be required for this to move forward. The level of effort for the CMG program will be large, involving a significant percentage of time from many of CMGP's senior scientists. The Regional/National Synthesis aspect of the program might occupy about 25% of CMGP's budget when fully funded. We estimate that 10 years will be required to fill in all regions and complete a National Report. We strongly recommend forming a multi-divisional and multi-agency advisory committee of colleagues, collaborators and customers.

We reiterate that developing standards, both data standards and map standards, is vital to establish a foundation for this work to proceed. These standards need to be developed in concert with the Knowledge Bank project or perhaps by the latter project with assistance from the Regional Synthesis project. Linkages will also need to be forged with BRD, NMD, NGMP, and the National Atlas as well as with the USGS Coastal Initiative. Other agencies, for example those represented at the workshop, will need to be kept informed of progress and routinely solicited for advice through the advisory committee.

## ***Appendix A – Summary of key recommendations from workshop participants-Expanded***

*(edited from meeting notes and participant contributions)*

Participants were asked to consider the following questions as perspective and context for their comments.

- 1) Should USGS produce regional geologic syntheses/assessment/maps?
- 2) What content of a regional synthesis would be of most use to your organization (top 3)?
- 3) What format would a useful synthesis take?
- 4) Are there syntheses that your program/agency/organization might like to produce cooperatively with USGS?
- 5) What regions or areas should take priority?

### **Some specific external comments**

#### National Oceanic and Atmospheric Administration, National Ocean Survey - Curt Mason

NOAA emphatically endorsed the NRC recommendation to “include regional scale products, broad national-scale assessment and tailored site-specific assessment as needed by customer”. NOAA acknowledged the USGS federal role in providing quality scientific information for use by coastal managers, but cautioned USGS to develop user-friendly products. Other coastal and marine agencies look to USGS to integrate understanding, and to provide high scientific standards, and technical expertise.

NOAA coastal managers would like CMGP to focus on synthesis of coastal geologic hazards, research on geologic controls on ecosystem structure and function, and on geologic and geomorphic studies related to geologic controls on biologic habitats. Products most useful to NOAA would be web-based

syntheses and databases along with GIS data layers of integrated assessments. Regional characterizations should be available as CD-Roms and map based overviews of geologically significant variables.

Synthesis efforts that should be directly linked to ongoing NOAA efforts are:

- ∑ Geologic characterization of Sanctuaries, NERRS, and Marine Protected Areas (MPA).
- ∑ Local and regional scale synthesis of coastal risk/vulnerability (erosion, tsunami generation)
- ∑ Coastal and nearshore sedimentary framework of Gulf of Mexico (wetland loss, hypoxia issues)
- ∑ Geologic assessment of Puget Sound (coastal risk and vulnerability; geomorphology/ecosystems function)
- ∑ Synthesis of coastal margin bathymetry and topography information (maps, sediment budgets, community models)
- ∑ Geologic framework of Ocean Exploration regions selected by the administration (Hudson Canyon, NW Hawai'i, NE Pacific Seafloor, Arctic Basin.)

Academia, Research Community, and National Undersea Research Program (NURP) - Peter Auster

There was strong concurrence that USGS/CMGP should produce regional offshore synthesis at multiple scales. Such perspectives allow us to understand the spatial patterns and dynamics of species and communities (biological diversity) at local, landscape, and biogeographic scales, all of which require an understanding of the underlying geological framework. This basic framework underpins both basic and applied research efforts, and directly links to goals of operant federal legislation including SFA, NMSA, ESA, and many others. In addition research site selection based on results of regional geologic synthesis insures focused research from the scientific community. Regional and national syntheses also provide scientific groundwork for developing frontier research themes using repetitive observations, regional perspective and linkages to other disciplines. Our vision of the “products”, “content” and “application” of a regional geologic synthesis is as follows:

