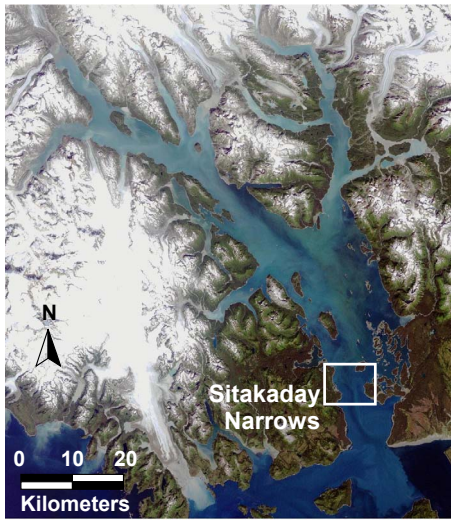
SCIENCE FOR SOUND MANAGEMENT OF ECOSYSTEMS IN ALASKA

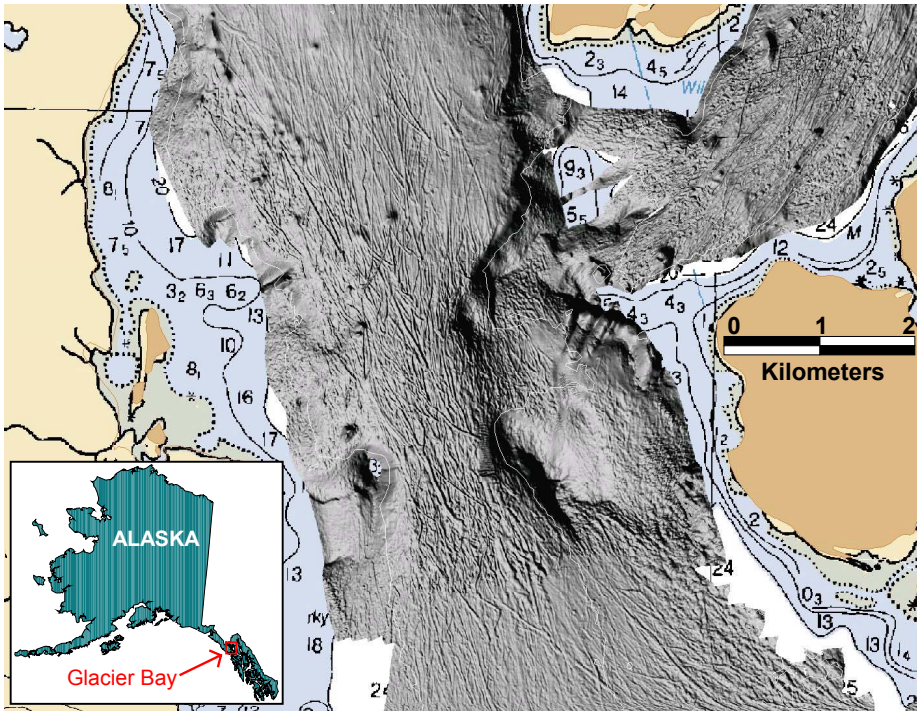
Mapping Benthic Habitat Using Geological and Oceanographic Tools - Glacier Bay, Alaska

As support for effective management of the Glacier Bay National Park ecosystem, the USGS is conducting multidisciplinary research to map benthic habitat and monitor oceanographic parameters. Marine biologists and geologists are using a combination of remote sensing and direct observations to provide the data necessary to evaluate human disturbance in this naturally changing ecosystem.

Satellite image of Glacier Bay, below, showing sediment load in the surface waters (paler blue).



Glacier Bay National Park and Preserve faces a variety of resource issues including commercial fishing, vessel interactions with critical species, retreating glaciers, global warming, and increasing user pressure, all of which require assessment and an understanding of marine ecosystems, natural change, and human disturbance.



Hundreds of gouges carved several meters into the bottom of Glacier Bay are visible in the multibeam acoustic image above. These gouges were incised by the keels of large icebergs (up to 160 meters thick) that calved from the face of the glacier that once filled all of Glacier Bay. Grounded ice was driven by tidal currents through Sitakaday Narrows (shown on image at left), which today experiences currents in excess of 8 knots. Depths on the underlying chart in fathoms.

Glacier Bay is a diverse fjord ecosystem with multiple tidewater glaciers and complex biological, geological, and oceanographic patterns that vary greatly along its length. The Bay was completely glaciated prior to the 1700s, and subsequently experienced the fastest glacial retreat recorded in historical times. As a result, some of the highest rates of glacial sedimentation and uplift are observed here. Glacier Bay is the deepest silled fjord in Alaska, with depths of over 450 meters. The variety of physical processes and depths creates many diverse habitats within a relatively small area. Mapping benthic (seafloor) habitats is thus crucial to understanding and managing Glacier Bay's complex marine ecosystem and the marine species therein.

