

Biogeographic Assessment of Samoa: In Support of the Two Samoas Initiative



An evolving cooperative investigation between NOAA, Samoa,
American Samoa, Conservation International, and the South
Pacific Regional Environment Programme



January 2010

Prepared by NOAA/NOS/NCCOS/Center for Coastal Monitoring and
Assessment/Biogeography Branch

About this document

This document was developed to inform project partners and other interested groups and individuals about an evolving biogeographic assessment in the country of Samoa. Formulation of this document was supported by NOAA's Coral Reef Conservation Program (CRCP) and the Center for Coastal Monitoring and Assessment (CCMA). The document is intended to foster discussion, explore ideas, and obtain feedback on the evolving scope and approach of the work. It is anticipated that this document will evolve into a detailed work plan that will define tasks, products, and project milestone dates based on the required science and available resources. The proposed work complements the biogeographic assessment underway in American Samoa (Kendall et al. in prep.).

For more information

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Project Summary

The evolving NOAA partnership project will provide information to support marine resource management in Samoa and help identify potential areas for a network of marine protected areas (MPAs) within the Samoan archipelago (i.e., the U.S. Territory of American Samoa and Independent Samoa). The planned assessment will include biological, habitat, and oceanographic aspects and will be a component of a broader-scale biogeographic assessment that spans the entire archipelago. A key to implementing the study is a coordinated approach among current and planned local and regional partners (Appendix II).

The proposed study complements the ongoing biogeographic assessment in American Samoa (Kendall et al. in prep.). The evolving Samoa study will be implemented in 2010 with initial funding from CRCP and CCMA. Planned products include geospatial analyses and maps depicting the spatial and temporal distribution of oceanographic features and patterns; potential larval transport pathways among islands; selected marine species; species assemblages; and identification of biologically significant areas. All of the products will require some level of training in their use and application to ensure maximum benefit to project partners.

The study will support the Two Samoas Initiative between Samoa and American Samoa to identify shared environmental problems, exchange management approaches, and consider resources that would benefit from coordinated management. These activities may result in formulating a network of marine protected areas throughout the entire Samoan archipelago. In addition, the biogeographic assessment will support the ongoing Samoa, South Pacific Regional Environment Programme (SPREP) and Conservation International efforts in defining and managing key biodiversity areas in the region.

Background

Geography

Samoa, formerly Western Samoa, is in the South Pacific Ocean 3,540 km south of Hawaii (Figures 1a-b). The total land area in Samoa is 2,900 km² consisting of the two large islands of Upolu and Savai'i which account for 99% of the total land area, and eight small islets: the three islets in the Apolima Strait (Manono, Apolima, and Nu'ulopa Island), the four Aleipata Islands off

the eastern end of Upolu (Nu'utele, Nu'ulua, Namua, and Fanuatapu), and Nu'usafe'e located about 1.4 km off the south coast of Upolu. The Samoan islands were created as the Pacific plate moved over a volcanic hotspot. Savai'i, a geologically young island, remains volcanically active and has erupted during the past century. Just to the east, Upolu appears to be extinct at the moment, but its subtle peaks and ridges illustrates that it is still a fairly new island. Older still are the smaller islands of American Samoa farther to the east.

