Phytoplankton Ecology

TINY DRIFTING OCEAN PLANTS CALLED PHYTOPLANKTON FUEL ALL LIFE IN THE SEA, FORMING THE FOUNDATION OF THE FOOD WEB.

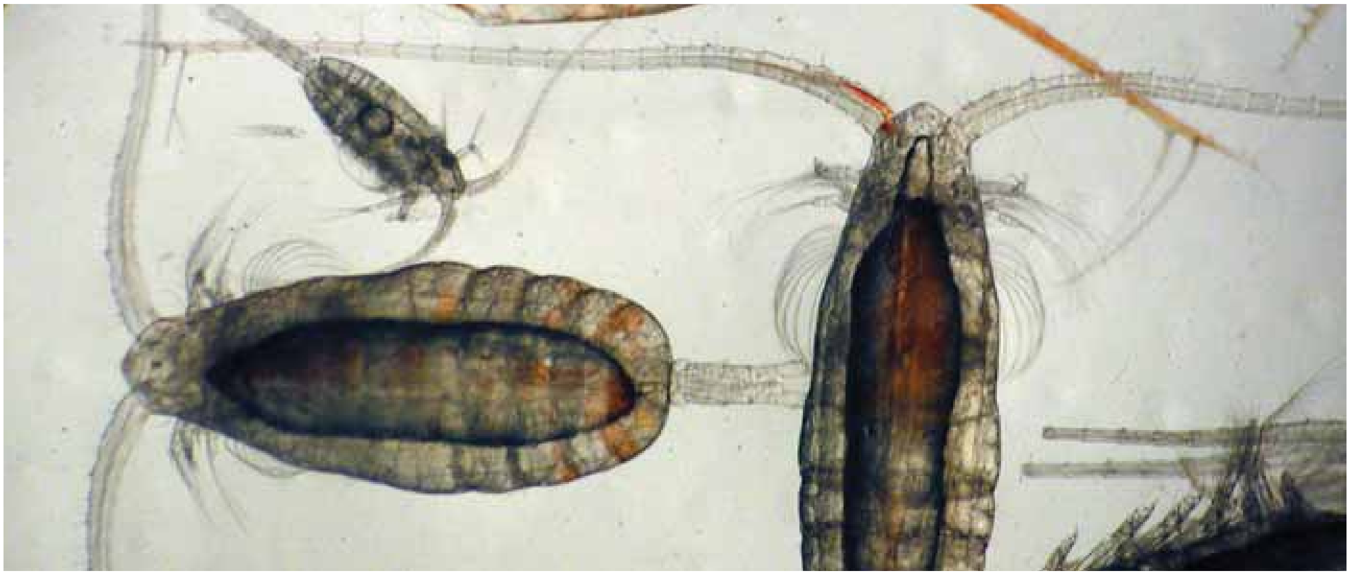
While the Board has not funded projects that focus solely on phytoplankton ecology, it has funded projects that measure phytoplankton abundance through fluorescence and relate it to changes in the surrounding ocean environment, such as the southeastern Bering Sea moorings and along the Seward Line. These studies improve our understanding of the timing of the spring bloom and in the case of the Bering Sea moorings, how the initial onset of phytoplankton production relates to the presence or absence of sea ice on the Bering Sea shelf. The timing of these blooms is important to the Bering Sea's food web.

A current scientific paradigm suggests that water column grazing by mesozooplankton has very little impact on ice-edge blooms in the northern Bering Sea. Most of the primary production sinks and becomes an important food source for the benthos. In the southern Bering Sea, later blooms feed the pelagic system. It also appears that middle shelf blooms in the Bering Sea are grazed less than those on the outer shelf, thus enhancing the benthic food supplies. Nutrient measurements have shown that both the ice-associated bloom and the more typical spring bloom strip the upper water column of nutrients. In November, when the strong summer thermocline breaks down, a fall bloom is signaled by an increase in fluorescence.

Zooplankton Ecology

MINUTE ANIMALS KNOWN AS ZOOPLANKTON REPRESENT THE SECONDARY PRODUCTION LEVEL AT THE BASE OF THE FOOD WEB.

Because they have relatively short life spans, mostly a year or less, and have varying degrees of control over where they drift, zooplankton respond very quickly to changes in their environment. Poor conditions for zooplankton mean less food is available for larger animals. As a result, larger animals also have a poor year, go somewhere else or eat whatever else is available. We need to know more about how zooplankton species respond to variability in ocean conditions. The Board has responded to this need in several ways – the zooplankton collections along the Seward Line; continuous plankton recorder studies across the North Pacific; and zooplankton studies within the NPRB-NSF Bering Sea Integrated Ecosystem Research Program. The Board also funded several other smaller studies.