Product	Content	Application
Digital Map Products – Show what data and information is available.	Integrated multiple seafloor map products as single/multiple coverages with interpretation (Data : bathymetry, grain size, backscatter, contaminants, empirical or interpolated landscape).	Relating distribution and abundance of species and communities to landscape features.
Synthesis of Geological Framework and Processes, (Science needs a paper product to reference in future)	Syntheses should provide a process perspective that focuses on the dynamics of the existing geological framework; discuss limitations and uncertainties in both interpretation and prediction.	Understanding of processes to better predict disturbance based on bathymetry, sediment type, circulation patterns, storm effects.
Dynamic Interactive Models	Dynamic circulation and sediment transport models. Ability to insert particles (with behavior) for spatial and temporal assessment of transport trajectories.	Predict sources and sinks of larvae and materials; predicting frequency and intensity of disturbance.

Looking to the future: Geologic framework should include some replicate small scale (nested) mapping and geologic synthesis of representative sites within biogeographic regions.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service - *Jim Thomas*

National Marine Fisheries Service must constructively respond to the recent Magnuson-Stevenson Act which requires regional and national benthic geologic characterizations and understandings of seafloor habitat to define Essential Fish Habitat (EFH) and to identify adverse impacts caused by fishing and non-fishing events.

Regional and national synthesis and geologic framework studies builds on existing USGS/NOAA funding initiative that seeks

- 1) to determine the effects of fishing gear on seabed habitats and
- 2) to identify and map benthic habitat characteristics and extent of fishing habitats.

The focus should be on seafloor geology, benthic geologic processes and habitat processes that lead to a geologic understanding of the short- and long-term linkages between biological resources, seabed habitat type and condition, and the impacts of fishing gear. Content of a regional synthesis should include morphology, surficial features, benthic roughness, texture, hardness, sediment thickness, seafloor history and temporal change, plus live bottom epibiotic and infaunal structures.

Seafloor characterization, including georeferenced digital backscatter and bathymetric data is ultimately needed for the entire US EEZ with initial priority for the entire U.S. continental shelf & slope and topical/issue priority “postage stamp” areas within each NOAA/NMFS region, including estuarine areas.

Desired products from regional synthesis should include GIS (ArcView or ArcInfo), digital mosaic bathymetry and backscatter imagery, as well as electronic and hard copy maps for managers and the fishing industry. Synthesis should also develop methods to extrapolate data from higher resolution site specific studies to shelf-wide application (areas of fishery management plan). Synthesis should be repeated periodically to determine fishing related and natural changes (Change or “recovery” maps).

NMFS would particularly like to cooperate in identifying and mapping Habitat Areas of Particular Concern (HAPC), marine refugia (MPAs), coral reef delineation, and restoration projects, as well as issue specific studies and maps to predict habitat susceptibility to effects of fishing activities.

Priority regions for NMFS are

- 1) Fishery recovery in Gulf of Main/Georges Bank;
- 2) Impacts of the largest US fishery in Bering Sea/Gulf of Alaska;
- 3) Extent and character of U.S. West Coast ground fish habitat on the shelf and slope;
- 4) Gulf of Mexico shrimp fishery (and bycatch) habitat alteration,
- 5) identifying MPAs (Western Pacific and Caribbean (least known) (NW Hawaiian Islands (coral reefs);
- 6) Anticipating impacts of sand and gravel mining Cape Cod to Florida Straits)

National Park Service (NPS) – Rebecca Beavers

Regional geologic syntheses that include the 7300 miles of shoreline and coast managed by the NPS will be valuable tools for NPS resource management. Management of the cultural and natural resources in 68 coastal NPS units must be based upon knowledge of geologic resources and processes. Effective communication of geologic knowledge by the USGS is vital to facilitate decisions about park resources with competing demands. USGS regional syntheses will help identify vulnerable shorelines and enable NPS to designate sites for long range (100 yr) NPS planning that considers the anticipated rise in sea level and fall in levels of the Great Lakes.

