NORTH PACIFIC RESEARCH BOARD

GULF of ALASKA PROJECT

B. Build Gillespie / www.chartingnature.com

Scott Johnson

Lindsey Arnold

Murre with fish: Ram Papish

gulfofalaska.nprb.org

Background photo: Ryan Wolt

Gulf of Alaska Integrated Ecosystem Research Program

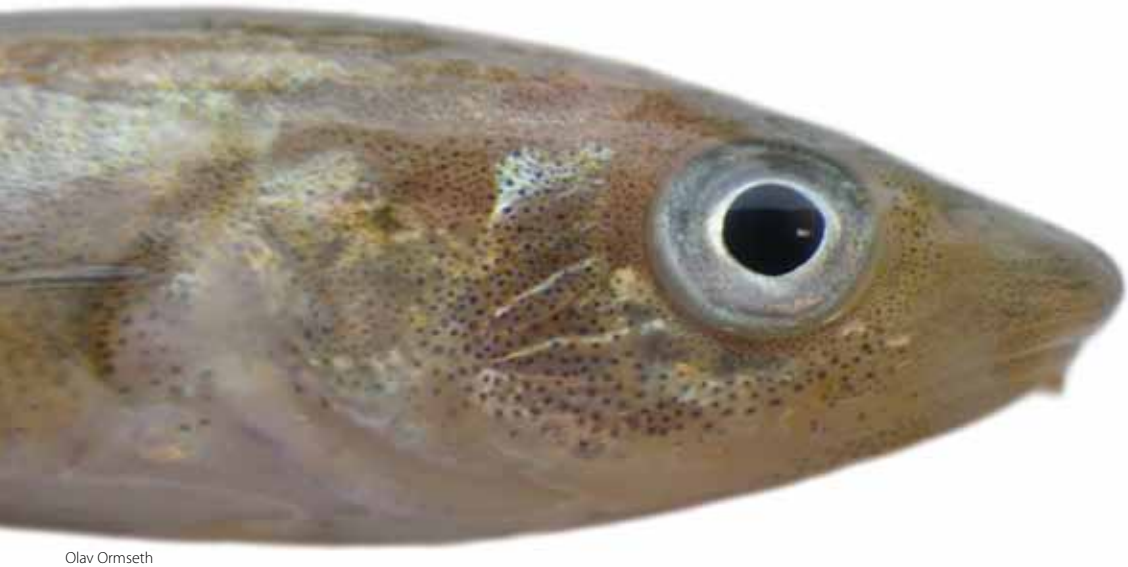
Wyatt Fournier

The Gulf of Alaska Project focuses on the challenges that commercially and ecologically important young-of-the-year groundfishes face that may affect their survival and recruitment into the breeding population. This $17.5 million project began in 2010 with funding from the North Pacific Research Board and substantial in-kind support for ships and staff from participating institutions. More than 40 scientists from 11 institutions are taking part in this interdisciplinary study of one of Alaska's most productive marine ecosystems. This project will continue through 2014.