Matt Berman and Jay Clark

LOWER TROPHIC :: Zooplankton Ecology

Continuously Recording Where Zooplankton Live

Projects T0004, 302, 536, 601, 803

RESEARCHERS OFTEN USE DEDICATED RESEARCH vessels to collect zooplankton. These expeditions may be very expensive and short in duration, offering only selected snapshots of the plankton communities off Alaska. An alternative program relies on volunteer commercial ships that tow a Continuous Plankton Recorder (CPR) along their regular routes. The CPR needs no accompanying scientist, making it relatively inexpensive to operate.

CPR studies off Alaska commenced in 2000 with funding made available under the North Pacific Marine Research (NPMR) Program. The Board added its support in 2002, using North Pacific Marine Research Institute research funds to continue an NPMR project (Project T0004 administered by the Alaska SeaLife Center). NPRB supported CPR deployments through 2009 by funding projects 302, 536, 601, and 803.

Project 803 continued CPR activities through 2008 (although data are not yet available) and into 2009. In September 2008, the Board approved setting aside $50,000 annually for five years to contribute to a CPR funding consortium coordinated by the North Pacific Marine Science Organization (PICES). Depending on funds made available from other sources, the CPR program may or may not be maintained at its past activity levels.

Great Circle Route

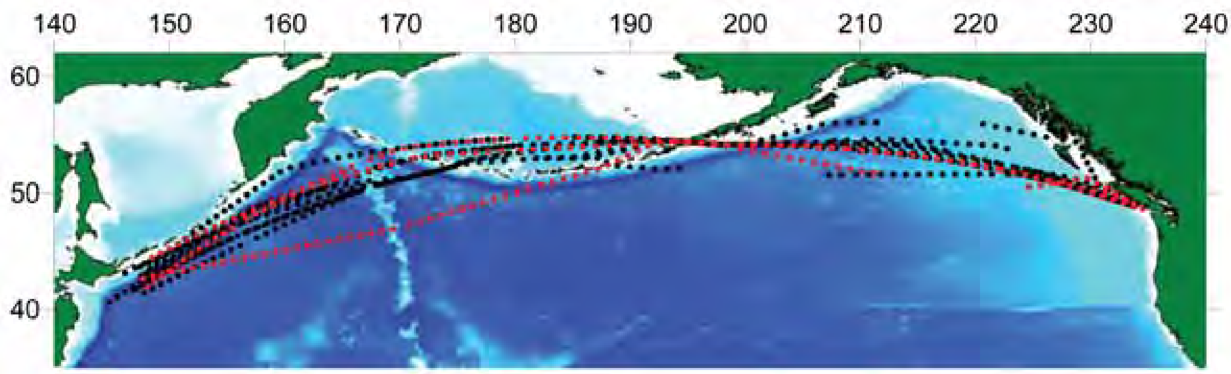
Commercial vessels tow a CPR for more than 6,500 kilometers across the Pacific, following the "Great Circle Route" from British Columbia to Japan. The sampling complements similar activities in the North Atlantic that have gone on for more than 60 years. Samplers collect zooplankton and data on temperature, salinity, and chlorophyll *a* (measured as fluorescence) down to a depth of about six meters. More than 3,000 plankton samples have been collected from crossings made mainly in April, June, and September/October, under funding provided by NPRB. So far, researchers have identified nearly 290 plankton species in the samples, including about 130 phytoplankton and 160 zooplankton species.

Distinct Neighborhoods

Transects pass through many different water masses and regions across the North Pacific, some more offshore than others. Scientists are starting to see some patterns, albeit highly variable ones, emerge from these past seven years of collections. There seem to be some ten distinct plankton communities (termed "mesoscale marine ecosystems") across the North Pacific, relating primarily to bathymetry and current systems. Many zooplankton species are common to all regions, but other species characterize just a few regions. For example, small copepods dominate in shelf regions and large subarctic copepods dominate in oceanic regions. Biomass also tends to be higher in shelf regions than in oceanic regions.

Some Like It Hot

Zooplankton appear to be strongly influenced by temperature, which has a strong influence on their metabolic and developmental rates, and probably on their survival rates. Water temperature thus may influence the presence of certain species. In warmer years, southern species may occur further north, expanding their range and abundance in the northern Gulf of Alaska, and thereby changing community composition. The western Gulf does not show the same temperature/zoogeographic relationship, possibly because eddies spinning off the Alaskan Stream add coastal water to the offshore region. Relating various zooplankton species to warm or cool conditions may provide greater understanding of why certain predator species, such as pink salmon, are more successful in some years than others, especially as their forage base relates to the prey quality, availability, and abundance of certain zooplankton species.