Shoreline change has been identified as one of the top issues of concern, also known as park ‘vital signs’, for monitoring in NPS coastal parks. Important components of an effective geologic synthesis will be shoreline position as well as the effect of geologic framework on shoreline evolution. Vulnerability of park resources to sea and lake level changes, earthquakes, tsunamis, coastal subsidence, and coastal engineering need to be assessed at the synthesis scale. These impacts could lead to impaired natural resource conditions, reduced recreational opportunities, and threats to cultural and historic resources and park infrastructure.

The content in a regional geologic synthesis of interest to NPS includes:

- ∑ present shoreline position;
- ∑ shoreline change and erosion potential;
- ∑ offshore regional geology framework as it effects the shoreline and ground water hydrology;
- ∑ regional and local sediment budgets;
- ∑ natural or cultural resources at risk to coastal and offshore geologic hazards;
- ∑ regional vulnerability to major storm events and water level changes;
- ∑ impacts of existing and planned coastal engineering (hard and soft structures) on shoreline processes;
- ∑ information and data products that can be used by park interpretive staff to inform the public about geology and geologic issues.

Synthesis products of the geologic framework must be applicable to ecosystem management, must tie onshore to offshore, and must tie geology to biology. It is very important that these syntheses be transferable to and easily interpreted by park resource managers. This information should be accessible by agency GIS databases, web browsers, and limited hard copy. This synthesis should be scalable to the national, regional, and individual park levels.

To facilitate these USGS syntheses, NPS will cooperate with USGS and NOAA in efforts to delineate Marine Protected Areas and protect Coral Reef resources in accordance with recent Executive Orders. NPS would like to work with the USGS to develop a multi-disciplinary and multi-agency strategic plan of coastal ecosystem inventory and monitoring. NPS encourages the USGS to work with NPS interpretive staff to communicate the results of these syntheses to the public.

U.S. Fish and Wildlife Service (USF&WS) – Tracy Rice

USF&WS as managers for extensive holdings of coastal and nearshore ecosystems, encourages USGS-UMGP to produce regional geologic syntheses/assessments/maps, especially in those areas mentioned below. As another federal ecosystem manager we would like to concur with the ecological recommendations presented by NOAA (Curt Mason), NPS (Rebecca Beavers), NMFS (Jim Thomas) and NURP/Academia (Peter Auster).

The content of a regional synthesis by USGS most useful to USF&WS would include:

- a) Habitat types -- how common-unique-diverse are geologic features relevant to the ecosystem such as hardbottoms, ridges and swales, wetlands, or SAV (Submerged Aquatic Vegetation). Bathymetry and surficial sediments are critical.
- b) Biological community surveys of those habitats. BRD input should be incorporated in regional geologic syntheses so fish and wildlife resource managers can tell how these communities differ by region or geologic location.
- c) Processes and their impact on bottom geologic change. USF&WS needs to be able to assess the ecosystem effects of change (relocating an inlet, or dredging of seafloor, erosion, climate), thus needs information on a likely sequence of events as they evaluate projects on 50 year lifespans?

A useful synthesis format would incorporate GIS, so USF&WS can add data layers; easy-to-read, colorful maps; easy-to-read, lay friendly, summaries; web sharing of everything. Syntheses should be referencable and address uncertainties and limitations of the data and their interpretation.

USF&WS refuges are currently developing (over the next 5 years or so) Comprehensive Conservation Plans (CCPs), which require natural resource characterizations. Geologic information is needed in both map and summary form. USF&WS refuge staff working on CCPs would encourage cooperative work on syntheses for their refuge lands. In addition, refuges routinely must determine if proposed construction projects are compatible with the refuge goals. Knowledge of the geology and geologic change is needed to understand if those chain-of-events consequences are compatible with the natural processes.

USF&WS regions or areas of high priority are those with many threatened and endangered species. Many of these species at the coast are dependent upon geologic processes. The agency needs to know where these areas should be, or were in the past, or could be restored to in the future, in order to aid in the recovery of those species. At present the mid-Atlantic, Gulf of Mexico, Hawaii and Alaska should receive higher priority.