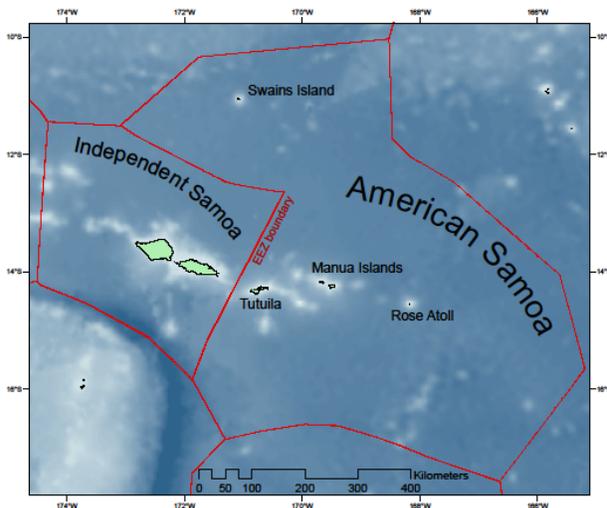


Figure 1a. Samoan Archipelago

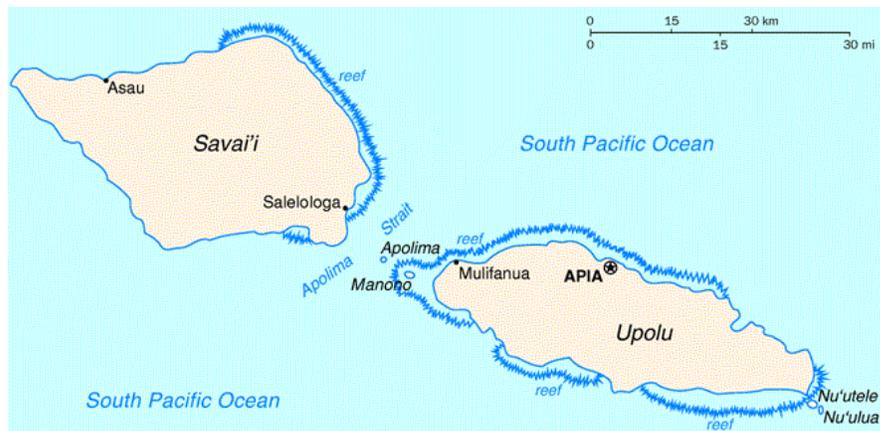


Figure 1b. Samoa Islands (Oceana from <http://geography.about.com/library/cia/blcwsamoa.htm>)

Related Activities

Several complementary activities in support of marine resource management in the Samoan Archipelago are presently underway and provide the impetus for the proposed regional biogeographic assessment. Foremost is the Two Samoas (American Samoa and Samoa) initiative to identify shared environmental problems, exchange management approaches, and consider resources that would benefit from coordinated management. In addition, both Samoa and American Samoa have active and expanding Community Based Fishery Management Programs with multiple villages engaged. Other studies that complement the initiative include the Fagatele Bay National Marine Sanctuary review and update of their management plan including consideration of boundary modification and proposed additional National Marine Sanctuary sites. Also, the government of American Samoa is implementing a Territorial MPA Network Strategy that will identify preferred sites to include in a no-take marine reserve network consisting of 20% of the territory's reefs (Oram 2008).

