

# Biological Oceanography

# Biological Oceanography - System Science

system, process

- What are the *polar ecosystem* interactions and implications for ecosystems from changes in *sea ice*?
- What is the biogeography and biodiversity of *chemosynthetic ecosystems*, their geologic settings, their chemical impact on the overlying oceans and their potential relevance to astrobiological exploration?
- What is the influence of free-drifting *icebergs* on pelagic ecology in the Southern Ocean?
- How are *ice-shelf* loss, glaciological changes, and other climate warming effects (e.g., increasing input of glacial till) restructuring marine ecosystems and altering *biogeochemical processes*?
- What are the impacts of sea ice on pelagic-benthic coupling, benthic community structure and *ecosystem response* in polar regions?
- How do the *physical processes* associated with sea ice development affect local *climate*, ecosystem, and water structure?
- What are the *scales* of polar ecosystem change, in time and space?
- What changing *environmental characteristics* of polar regions impact marine ecosystems? For example, frequency and location of storms, winds, sea ice extent and seasonality, location of oceanographic fronts, changing ice shelves and polynyas, proliferation of icebergs, greater inputs of terrestrial material and freshwater from glaciers and rivers.
- What can we learn by contrasting/comparing *Arctic and Antarctic* polar ecosystems? How do sea-ice effects, as ecosystem drivers, compare between the Antarctic (and cold continent surrounded by sea ice) and the Arctic (sea ice surrounded by warmer continents)?

# Ecosystem Structure and Function

structure, process, driver

- How do *biodiversity*, *ecosystem function*, and *biogeochemical cycles* vary as a consequence of environmental forcing in the unique marine ecosystems of Antarctica and the Arctic?
- How do marine ecosystems under permanent sea ice compare in structure and function to those under ice shelves? Are loss of ice shelves and large areas of permanent sea ice *ecological analogous*?
- What is the impact of *sunlight* with the heat and mass balance of ice and ocean system, on biological activity in and under the ice?
- What is the relationship between environmental factors affecting *microbial* (phytoplankton, bacteria, Archaea, protozoa) diversity, composition, abundance and production and their drivers (physics, chemistry, biology, etc.) at the interface atmosphere-ice-ocean?
- What is the dynamic ecological structure of deep *pelagic and benthic communities* in polar regions?
- How do *zooplankton* impact the cycling of carbon in polar regions? How will climate change modify *benthic-pelagic coupling* and the utilization of primary production by the zooplankton?
- What are the habitat requirements of ice-associated *marine mammals*, *penguins* and *birds* and how will these species respond to diminished sea ice and snow cover? What are the abundance, distribution, and trends of ice-associated marine mammal, bird and penguin populations?
- How are the *interactions* of light and *iron* limitation affecting *photosynthesis* in Antarctic phytoplankton?
- What are the main sources of iron as a microbial *nutrient* in polar regions, and do sea ice and ice shelves influence its availability?

# Ecosystem Structure and Function

## A Changing Environment

structure, process, driver

- What is the impact of climate *change* on the marine physical environment and how will it impact pelagic/zooplankton/benthic ecology, including *life histories*?
- How will the roles of microbes in polar biogeochemical cycles change with *sea-ice loss* and *climate warming* in polar regions?
- What are the major *ecological/physiological drivers* for change likely to be in the next 10-20 yr?

Possibilities include:

Reduced pH (*acidification*)

Warming *temperatures*

Enhanced benthic *predation* from duraphagous predators

Salinity stress due to increase in sea ice and glacier *meltwater input*

Greater *iceberg scouring* from ice-shelf disintegration

Increasing *sedimentation* and turbidity from glacial ablation and meltwater input

Changing *seasonality*

Increasing ocean *stratification* in some areas due to meltwater input

Deeper *mixing* in other areas due sea-ice loss and greater wind stress

# Physiology and Ecology of Marine Organisms

structure, process, driver

- *Reproductive* seasonality, environmental effects on *physiology*, *larval transport* and *biogeography*.
- What is the physiology, *distribution*, and *abundance* of pelagic and benthic fishes
- What are the roles of phagotrophic *protists* in pelagic systems
- How do Antarctic fishes fold *proteins* efficiently at low temperatures? What effects do elevated temperature regimes have on the *embryonic development* of Antarctic fishes? What are the *phylogenetic relationships* among Antarctic fishes?
- What is the response of polar plankton to *Ultraviolet Radiation* and *Ocean Acidification*?
- 1.27. How does *sea ice biology* change in response to atmospheric and oceanic variations?