US Army Corps of Engineers (USACE) – *Charles Chesnutt*

The Corps of Engineers has begun to approach issues on a broad regional basis through its regional Divisions. The USACE needs to rely on other agencies such as CMGP to assist in collecting and synthesizing the data and supports this effort since the USGS is viewed as a major regional data source.

The primary areas of concern relate to coastal sediments and sediment budgets as they impact management of the sediment resource under USACE responsibility. The USACE would like to have national syntheses to allow national management decisions which would be implemented by the regions. Specific areas of focus at the moment include: NE Gulf of Mexico; St. Marks FL to W. End of Dauphin Island to end of Miss. Coast; Lower half of Maine, Southeastern Lake Michigan; Southern California, Ca Dana Point to Del Mar; Long Island; New Jersey shore.

Products including regional synthesis of nearshore bathymetry, sediment texture, and sediment sources along with modeling and predictive capabilities towards understanding resource and environmental impact are CMGP synthesis areas that would assist the USACE. The GIS should support models with underlying data available to state and local governments. Links should also be built to NGDC databases.

Environmental Protection Agency – *Barry Burgan*

EPA is strongly focused on water and sediment quality and biotic conditions, and thus does not profess strong needs for geologic input. An EPA goal in the coastal area (mostly inside 3 mi. and in estuaries) is to develop a national coastal condition report card with regard to issues of water and sediment quality and biotic conditions, as well as designated uses and compliance with water quality standards. There are strong partnerships with the states. EPA hopes to report on all coastal programs or all coastal areas, recognizing that information is lacking on near-coastal waters and on coastal habitat. In addition to habitat information, USGS might partner with EPA where assessment of “sediment quality” calls for sediment contaminant, toxicity, TOC, and grain size as indicator data. EPA also monitors 103 Ocean Dumping sites using sediment character as one criterion.

EPA has developed a three tiered National Coastal Research and Monitoring strategy with regional and national reports which includes a strong coastal data management effort. The program will be implemented at selected sites by expanding existing joint NSF, EPA, NOAA, and NASA research program. Although USGS & DOI are not specifically identified, linkages seem appropriate in some instances. EPA sees a strong need to develop consistent data standards which should involve USGS.

Coastal States Organization - *Kerry Kehoe*

Coastal States Organization (CSO) represents most of the 35 coastal states and territories, and coastal hazards are in the top three issues for most coastal states. Public safety, the protection of public infrastructure, and protection of natural features and the environmental and economic benefits of beaches are the primary concerns.

The coast states have a responsibility to balance conflicting coastal demands. This task is becoming more complex because states and communities are faced with making decisions without the necessary data and information to validate the assumptions upon which the decisions are based. For instance, states and communities are making commitments to beach nourishment projects with anticipated project life-spans of 50 years when the availability of sand resources to maintain these projects is often unknown. This lack of knowledge is resulting in assumptions and decisions that will limit future response options of states and communities to shoreline change resulting from coastal erosion, coastal subsidence, earthquakes and tsunamis, and sea level rise.

The complex linkages and many different feedback loops affecting shoreline change are difficult to identify and understand from the level of an individual state. In addition to the need to understand littoral systems from a regional perspective, all of the factors affecting shoreline change -- the environmental, ecosystem, and economic, -- must be taken into account.

One of the limitations that federal data has often had from the states perspective is inappropriate scale. States usually need a higher resolution of detail than is available from regional studies or assessments.

The primary objectives of the development of a regional or national synthesis should include developing improved products and services for decision-makers with a recognition that there will be more than one user and one application for research studies. It would also be helpful to the states to have a single port of entry for coastal data and information. To that end, there are a many federal agencies with coastal data and information resources (NOAA's Coastal Services Center might be such an entry). An integrated strategy across the federal agencies is needed. The existing CMGP and NOAA combined studies are good examples of how this can be done. These coordination and integration efforts need to be extended beyond project examples to the regional and national mission level of the agencies and programs.