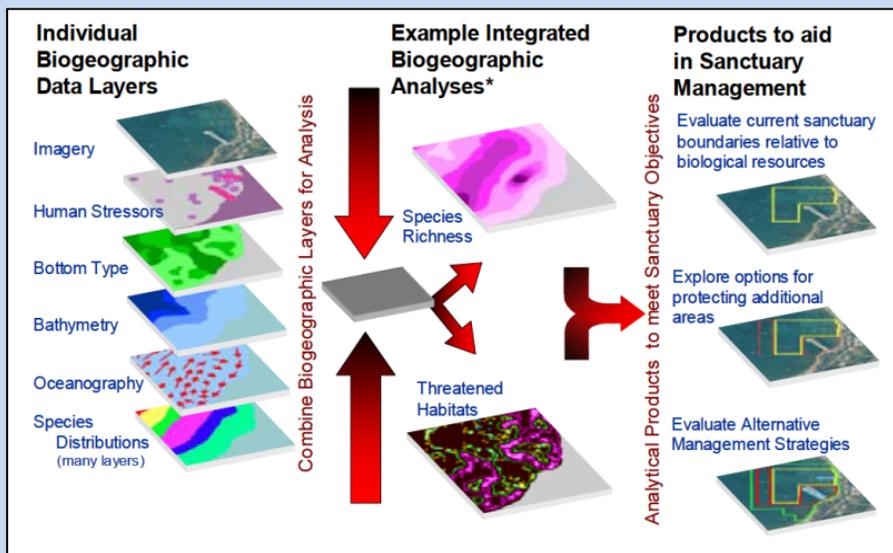
Project Kick-off Meeting

A multi-agency meeting with Samoa, American Samoa, and regional partners was held on August 14, 2009 in Apia, Samoa to discuss the feasibility of conducting a biogeographic assessment in Samoa. A key action in the meeting was to identify existing data that can contribute to the assessment and also identify gaps in information. At the conclusion of the suite of meetings, the participants (Appendix I) concluded that a Samoan biogeographic assessment is feasible to undertake with existing data and that the identification of key data gaps by the proposed investigation would support partners in developing supplemental data collection efforts. The proposed effort builds on previous Samoa initiatives to manage marine resources and will make maximum use of existing data. Data sets that cover large areas of Samoan waters will be critical components of the biogeographic assessment to support marine resource management, including exploring future marine protected areas to complement those already in place in Samoa.

What are Biogeographic Assessments?

Biogeography is the study of spatial and temporal distributions of organisms, their associated habitats, and the historical and biological factors that influence species' distributions. Biogeography provides a framework to integrate species distributions and life history data with information on habitats of a region to characterize and assess living marine resources. The biogeographic data are integrated in a Geographical Information System (GIS) to enable visualization of species' spatial and temporal patterns, and to predict changes in abundance that may result from a variety of natural and anthropogenic perturbations or management strategies. The complexity of products from biogeographic analysis range from simple species distribution maps or a particular habitat, to more complex products that combine single data layers to create maps of biodiversity or habitat complexity. Often biogeographic analyses focus on determining the strength of coupling between habitats and species and defining discrete areas of biological significance.

Typically a biogeographic assessment is comprised of three primary activities (diagram below): 1) compile or create individual biogeographic data layers, 2) perform integrated biogeographic analyses, and 3) develop products to aid in management. The assessment process shown is based on geospatial and temporal analyses of existing physical and biological data and has resulted in many spatially-oriented products that assist managers in understanding how ecosystems function.



Study Approach

The assessment will be conducted for waters within the Exclusive Economic Zone (EEZ) of Samoa and more broadly over the entire Samoan Archipelago as datasets and coordination allow. The majority of the analyses will focus on the narrow shelf around the islands where the coral reef ecosystems are located. To provide geographic context beyond Samoa and understand connections among islands in the region, selected oceanographic analyses will be conducted at a wider spatial extent to include the EEZ of the surrounding island nations.

The assessment will provide spatially explicit depictions of ecological resources, biologically significant areas, oceanographic patterns, larval transport processes, and the connectivity among them. These factors represent a primary information need for marine and coastal management decisions and are especially relevant to the design of marine protected areas.

The proposed time frame is subject to change and is based on management needs and available resources from partner agencies. One to three years is typically required to conduct an integrated biogeographic assessment, depending on the complexity of the management issues, data availability, and the existence of published information. However, based on initial data discovery efforts we propose a 14 month study in Samoa using existing data. The study would be modified if complementary field-based proposals are funded which would provide new data for analysis and integration with existing data sets.

Potential Study Components

Potential tasks to complete the assessment are outlined below. For each task we provide a brief summary description, estimated date of completion, and a list of potential products. It is expected that this list will evolve into a more detailed project work plan early in 2010 based on feedback from project partners.

List of Potential Tasks

1. Create draft work plan
2. Complete oceanographic characterization
3. Conduct larval connectivity modeling
4. Gather and evaluate data
5. Create database and select analytical techniques
6. Conduct biogeographic analysis
7. Provide draft biogeographic mapping products for review
8. Develop final digital products

Description of Potential Tasks

Task 1: Create Draft Work Plan

Estimated completion date: January 2010

The draft work plan serves as a road-map for project implementation. The work plan should be viewed as an evolving document that will be modified as needed to meet project partner needs.

