Marine Contaminants

Justification/Issues Being Addressed

GLBA is quintessentially a marine park. Along with weather, glaciers, and landform, oceanography drives the park's ecosystems and entirely dominates the dynamics of many biological communities. A number of the SEAN Vital Signs applicable to GLBA (e.g., Marine Predators, Intertidal Invertebrate Communities, Kittlitz's Murrelets) are themselves directly or indirectly influenced by oceanography. By monitoring marine water mass characteristics, managers can detect changes that are likely to influence the condition of resources of many types throughout the region. Oceanographic monitoring is important to understanding the Southeast Alaska marine system, the linkage between atmospheric and oceanic systems, and the implications of climate change in high-latitude systems.

Standard oceanographic data are universally recognized among marine scientists as essential to understanding how ocean waters move and behave, and thereby drive the associated biology. Along with water column stability and nutrient availability, the availability of light drives primary productivity which then controls the dynamics of secondary productivity and indeed the entire marine trophic web. Ocean acidification (declining pH) is one result of global warming/climate change (increasing atmospheric carbon dioxide concentration) that may have profound effects on marine ecosystems. Marine contaminants are clearly anthropogenic and are widely recognized as threats to pristine marine ecosystems.

An excellent long-term (15 y) dataset of oceanographic parameters has accumulated from a series of 2-7 cruises per year during which standard CTD (Conductivity, Temperature, Depth) casts have been made at 24 permanent stations in Glacier Bay and adjacent waters in Icy Strait. It is believed that GLBA's marine waters are of exceptional quality, and that park marine waters can serve as a pristine reference against which other NPS marine waters can be compared.

Specific Monitoring Objectives to be Addressed by the Protocol

1. Determine the changes in the spatial (three-dimensional) and temporal oceanographic trends in water temperature, salinity, turbidity, pH, dissolved oxygen, light penetration, primary productivity, and contaminant levels of the Glacier Bay water column through continuation of quarterly sampling.
2. Document and track marine contaminant levels through long-term sampling of blue mussels in GLBA and SITK and in conformance with methods in-place at the MusselWatch site at KLGO.

Basic Approach

The recommended approach consists of three general elements: (1) periodic measurement of standard oceanographic parameters in Glacier Bay proper, (2) monitoring of select contaminants (marine waters immediately adjacent to SITK are included in this component), and (3) development and implementation of a system to harvest others' oceanographic data from outside Glacier Bay proper.

(1) Standard Oceanography
With technical assistance from the USGS, GLBA has developed and implemented a detailed protocol describing CTD casts to measure water temperature, salinity, photosynthetically active radiation (PAR), optical backscatterance (OBS – turbidity), and chlorophyll-*a* fluorescence (proxy for phytoplankton concentration = primary productivity index) throughout the water column at 24 permanent stations (Hooge et al. 2003, Etherington et al. 2007). The stations extend from just outside the mouth of Glacier Bay proper (the Bay's source waters in Icy Strait) up to the heads of both the East and West Arms. They are generally mid-channel and equidistant, sampling a range of depths from sills to deep basins across the Glacier Bay distance-from-tidewater-glaciers/turbid-outwash-streams gradient. Stations are visited seasonally every year, generally during spring (Mar.-Apr.), summer (July), fall (Oct.), and winter (Dec.-Jan.). Initially the cruises were made using a large (50-ft.), relatively slow (10 kts.) vessel, but in recent years it has been discovered that the cruises can usually be accommodated by an adequately-equipped smaller (30-ft.), faster (25 kts.) vessel, allowing the entire transect to be accomplished in two days during all but the winter season. In winter, poor weather and limited daylight often require a larger vessel and/or an additional day. This protocol, with the modifications/additions immediately below, will be adopted by the SEAN.

Important revisions to this protocol include addition of dissolved oxygen and pH probes to the CTD instrument. Two stations (Geikie Inlet) should be removed from the current transect to reduce sampling time, to be replaced by 1-2 new stations (Icy Strait source water).

(2) Marine Contaminants
In 2007, SEAN funded a baseline marine contaminants project (Tallmon 2007) sampled intertidal blue mussels (*Mytilus trossulus*) from several sites in GLBA (both within Glacier Bay and in outside waters) and at SITK and KLGO. Mussels provide an excellent time-integrating bio-proxy for a broad spectrum of marine water pollutants (persistent organic pollutants, polycyclic aromatic hydrocarbons, and metals). The protocol followed was similar to that of NOAA's nationwide Mussel Watch Program (http://www8.nos.noaa.gov/cit/nsandt/download/mw_monitoring.aspx). A single representative site will be selected from the Glacier Bay locations, and a SITK site will be similarly selected. These sites will be monitored in alternate years (mid-summer), starting in 2009. Every attempt will be made to encourage NOAA to add these sites to its larger Mussel Watch Program.

(3) Data Harvest
Collecting oceanographic data from outside Glacier Bay proper requires a large vessel and is cost-prohibitive for the SEAN. Nevertheless, these "outer waters" mix freely with adjacent park waters and are critically important to understanding the dynamics of the park's marine ecosystem. Any data from Icy Strait, Cross Sound, or the Outer Coast (out to 100 km) will be harvested from other agencies/institutions (e.g., NOAA, University of Alaska, ADF&G) and analyzed/archived to become part of a long-term record used to elucidate trends. An example data source is the Alaska Ocean Observing System (AOOS).

Principal Investigators and NPS Lead

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Development Schedule, Budget, and Expected Interim Products

YEAR	TASK/PRODUCTS	PERSONNEL	SEAN BUDGET ($)
Year 1	Refine existing GLBA oceanographic protocol to include added probes/parameters and stations. Purchase dissolved oxygen and pH sensors and add to CTD instrument package. Develop Cooperative Agreement (CA) with USGS to conduct cruises, maintain CTD, and analyze/synthesize/report data in reduced and useful form for long-term monitoring (GLBA provides vessel support and CTD). Develop SEAN oceanographic data archive. Continue annual sampling (4 cruises/year). Acquire existing (NOAA) marine contaminants protocol, select sampling locations, purchase sampling supplies, and contract a laboratory for analyses. Develop data harvesting strategy.	GLBA/SEAN staff; USGS	$5,000 for DO and pH probes. $10,000 for USGS expert services.
Year 2	Conduct annual oceanographic sampling. Harvest external oceanographic data. Collect bi-annual contaminants samples, and report results.	GLBA/SEAN staff; USGS; SITK staff	$10,000 for USGS expert services. $500 for contaminant sampling supplies. $5,000 (2 samples x 2,500) for contaminants sample analysis/shipping.
Year 3	Conduct annual oceanographic sampling. Harvest external oceanographic data.	GLBA/SEAN staff; USGS	$10,000 for USGS expert services.
Year 4	Conduct annual oceanographic sampling. Harvest external oceanographic data. Collect bi-annual contaminants samples, and report results.	GLBA/SEAN staff; USGS; SITK staff	$10,000 for USGS expert services. $5,000 (2 samples x 2,500) for contaminants sample analysis/shipping.
Year 5	Conduct annual oceanographic sampling. Harvest external oceanographic data.	GLBA/SEAN staff; USGS	$10,000 for USGS expert services.
Total estimate for first 5 years			**65,500**
Total estimate for first 10 years			**136,000** (assumes 20% increase in USGS support costs, and 30% increase in contaminants sample analysis/shipping costs)