Federal Emergency Management Agency, National Flood Insurance Program – *Mark Crowell*

The FEMA – Coastal connection is primarily in the National Flood Insurance Program’s (NFIP) flood mapping and erosion studies including all the US, the Great Lakes and island territories. Landslide risk, sea level rise and tsunami risk are not presently high priority for FEMA through NFIP. FEMA already maps areas subject to on percent annual chance of coastal flooding and could potentially be mandated to map long-term erosion hazard areas. Priority areas are densely developed and populated coasts.

To accomplish this mission FEMA needs data and information on long term change in hazard areas, wave heights, wave run-up, and dune erosion. FEMA relies heavily on state data sources for this information. Regional CMGP synthesis would be helpful if they included data on cultural features and if high resolution DEM and bathymetric data are included (vertical accuracies of 1 to 2 feet). In addition scientific assessment of beach nourishment and shore protection features would be helpful.

FEMA works on political jurisdiction levels. USGS can help by providing maps and information products at a large (many states combined) level with standard formats, all spatial georeferenced, GIS, and digital. FEMA will then be able to extract data to the required level of resolution as needed.

Priority for information based on number of structures at risk within the 60 year erosion hazard area suggests the following distribution Atlantic Coast (55%), Great Lakes (18%), Gulf of Mexico (14%), Pacific Coast (13%).

Geological Survey of Canada - Gordon Fader

In Canada, while "synthesizing" offshore geology during the 80s, the GSC found offshore areas where there was no detailed data. So we attempted to map them, at a broad scale; then we were cut back partly because we left the impression that "everything was done". Thus at the moment the GSC does not map systematically; taking instead a shotgun approach. The current Canadian SeaMap proposal, however, will move back to systematic offshore mapping. The proposal calls for approximately \$33M/year in funding for 10+ years.

The regional synthesis and geologic maps the GSC produced, maps the Quaternary as formations. These products have a broad use by engineers, fishing community, wastewater outfall designers, military, oil and gas industry, ecotourism, marine archaeology, harbour managers, geologists, RCMP and TSB, and others. The content list for GSC synthesis maps can be extensive. Examples are:

- ∑ Surface and subsurface Quaternary features of continental margins and geomorphic classifications,
- ∑ Bedrock (pre-Quaternary info), tectonic elements and
- ∑ Quaternary sediment thickness
- ∑ Crustal thickness, seismicity, stress orientation
- ∑ High resolution magnetic and gravity maps.

GSC sees the present need for higher resolution; high-resolution magnetics, shallow bedrock and surficial framework, and understanding of dynamic geologic processes. The multibeam "revolution" with 100% coverage, is now GSC's first survey priority. Resolution decides the scale of the map products so as to maintain the maximum resolution while population and management issues control areas/priorities. GSC has found that the emergence of national habitat management (Oceans Act) is acting as a key driver for program priorities. This also has resulted in government and private partnerships that are the key for the survival of the GSC.

Geological Society of America. – *Dennis Goldman*

GSA's broad constituent base consists of individual earth scientists in instruction, industry and the public in addition to research, management or regulatory entities. From this generalist perspective GSA encourages CMGP to develop regional synthesis as a recognized non-biased, non-political source of information with unique capabilities.

The content of regional synthesis should support protection of human and ecologic welfare. The synthesis should also monitor natural resources and provide the public with geologic information that facilitates decisions on resources with competing demands. We envision a geologic baseline that can be used for monitoring, predictive models for deciding future trends and impacts, and for multidisciplinary modeling efforts. Synthesis should consider episodic and catastrophic events that impact society and ecosystems and can be used to assess long-term and short-term anthropogenic and non-anthropogenic impacts.