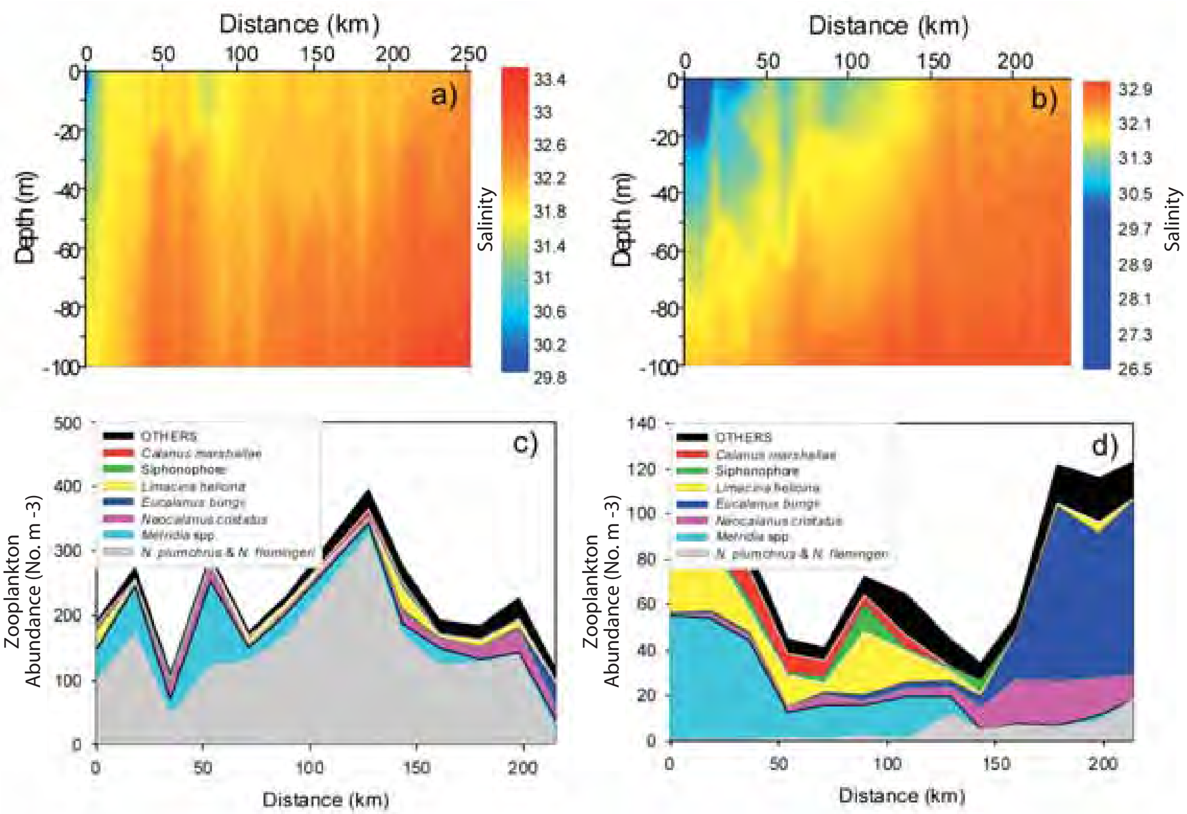
Position of samples that have been processed. Samples processed under Project 536 are shown in red. The typical great circle route shows a high density of samples, but the Sept 2005 route crossed the Gulf of Alaska further south than normal and the May 2006 route avoided a storm in the Bering Sea and traversed the western Pacific much further south than normal.

LOWER TROPHIC :: Zooplankton Ecology

Modeling Where Zooplankton Go in the Gulf

Project 805

PROJECT 805 IS A MODELING STUDY THAT FOCUSES ON BIOLOGICAL AND PHYSICAL PROCESSES INFLUENCING transport of oceanic zooplankton onto the southeast Bering Sea and Gulf of Alaska shelves under a variety of climate scenarios. Based on these models, field studies can be targeted in time and space on key transport events to eventually provide quantitative information on potential physical-biological mechanisms that influence variability in year-class strength of forage and commercial fish stocks.



Salinity and zooplankton abundance across the Gulf of Alaska shelf during a period with no notable frontal structure (a and c) and during a period with a strong frontal structure (b and d). Image from project statement of work.

LOWER TROPHIC :: Zooplankton Ecology

A Closer Look at Euphausiids

Project 806

STUDIES OF KEY SECONDARY PRODUCERS LIKE *EUPHAUSIIDS* will help us understand their role in the food web and how they may be influencing upper-level predators—salmon, pollock, herring, and rockfish, as well as seabirds and marine mammals. Project 806 will provide information about *Euphausia pacifica* from the Gulf of Alaska by exploring the range of reproductive and growth behaviors exhibited by individual females maintained over several months in a controlled laboratory setting.

Russ Hopcroft