The many faces of the sea: Planning and implementing marine ecosystem science in a changing world

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Danielle M.S. Dickson, Nora L. Deans

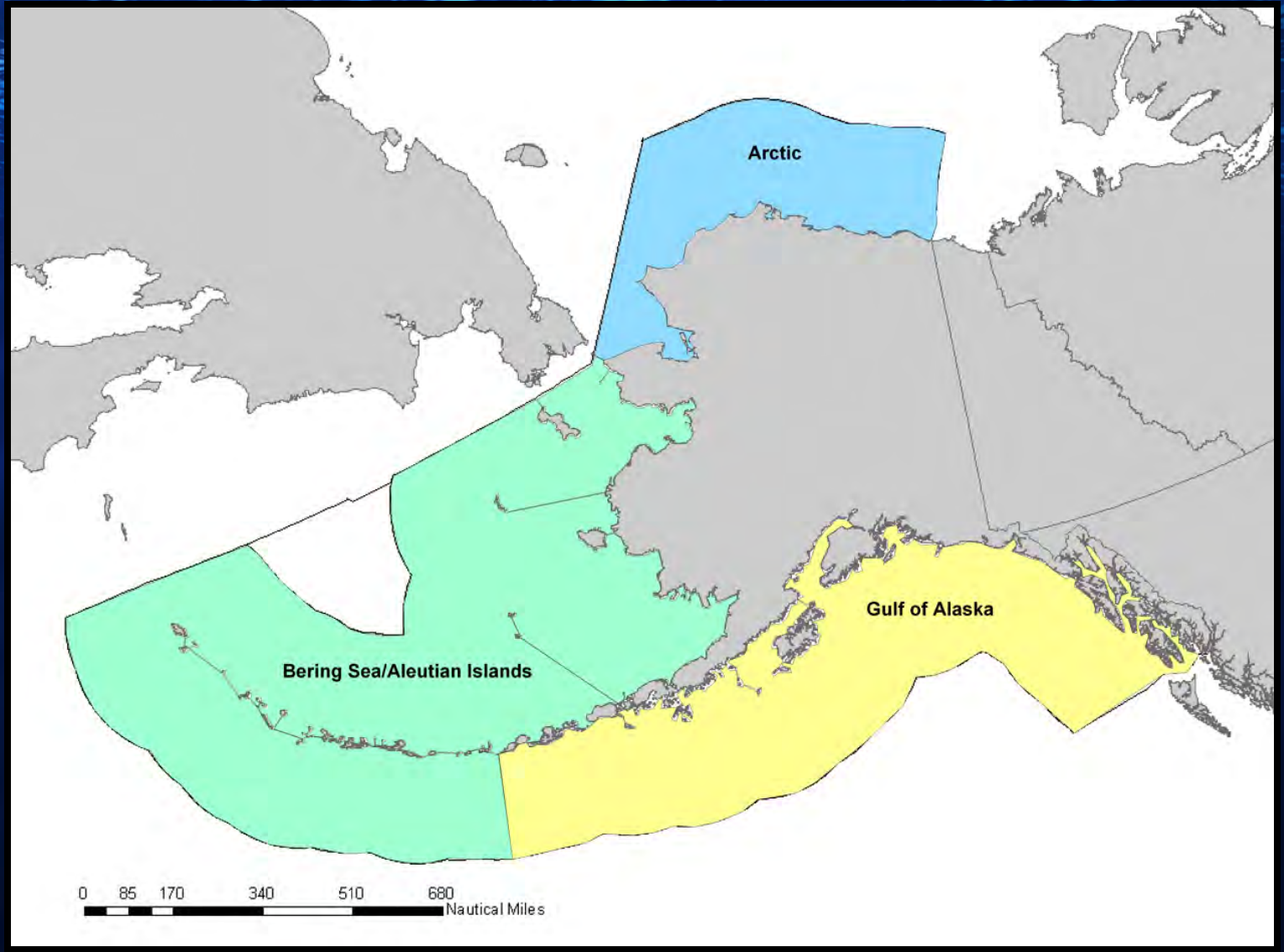
North Pacific Research Board - Vision



Building a clear understanding of the North Pacific, Bering Sea, and Arctic Ocean ecosystems that enables effective management and sustainable use of marine resources.