GSA encourages a product that is timely and readily available (web based) and at level that is useful for both public and scientists. This may take more than one paper product or perhaps several web-based layers. Ideally the synthesis should provide a kind of yellow pages of who is doing what research. Ambiguity and uncertainty should be quantified whenever possible.

USGS MUST cooperate better with other federal agencies, state agencies, university, industries, specific public interest concerns (e.g. Native Americans) as synthesis products and outcomes are developed. GSA feels having end users involved in synthesis products is very important and provides a new dimension for CMGP.

**Some specific internal comments –**National Biological Assessment – Biological Resources Division (BRD), USGS – *Michael Mac*

BRD produced a synthesis “Status and Trends in the Nation’s Biological Resources” as a second edition of a national biological synthesis/assessment. The national view gives rationale and focus for BRD, identifies information gaps and guides research. Importantly, it also informs Congress and the Public.

The goals included compilation of existing data on animals and ecosystems and identification of information sources. The national report was built on a series of regional assessments with a common format that emphasized processes, characteristics of systems and identification of trends.

To accomplish the synthesis, BRD recognized it needed to:

- 1) Establish a dedicated budget, leader and staff (the effort took 4 years);
- 2) Define the intended audience for the synthesis, which helped to determine the lay out (Technical audience vs. general public, vs. Congress);
- 3) Establish priority and timeliness of included information (recent vs. historical data; hot button issues); and
- 4) Determine regional/topic authorship and editors to help with different agendas, styles, timetables with multiple authors. The present version is a paper report, but we envision an electronic version in the future, with paper executive summary.

National Cooperative Geologic Mapping Program (NCGMP)– Geologic Division, USGS– *Martha Garcia*

Geologic maps are a form of synthesis at different scales. The “cooperative” in NCGMP is with the states, and important for program success and funding, and for determining the federal role. There has to be a need and relevance for a federal agency (USGS) to be involved with mapping. NCGMP has also found success by having strong and early involvement of customers, advisors and collaborators in running program and working in regions where strong relevance for geologic maps has been determined. This involves numerous workshops and forums and strong collaborators with funding, as well as the use of external reviewers, and matching grants with states and universities. CMGP should consider where there are real opportunities for success.

NCGMP provides synthesis studies not assessments, which are developed by cooperators. For example: On the Carolina Continental Margin 3D geologic maps and correlations are being developed off- and on- shore for state and federal water resource agencies to assess salt water intrusion concerns. The research involved in developing 3D techniques to construct geologic maps has allowed NCGMP to retain the information of traditional geologic maps yet provide a more detailed picture of the subsurface. Some caution is needed to know where the data is real and where it is not in the framework.

National Water Quality' Assessments –Water Res. Div. (WRD) - *Bob Shedlock & Paul Barlow*

WRD's national water assessments seek to establish the status, trends and understanding of water resources. Products are identified first by focusing on questions that define the boundaries of the studies. The outputs are built on a nationally consistent framework, coordinated by a national leadership team, which has multiple external advisory groups. One key to success has been building teams dedicated to the synthesis and assessment efforts.

National topical teams develop output based on aggregated local efforts in a tiered plan. Assessments start with a retrospective analysis, then assess regional/national trends that can be used to prove or disprove suppositions. Priorities are set by population densities. WRD is moving towards electronic publications with many databases published on CD-ROM. However paper products are still in use but they may be shorter and shorter, containing summary types of data.

WRD related "Needs for Regional Geologic Synthesis" for USGS WRD focus on two related issues:

1) *Geologic synthesis of broad coastal areas:*

Ground water hydrologists need a regional definition of the geologic continuum from on-shore to near-shore to off-shore environments, both at the shallow, surficial scale and at the deeper, regional scale. Geologic information is needed at the upper several meters to better understand geologic controls on ground-water discharge to coastal ecosystems, which is particularly important in understanding ground-water nutrient delivery to coastal waters. Deeper in the section, geologic information is needed to understand controls on regional ground-water flow systems, such as the movement of coastal freshwater-saltwater interfaces. In each zone, the depth of interest should be consistent with the depth-scale of the regional aquifer systems. Of interest here is detailed, three-dimensional definition of the coastal geologic framework, such as is currently underway for the Chesapeake Bay Impact Crater. This work could include type geologic cross sections at selected locations that would provide sedimentary models that could be applied in areas where direct geologic data (but perhaps geophysical data) were unavailable. This sort of information would be immediately applicable to ground-water simulation models of aquifer systems in coastal areas.