Marine ecologists from the USGS Alaska Science Center's Glacier Bay Field Station and marine geologists from the USGS Coastal and Marine Geology Program are combining expertise to map habitats at Glacier Bay. The approach seeks to understand two of the primary physical determinants of benthic habitat in the marine system: oceanography and surficial geology. This understanding will then be combined with biological data and placed within a flexible marine geographic information system (GIS) so that relationships and "what if" scenarios can be tested.

A wide variety of tools are being used to determine these major habitat components, as described on the reverse side of this sheet.

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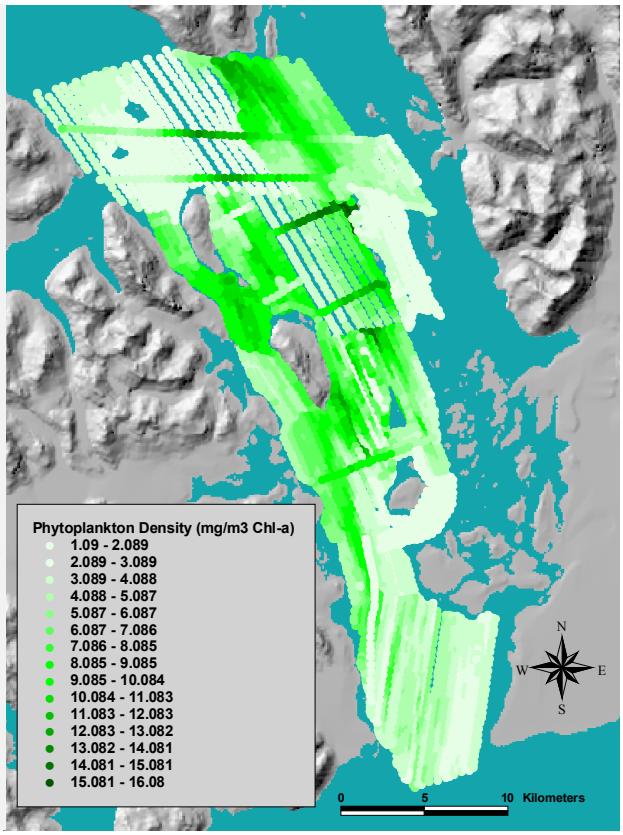
The survey vessel R/V Davidson*, with a hull-mounted multibeam mapping system used to image almost half of Glacier Bay's waters deeper than 30 meters. The vessel also has an oceanographic laboratory that was used to obtain continuous measurements of phytoplankton density throughout the June, 2001 research cruise (figure to the right).*

GEOLOGIC CLASSIFICATION

Multiple methods are being used to map and understand the surficial geology of the bottom, including multibeam acoustic mapping/imaging, sidescan sonar imaging, and on-site ground-truthing. In June 2001, nearly half of Glacier Bay was surveyed using a multibeam system, which produces both a detailed digital depth model (seen on the first page) as well as data on acoustic backscatter, which is related to bottom composition such as boulders or sand. Sidescan sonar mapping of seabed backscatter was previously conducted in many of the shallower areas of the Bay to delineate habitat. Ground-truthing of the data by sampling or direct observation is essential to determine the validity of the remotely sensed data. Extensive ground-truthing was conducted by divers, drop cameras, and submersibles. The remotely sensed and ground-truthing data will be integrated into a marine GIS. Then geologists and biologists can produce benthic habitat maps identifying those geological and oceanographic features that significantly influence species abundance and distribution.

Diver conducting ground-truthing surveys with a diver propulsion vehicle, a digital video camera, and a mixed-gas rebreather. The diver is linked by communications and a transponder to a real-time data collection system in the support vessel. Photo by Jeff Mondragon.

Phytoplankton density at 5 meters depth (measured as mg/m^3 of chlorophyll-a). Samples were taken continuously throughout the June, 2001 cruise of lower and central Glacier Bay. These data demonstrate the large variation in phytoplankton depending on time, location, and stage of the tidal cycle. This figure also shows the full extent of multibeam mapping data (of which the Sitakaday Narrows segment is shown on the reverse side of this sheet).



OCEANOGRAPHIC CLASSIFICATION

Multiple years of direct oceanographic sampling are being combined with satellite imagery to map the major oceanographic processes that influence marine resources at Glacier Bay. Such processes include primary production, phytoplankton distribution (see figure above), upwelling, deep-water renewal, as well as sediment load (seen on the first page) and fresh water input. Special GIS tools have been developed to handle the temporal and three-dimensional variability of oceanographic data (e.g., see the Oceanographic Analyst at www.absc.usgs.gov/glba/gistools/)

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FUTURE WORK

High-resolution multibeam mapping provides an unprecedented new baseline for resource and habitat assessment. Full integration of the new data set will require additional ground-truthing data and analysis. New research sites and new research questions are already being planned. Contingent on additional funding, the remaining portions of Glacier Bay will be surveyed using a multibeam system. The USGS goal is to develop integrated geological and oceanographic habitat models for the marine benthos in Glacier Bay, as a step toward determining the habitat relationships of critical species and resources within the Park.

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COOPERATING ORGANIZATION:
National Park Service

A seapen on pebble substrate, Glacier Bay.

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