Olav Ormseth

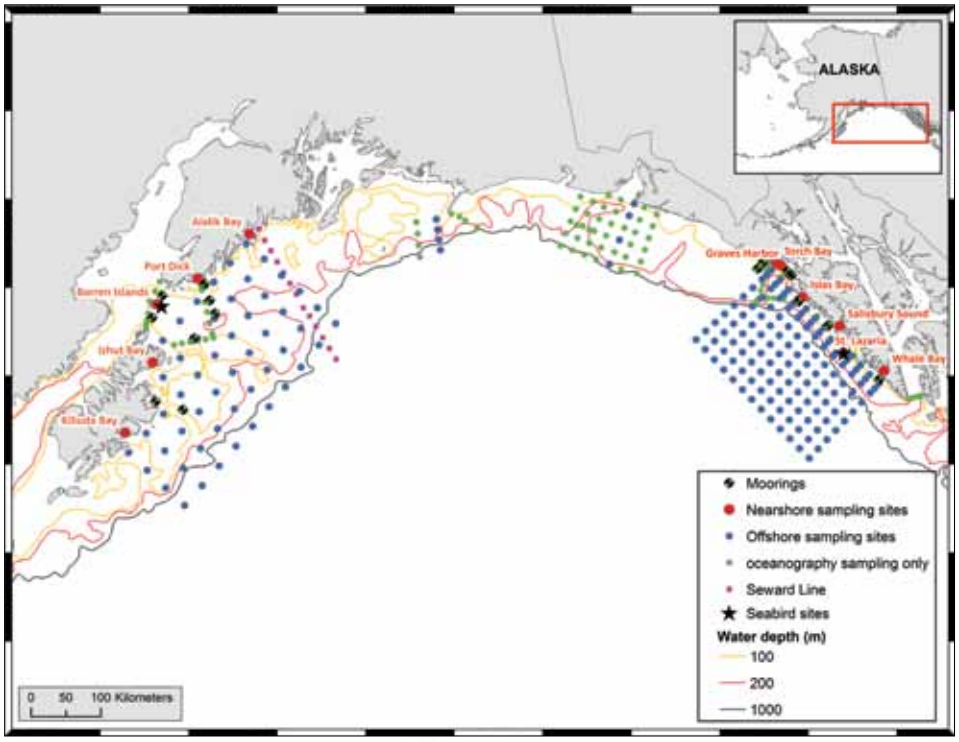
Specifically, this research project examines the interactions between physical and biological oceanography and food web relationships to understand how the environment influences the young-of-the-year survival and recruitment of five commercially and ecologically important groundfishes. The five focal fish species are arrowtooth flounder (*Atheresthes stomias*), Pacific cod (*Gadus macrocephalus*), Pacific ocean perch (*Sebastes alutus*), sablefish (*Anoplopoma fimbria*), and walleye pollock (*Theragra chalcogramma*). These five species have evolved different strategies for survival in response to environmental conditions, and may respond differently to environmental change.

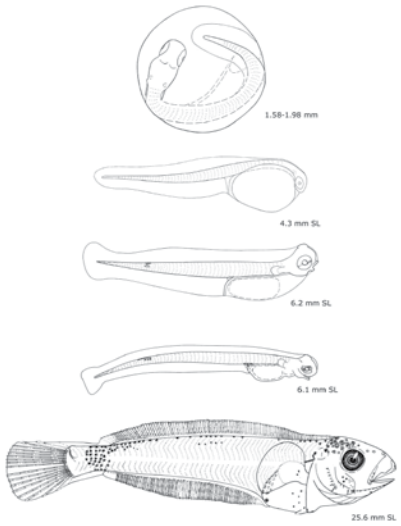
Information is being collected during spring, summer, and fall from Southeast Alaska to Kodiak Island. Vessel-based surveys extend from nearshore to offshore waters beyond the edge of the continental shelf. Fish and oceanographic data are also collected in several smaller embayments to document fish nursery habitats. Finally, seabird studies at land-based sites on St. Lazaria and East Amatouli Islands are examining the predation impacts of seabirds on young fish.



PACIFIC COD
Gadus macrocephalus

Olav Ormseth





ARROWTOOTH FLOUNDER
Atheresthes stomias

Illustration by Beverly Vinter

Three core hypotheses are driving the Gulf of Alaska project:

- **The gauntlet:** The primary determinant of year-class strength for marine groundfishes in the Gulf of Alaska is early life survival. This is regulated in space and time by climate-driven variability in a biophysical gauntlet that includes offshore and nearshore habitat quality, larval and juvenile transport, and settlement into suitable habitat.
- **Regional comparison:** The physical and biological mechanisms that determine annual survival of juvenile groundfishes and forage fishes differ in the eastern and western Gulf of Alaska regions.
- **Interactions:** Interactions among species (including predation and competition) are influenced by the abundance and distribution of individual species and by their habitat requirements, which vary with life stage and season.

THE GAUNTLET

REGIONAL COMPARISON

INTERACTIONS

Jamal Moss

Gerry Sanger

Alexandra Ravelo

Integration across disciplines is a key aspect of the study. Scientists with a broad range of expertise in diverse fields of study (including physical and biological oceanography, fisheries and seabird biology, and mathematical modeling) are working together towards a better understanding of the Gulf of Alaska ecosystem.

Kimberly Rand

Field Studies

Physical oceanographers are collecting information about the properties of Gulf of Alaska waters. Temperature, salinity, nutrient, and iron concentrations are all measured across the sampling domain. We are also measuring the flow of currents using passive drifters and moored observational instruments.

Biological oceanographers are studying the phytoplankton and zooplankton, the tiny plants and animals that make up the base of the marine food web. We are measuring chlorophyll levels, the species composition, and rates of primary production, and making comparisons between the eastern and western Gulf of Alaska in spring and fall. This will allow for a better understanding of how the timing and magnitude of plankton blooms affect the other organisms in the food web that rely on them. We are also examining the distribution of zooplankton of various sizes, including larval fish. This will provide information about the food resources available to the five focal groundfish species during their first year of life, when they are passively drifting in the water column.