2) *Geologic synthesis in areas of tidal streams and brackish-water surface bodies(estuaries).*

Ground water hydrologists also need definition of the sediment sequences in stream valleys extending from freshwater tidal streams to brackish/saline-water estuaries, as well as models of depositional processes in these transitional systems to understand the pathways of ground-water discharge to streams in coastal tributaries and nutrient transformations from ground-water to surface-water systems. Work in such environments would also increase our understanding of nutrient transport and cycling between freshwater streams and estuaries and ultimately between watersheds and the coastal ocean. This type of study would be particularly important in assessing the impacts of increased human development in coastal areas.

National Energy Resource Program Assessments (ERP) – Geologic Division– *Dave Houseknecht*

National assessment/synthesis from the ERP perspective has been the national oil and gas resource assessment efforts. Assessment needs to be defined and will change through time. ERP assessments are updated periodically and have the following criteria:

- ∑ Complete digital coverage – geographic, geologic, GIS at different scales,

- ∑ Hierarchical – can zoom in and out to view,
- ∑ Fully aggregational and disaggregational - can assemble different attributes and scales.
- ∑ Have statistical validity built-in to aid in unifying or dividing data.
- ∑ Provide for a snapshot of resource status as well as a framework for specific assessments
- ∑ Ability to rapidly respond to request (24-48 hrs to Congress or Fed Agencies)

ERP experience indicates the need for synthesis to meet the need and expectations of external users while considering the reality of USGS responsibility, expertise and funding, as well as external interagency turf issues, and the needs of States, industry and advocacy groups.

Within the USGS, ERP assessments were supported when they had clear and well articulated goals, objectives, and priorities. Of particular importance was “steering” the assessment with a global perspective and nested projects with management providing an overarching context and assuring uniform and enlightened methodology. The USGS culture was challenged to allow curiosity driven management and curiosity driven science to operate in parallel within a global perspective. Assessments as agency “mission” work, global perspective and management need often conflicted with local research innovation, basic science.

#### National Earthquake Hazard Program (EHP) – Jill McCarthy

EHP comments are focused specifically on natural hazards in the marine and coastal environment and reflect an Earthquake perspective. First of all, I should note that my interpretation of the phrase "assessments" (as used in the NRC report) goes beyond regional data compilation, interpretation, or synthesis. To me, assessments are more quantitative determinations designed to address particular issues. Assessments draw from the existing state of knowledge and thus require existing research and synthesis upon which to build.

Within the Earthquake Program seismic hazard assessment activities represent 40% of our program and include the research activities required to perform the assessment (fault characterization, recurrence rates, crustal structure studies, seismicity, slip histories, etc). In 1996, the EHP completed a seismic hazard assessment for the Nation, as represented by a series of maps and their associated databases. These maps are based on consensus opinions and are generated after regional workshops designed to solicit input from those working in the region. Current work is now being focused at updating these maps and developing more detailed assessments in a few at-risk metropolitan areas. The national maps, and their associated databases, are all available on the web (the databases are as popular as the maps themselves).