Anticipated Products:

- NOAA/Coral Reef Conservation Program proposal (Complete)
- Project concept document (Complete- this document)
- Work plan

Task 2: Complete Oceanographic Characterization
Estimated completion date: February 2010

The oceanographic characterization for the Samoan archipelago was identified as a key information need during project kickoff meetings and is well underway. A draft report based on satellite data is presently under internal review. Wind, ocean current, water temperature (Figure 2), sea surface heights, and ocean color are among the topics considered. Yearly, seasonal, and anomalous patterns in these variables are the focus of the report. This task of the project is fundamental to understanding the physical setting of all other project components.

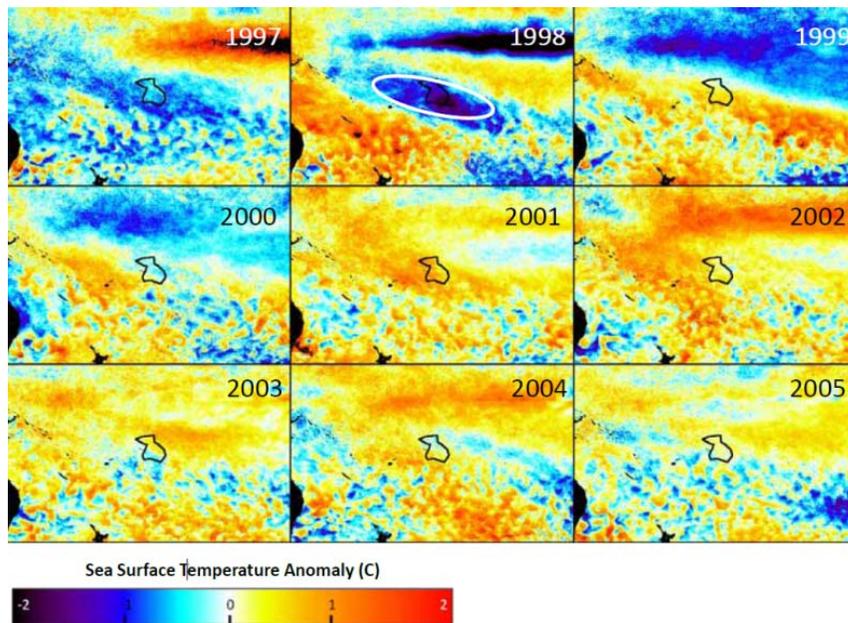


Figure 2. Sea surface temperature anomalies for July. Note low values in 1998.

Products:

- Oceanographic setting report
- Digital products

Subtasks:

- Draft report (Complete)
- Internal review (Underway)
- Revisions

Task 3: Conduct Larval Connectivity Modeling
Estimated completion date: May 2010

The goal of this component of the project is to understand the linkages among islands and submerged banks throughout the entire Samoan Archipelago based on passive transport of larvae in ocean currents. This was identified as a key information need by local project partners during kickoff meetings. The Hybrid Coordinate Ocean Model (HYCOM) will be used to estimate the trajectory of passive larvae originating from each island or bank in the archipelago (Figure 3). Season, larval duration, annual variability, and other factors will be evaluated for affects on transport and connectivity of reef systems throughout the archipelago. This component of the project is necessary to understand “connections” among islands in the archipelago and the adjacent island nations.

Products:

- Connectivity report
- Digital products

Subtasks:

- Literature review for model parameterization
- Obtain drifter datasets for model parameterization/validation
- Produce draft model outputs
- Review model results with NOAA/Coral Reef Ecosystem Division and Dr. Eric Trembl, University of Queensland
- Revisions