Ashley Hovis

Fisheries biologists are conducting trawl and acoustic surveys to provide information about the predators that may affect the survival of young-of-the-year groundfishes. In this way, we can document the various fish that are present in the Gulf of Alaska seasonally and regionally. We are conducting a variety of diet studies on adult and juvenile fish using stomach content, stable isotope, and fatty acid analyses. These diet studies will confirm which species of adult and juvenile fish eat the young-of-the-year groundfishes.

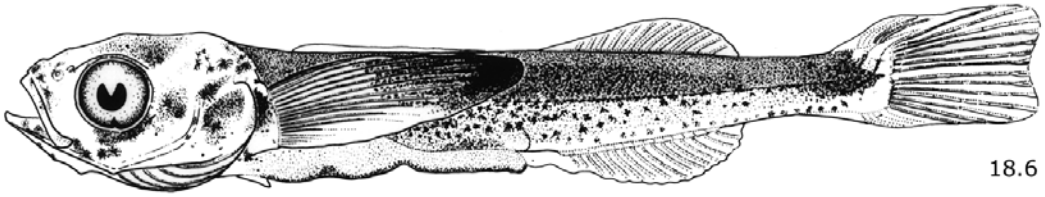
Energetic studies are also ongoing to estimate the physiological requirements of various fish species, including the five focal groundfish species. This tells us about the growth rates of the different fish species and allows us to estimate how much food the species require. This information in turn helps us to predict the likelihood that the five focal groundfish species will survive to produce offspring of their own.

Kimberly Rand

Seabird and marine mammal researchers are collecting data from research vessels, with seabird studies also being conducted at land-based sites on St. Lazaria and East Amatuli Islands. At the land-based sites, we study seabird foraging patterns, diets, and growth rates of chicks. Both the vessel and land-based studies provide information about seabird predation on groundfish species in the Gulf of Alaska.

Nursery habitats for the five focal young-of-the-year groundfishes are also being studied in bays around the Gulf of Alaska. We will classify bays according to the proportion of suitable habitat they provide and then use mathematical models to estimate how many fish are likely to settle in suitable habitat.

Olav Ormseth



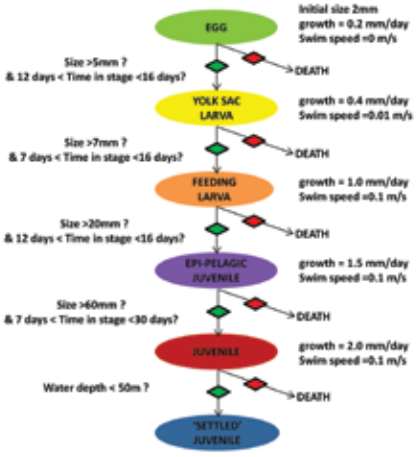
SABLEFISH
Anoplopoma fimbria
Illlustration by Henry Orr

Retrospective Studies

Environmental variability can make it difficult to identify patterns without examining data collected over relatively long time periods. As a result, the Gulf of Alaska Project includes an analysis of historic data to place the results of the current field study into context. These observations include ocean temperature, circulation, chlorophyll and nutrient concentrations. We are also describing historic patterns in biological conditions, such as the abundance and distribution of plankton, fish, and their predators. In short, we are summarizing what is known about the five focal groundfish species and how they respond to their environment based on past research.

Modeling Studies

Using field and historical data as inputs to mathematical models, we are estimating how many young-of-the-year groundfishes will be transported to suitable nursery habitats and survive. We are using oceanographic models to predict ocean currents and to describe how larval fish are likely to be transported throughout the Gulf of Alaska while using a nutrient-phytoplankton-zooplankton model to predict where the young fish will find food along their journey. We are developing individual-based models that model the behavior and movement of young-of-the-year groundfishes as they grow throughout their first year of life. In addition, we plan to use multi-species models to incorporate the interactions among fish species to provide information about competition and predation. Using all of these models in combination will allow us to predict rates of survival and recruitment of the young-of-the-year groundfish that are the focus of the Gulf of Alaska Project.