The hazard assessment project has arguably been the EHP's most successful and important contribution to earthquake hazard reduction during the past decade. The results form the basis of new building codes for the nation and are used by insurance companies, state and local governments, consultants, FEMA, and design professionals. Much or all of the credit goes to one person, the project leader (Art Frankel) He and his staff have worked diligently and patiently with customers and collaborators, seeking input, crafting consensus, responding to hundreds of inquiries, making sure that deadlines are met, and explaining the methodology to users. He has been tireless in his efforts and has been a very effective

bridge to the scientists working in the regions. Not only has it been critical to have a single champion such as Art to take charge, it also has been essential to have someone with his scientific stature who is respected and is viewed as fair and even handed. I urge CMGP to visit the project web site at:  
<http://geohazards.cr.usgs.gov/eq/>

I think it would be useful for the CMG Program to undertake a comprehensive multi-hazard assessment for the Nation's coastal areas. FEMA has often bemoaned the fact that there is no single, consolidated hazard assessment for the Nation. Marine could play an important role in jump-starting this effort. Regional hazard assessments are primarily completed in the Marine Program. This would be the obvious next step. I see endorsement for this as I read the NRC report. Here are some specific suggestions:

- I. Format: - Probabilistic analysis with multiple time frames (10 years, 20, 30, 50)
  - Uncertainty quantified
  - Can be disaggregated to show contribution from specific hazards
- II. Content: - Multi-hazard. Submarine landslides/slumps, fault rupture, tsunamis. (Coastal erosion??)
- III. Where: - National scale first. Followed by more detailed studies of at-risk coastal communities
  - Need to evaluate how far out to extend the study area -- inner shelf? slope?
- IV. Cooperation: - Of course EHP would be happy to work cooperatively with CMG in the development of the methodology and to ensure that there are no disconnects at the shoreline.

**Short comments and suggestions from meeting participants –**Eastern Regional Perspective - *Dave Russ*, Eastern Regional Geologist, USGS

Regional synthesis need to develop internal links the consider where the USGS Regions and the Bureau is going. National programs are the strength of the USGS, with implementation on a regional basis. New Program direction is toward multidisciplinary mega-projects. In the Eastern Region these regions include the Great Lakes, New England, Middle Atlantic, and Lower Mississippi River.

New USGS sees new opportunities to develop or strengthen partnerships and work in geographic areas defined by a related set of physiographic and climatologic characteristics along with common societal and stakeholder issues where the USGS should increase its presence and application of its science. Regional synthesis needs to define the audience and to key in customers early.

NOAA- National Geographic Data Center (NGDC) – *George Sharman*:

NGDC is developing coastal relief models (DEMs) from USGS, plus NOS hydrographic data, single 3 arc-spacing combined. These synthesis products are developed in several formats and output on CD with web interface. NGDC finds that the public customer priority should be highest with simplified, accurate, and understandable products. CMGP should also anticipate inquiries from people they wouldn't have expected.

New England Aquarium – *Mike Conner*

Regional synthesis are an excellent opportunity to build CMGP's customer base. NE Aquarium has about 1.5 million visitors and 3 million hits on website, an example of outreach potential for products. Often customers do not know who they are, but CMGP should consider broadening the customer base by such techniques as training sessions to show people how to use our data and products. Customers can not be supportive unless they know what CMGP is doing.

National Park Service (NPS) – *Lindsay McClelland*

NPS also has vigorous public interactions (via interpretive staff and websites) and would be a good conduit for your regional information. NPS finds that the public is open-minded and interested, and can be educated. Outreach should be a key component of regional synthesis

USGS, National Cooperative Geologic Mapping Program – *Dave Soller*.

CMGP needs to develop links (via the CMGP National Knowledge Bank) to other databases in USGS, especially those mandated by the mapping act and that held as the geologic map database.

DOI Office of Insular Affairs – *Karen Koltas* –

CMGP should keep in mind several current DOI initiatives as opportunities for regional synthesis focus: 1) Under the Coral Reef initiative, 20% of the reefs are to be designated as no-take ecological reserves by 2010. Habitat assessment will be an important component of this initiative (See Coral Reef taskforce website) 2) Executive order calling for Marine Protected Areas (MPS's) calls for lots of assessments.

***Appendix B: Workshop Participants***

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