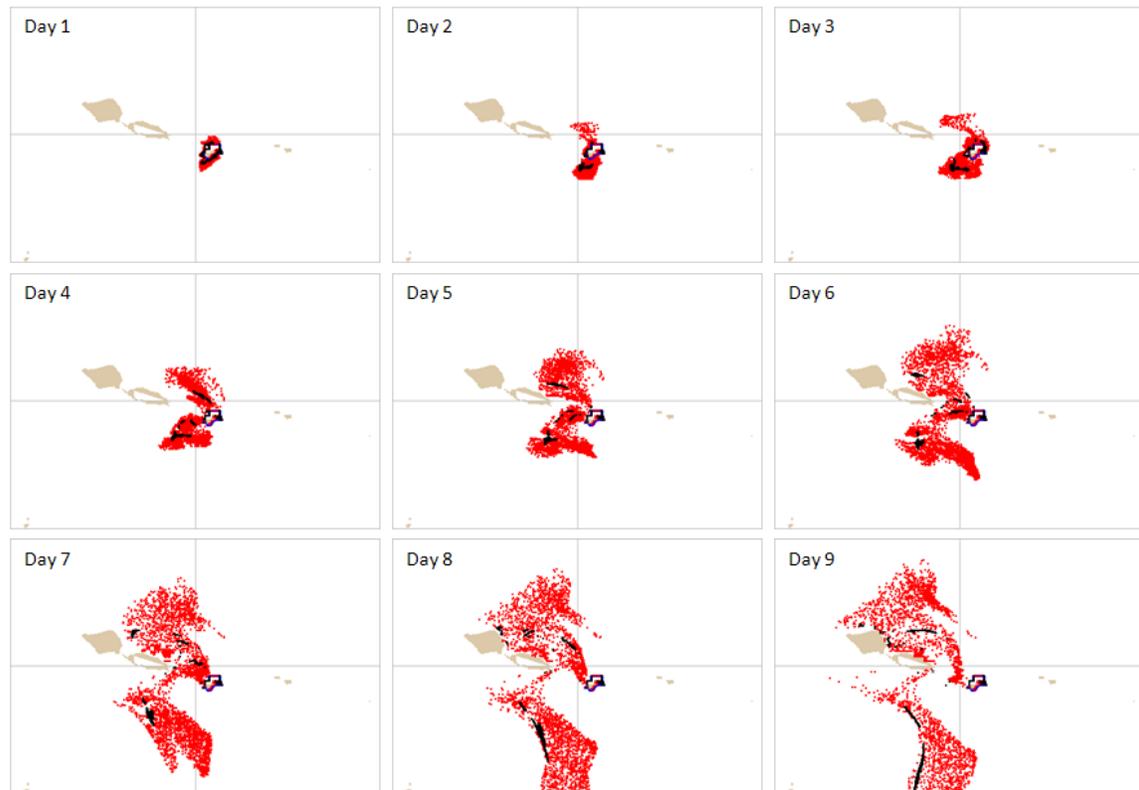


Figure 3. A nine day time series beginning October 1, 2005 of HYCOM results for particles (passive larvae represented by red dots) began around Tutuila, American Samoa. Note the transport to the north shores of Savai'i and Upolu.

Task 4: Gather and Evaluate Data

Estimated completion date: June 2010

Primary datasets will either be spatially comprehensive throughout Samoa or at a minimum be based upon a stratified random sampling design to allow Samoa-wide scope of inference. Datasets that lack spatial attributes, are limited in geographic extent (e.g. one bay or coastal region), cannot be standardized (e.g. lacking metadata or standardized methodology), or are out of date and therefore not likely to represent current conditions, will not be used. Habitat data/maps (Figure 4), reef fish and corals will be the primary focus. Many of the references for prior work in the region are under consideration and are listed available on-line at <http://www.reefbase.org/main.aspx> (provided by Paul Anderson). Key datasets were identified by

SPREP during the August 2009 kickoff meetings (i.e. benthic maps, MPA boundaries, remote sensing imagery). Much of the work to identify, obtain, and evaluate all biogeographic (marine ecological and oceanographic) datasets is complete for complementary datasets for the American Samoa part of the archipelago.