DRAFT INDIVIDUAL-BASED MODEL FOR SABLEFISH
Illlustration by Georgina Gibson

Kimberly Rand

Progress to Date

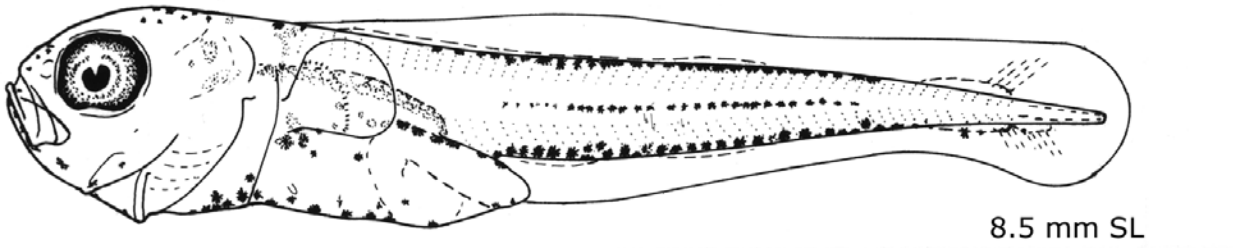
The first intensive field season was completed in 2011 and another is planned in 2013. In 2011, we found that oceanographic conditions were different from what was expected based on prior research. Satellite and field data indicated very low phytoplankton biomass throughout the Gulf of Alaska, and very few young-of-the-year groundfishes were caught during field sampling efforts. Salps (tubular gelatinous animals that eat phytoplankton) were also observed in surprising numbers throughout the study area and may help explain the low biomass of phytoplankton. Variations in both short term and decadal climatic patterns can have effects that are felt throughout the North Pacific, and we are examining if these may explain the surprising findings.

In 2012, more reduced fisheries and oceanographic data were collected offshore, and conditions more closely resembled what we expected based on historic data. Many young-of-the-year groundfishes were caught throughout the Gulf of Alaska, providing information for the models that aim to describe the movements of these fishes as they pass the gauntlet from offshore spawning areas, across the continental shelf, to nursery areas nearshore.

Communication and Outreach

The results of this project are already being communicated to a variety of audiences. Researchers regularly share news via blogs from the field that appear on the project website (http://gulfofalaska.nprb.org/). This research is also being presented at scientific meetings such as the annual Alaska Marine Science Symposium and public events such as the Sitka WhaleFest. Production of short videos communicating the important scientific results of our research is planned, with the hope that these videos will inspire young people to consider careers in science.

In summer 2011, NPRB co-sponsored an annual EARTH (Education And Research: Testing Hypotheses) workshop focusing on the Gulf of Alaska. The six-day workshop brought together educators from Alaska and elsewhere in the United States, and scientists who conduct research in the Gulf of Alaska. Educators from both formal and informal education participated, including the Prince William Sound Science Center, the Center for Alaskan Coastal Studies, and the Sitka Sound Science Center, among others. Scientists participating in the Gulf of Alaska project helped educators to develop lessons based on the Gulf of Alaska ecosystem for various age levels.



PACIFIC COD
Gadus macrocephalus

Illlustration by Beverly Vinter

A Gulf of Alaska Board of Investigators (GABI) representing each component of the study is guiding the overall effort, and working closely with the NPRB Program Manager to ensure a successful, integrated study in the Gulf of Alaska. The GABI works to ensure that the program objectives are met and makes consensus-based judgments about balancing research priorities when necessary. Current GABI representatives include Russ Hopcroft, Carol Ladd, Jamal Moss, Olav Ormseth (Chair), and Molly McCammon.

A data management team that includes Axiom Consulting and Design and the Alaska Ocean Observing System joined the Gulf of Alaska Project in 2012. They have developed a private workspace to facilitate data sharing among the scientists involved in the project. Data managers will ensure the data needs of the scientists are met, and that a permanent well-documented data archive will be transferred to NPRB upon completion of the project.

GROUP PHOTO OF THE GULF OF ALASKA PROJECT TEAM, MARCH 2012.

Communication, Education, and Outreach for the project was handled by Nora Deans, the former CEO Director of NPRB prior to 2013. In 2013, the Sitka Sound Science Center joined the program to coordinate communication, education, and outreach activities.

A website for the project at http://gulfofalaska.nprb.org/ includes statements of work and progress reports, maps of the study area and sampling sites, some preliminary results, blogs, and additional information about the program.

Questions about the project may be directed to the NPRB program manager, Danielle Dickson (Danielle.Dickson@nprb.org) or the NPRB Science Director, Francis Wiese (Francis.Wiese@nprb.org).

Olav Ormseth

Program Structure

Many researchers are contributing to the Gulf of Alaska Project. They are listed here according to their areas of expertise, and some individuals are working on multiple components of the project.

Controlling Mechanisms for Nutrients, Plankton, and Larval Fish in the Gulf of Alaska

(Physical, chemical, and biological oceanography)

Ana Aguilar-Islas, University of Alaska Fairbanks
Miriam Doyle, University of Washington
Janet Duffy-Anderson, NOAA Alaska Fisheries Science Center
Kerri Fredrickson, Western Washington University
Russell Hopcroft, University of Alaska Fairbanks
Nancy Kachel, NOAA Pacific Marine Environmental Laboratory
Carol Ladd, NOAA Pacific Marine Environmental Laboratory
Ann Matarese, NOAA Alaska Fisheries Science Center
Calvin Mordy, University of Washington
Jeff Napp, NOAA Alaska Fisheries Science Center
Robert Rember, University of Alaska Fairbanks
Marie Seguret, University of Alaska Fairbanks
Phyllis Stabeno, NOAA Pacific Marine Environmental Laboratory
Dean Stockwell, University of Alaska Fairbanks
Suzanne Strom, Western Washington University
Peggy Sullivan, NOAA Pacific Marine Environmental Laboratory

Structure of Gulf of Alaska Forage Fish Communities

(Nearshore fish surveys, acoustics, fish diet and habitat studies)

Kerim Aydin, NOAA Alaska Fisheries Science Center
Suzanne Budge, Dalhousie University
Alex DeRobertis, NOAA Alaska Fisheries Science Center
John Horne, University of Washington
Dave McGowan, University of Washington
Olav Ormseth, NOAA Alaska Fisheries Science Center
Kim Rand, National Oceanic & Atmospheric Administration
JJ Vollenweider, NOAA Alaska Fisheries Science Center
Shiway Wang, Sedna Ecological, Inc.

Surviving the Gauntlet in the Gulf of Alaska

(Offshore fish, seabird, and marine mammal surveys, fish energetics, and retrospective analyses)

Shannon Atkinson, University of Alaska Fairbanks
Brendan Coffin, University of Alaska Fairbanks
Casey Debenham, NOAA Alaska Fisheries Science Center
Wyatt Fournier, NOAA Alaska Fisheries Science Center
Nadine Golden, U.S. Geological Survey
Jon Heifetz, NOAA Alaska Fisheries Science Center
Ron Heintz, NOAA Alaska Fisheries Science Center
Jamal Moss, NOAA Alaska Fisheries Science Center
Franz Mueter, University of Alaska Fairbanks
Shari Mullen, NOAA Alaska Fisheries Science Center
Jane Reid, U.S. Geological Survey
Kalei Shotwell, NOAA Alaska Fisheries Science Center
Leslie Slater, U.S. Fish & Wildlife Service
Ashwin Sreenivasan, NOAA Alaska Fisheries Science Center
Jason Waite, University of Alaska Fairbanks
Marilyn Zaleski, NOAA Alaska Fisheries Science Center
Mark Zimmerman, NOAA Alaska Fisheries Science Center

Exploring Gulf of Alaska Groundfish Dynamics with Integrated Biophysical Models

(Mathematical modeling)

Kerim Aydin, NOAA Alaska Fisheries Science Center
Ken Coyle, University of Alaska Fairbanks
Georgina Gibson, University of Alaska Fairbanks
Kate Hedstrom, University of Alaska Fairbanks
Al Hermann, University of Washington
Sarah Hinckley, NOAA Alaska Fisheries Science Center
Carol Ladd, NOAA Pacific Marine Environmental Laboratory
Jocelyn Lin, NOAA Alaska Fisheries Science Center
Carolina Parada, University of Washington
William Stockhausen, NOAA Alaska Fisheries Science Center
Peggy Sullivan, NOAA Alaska Fisheries Science Center

Communication, Education and Outreach

Lisa Busch, Sitka Sound Science Center
Nora Deans, North Pacific Research Board
Liz McKenzie, Sitka Sound Science Center

Data Management

Rob Bochenek, Axiom Consulting and Design
Molly McCammon, Alaska Ocean Observing System
Will Koeppen, Axiom Consulting and Design
Ross Martin, Axiom Consulting and Design

North Pacific Research Board Program Management

Danielle Dickson, NPRB Program Manager
Francis Wiese, NPRB Science Director