Products:

- Individual biogeographic data layers
- Complete biogeographic data inventory

Sub-tasks: Evaluation of each dataset will include key attributes such as:

- Scope of inference
- Spatial extent
- Time period
- Availability
- Comparability with other datasets



Figure 4. Draft habitat maps (red lines) have been produced by Paul Anderson, SPREP for nearshore areas around Samoa based on remote sensing data. A small section of the northwest coast of Upolu is pictured here. Map validation was identified as a desired information need that the biogeographic assessment could provide assistance with.

Task 5: Create Database and Select Analytical Techniques

Estimated completion date: August 2010

Specific biota and ecological features chosen for analysis will be dictated by discussion with project partners as well as data availability and quality. Suitable datasets will be converted into consistent units (e.g. density) and input into a GIS. Independent biological and physical datasets will then be synthesized into a spatially comprehensive database. Spatial analyses may range from simple presence/absence of species within a grid cell framework to more complex geostatistical approaches that link biota with physical environmental variables. The variety and comparability of the input datasets are expected to have a major influence on the character of the analyses. A preliminary approach to analysis will be provided to project partners for review.

Products:

- GIS and database
- Distribution models for variables such as coral and reef fish biomass, density, diversity
- Example analytical approach

Subtasks:

- Convert datasets to consistent spatial framework
- Ingest spatial datasets into GIS

- Synthesize datasets for maximum spatial coverage
- Example of distribution models
- Achieve consensus on example analyses

Task 6: Conduct Biogeographic Analysis
Estimated completion date: October 2010

This task represents the core of the biogeographic analysis. The goal of this task is development of Samoa-wide distribution models for key ecological and biogeographic features followed by integrated analysis of multiple data layers. Based on these results, spatial and temporal patterns of ecosystem features will be investigated. Breakpoints, spatial trends, and “hot spots” for key ecosystem features will be identified in these analyses. Fish richness, biomass, community structure as well as coral richness, cover, and community structure will be the focus of these analyses.

Products:

- Quantitative and qualitative assessments that identify biogeographic patterns and bio-physical relationships of species assemblages

Subtasks:

- Creation of single data layers
- Multivariate analysis of data layers

Task 7: Provide Draft Biogeographic Mapping Products for Review
Estimated completion date: November 2010

Drafts of coral, fish, habitat, and other maps (e.g. species richness, diversity) will be made available to project partners, interested members of the community, and other experts for review. A list of questions will be provided to reviewers to obtain feedback on specific areas of the analysis.

Products:

- Draft analytical results (maps, statistical results)
- Database on habitat affinities and utilization for selected species
- Questions/issues for reviewers
- List of key data gaps
- Status report

Task 8. Develop Final Digital Products
Estimated completion date: April 2011

Once products have been reviewed and revised, final products will be prepared in an appropriate format for inclusion in management plans.

Products:

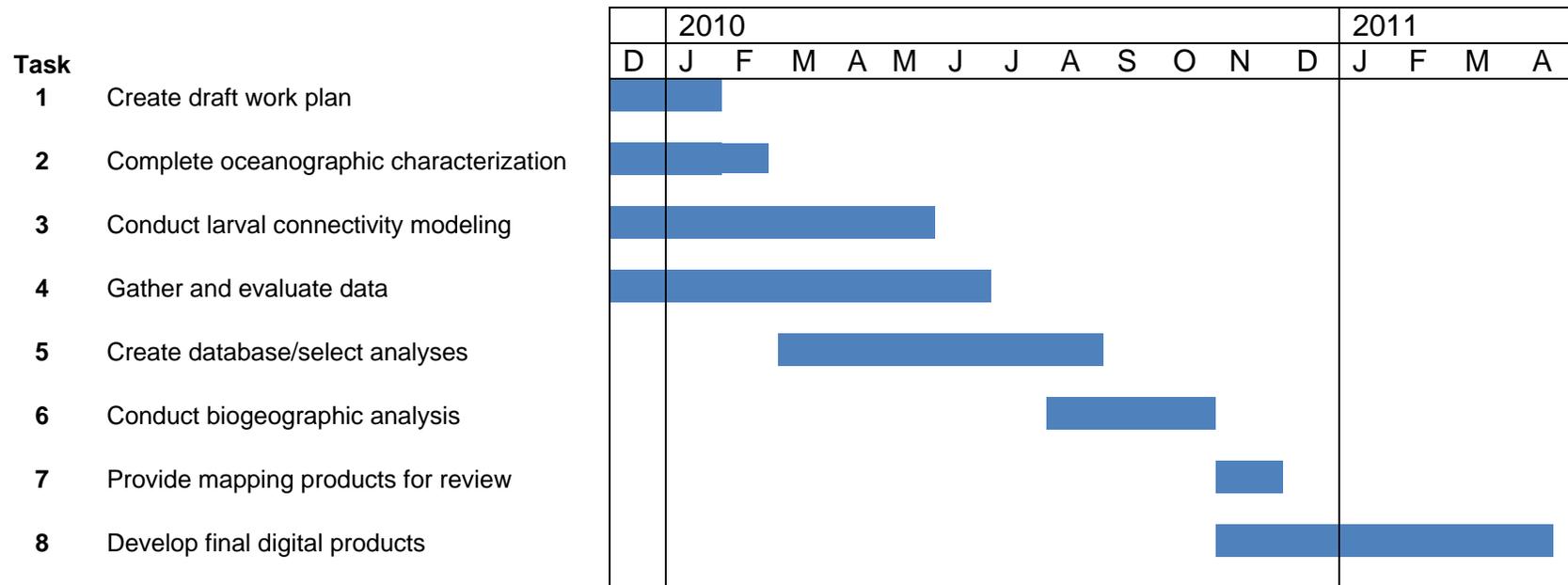
- Final summary report describing the analysis, results, and interpretation of the results
- GIS on species, habitats, and important biological areas in the study area
- Database on species and habitats
- Map and/or list of data gaps

Summary of Next Steps

- Project partners review this concept document and set of potential tasks to create work plan (Completed January 2010).
- Refine the need and uses of the planned assessment to meet Samoa marine resource management needs through a series of meetings (April 2010).
- Continue evaluation of available biophysical data for the region (June 2010).
- GIS synthesis of biophysical data and create initial/example biogeographic analyses with project partners (August 2010).
- Modify the biogeographic assessment process to meet Samoa and Two Samoas objectives (August 2010).
- Develop draft biogeographic assessment that includes synthesis, analysis, and integration of selected ecological and oceanographic data (October 2010).
- Conduct workshop with local experts to review draft report and then incorporate comments and revise report (November 2010).
- Deliver project results and recommendations via hard copy reports and maps, CD-ROM, and internet-based products (March 2011).

Project Schedule

A 14 month project is anticipated depending on final project components selected. Project milestone dates are approximate.



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Appendix I: Meeting Participants in Apia, Samoa, August 14, 2009

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Lui Bell (SPREP)
Sue Miller Taei (CI)
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Mose Topofo (MAF)
Joyce Samuelu Ah Leong (Fisheries)
Lelei Peau (ASDOC)
Francois Martel (CI)
Gene Brighthouse (Fagatele Bay, NMS)

Appendix II: Current and Planned Regional Partner Agencies

American Samoa Department of Commerce (ASDOC)
American Samoa Department of Marine and Wildlife Resources (ASDMWR)
Conservation International (CI)
Fagatele Bay National Marine Sanctuary (FBNMS)
Ministry of Agriculture and Fisheries (MAF)
National Park of American Samoa (NPAS)
NOAA Center for Coastal Monitoring and Assessment (CCMA)
NOAA Coral Reef Ecosystem Division (CRED)
NOAA Office of National Marine Sanctuaries (ONMS)
Samoa Ministry of Natural Resources and the Environment (MNRE)
Secretariat of the Pacific Regional Environment Programme (SPREP)