Large Marine Ecosystems



Science Implementation

- Competitive
- Annual RFP
- IEPRs

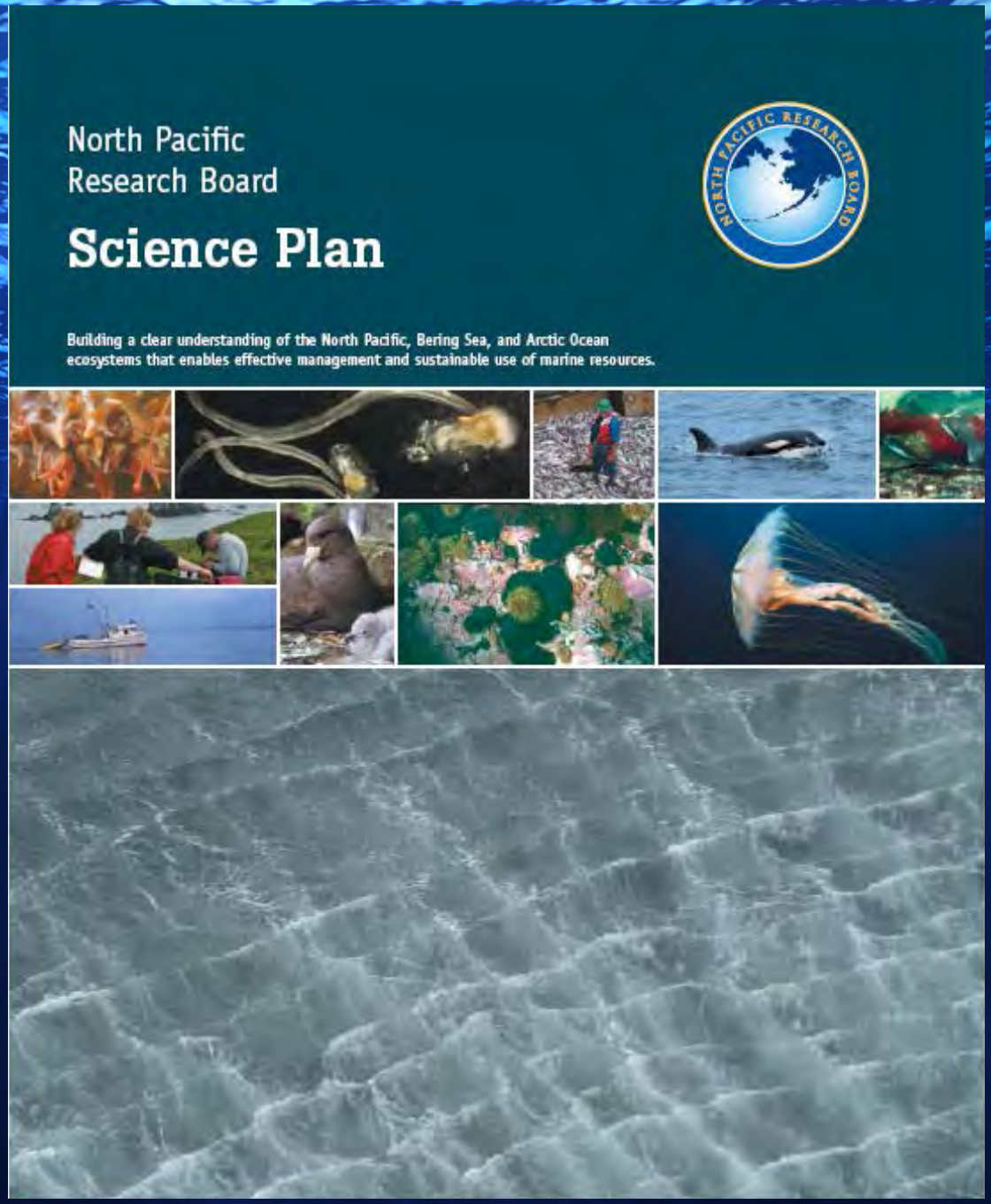


Table 1. NPRB-supported research initiated in 2002-2012.

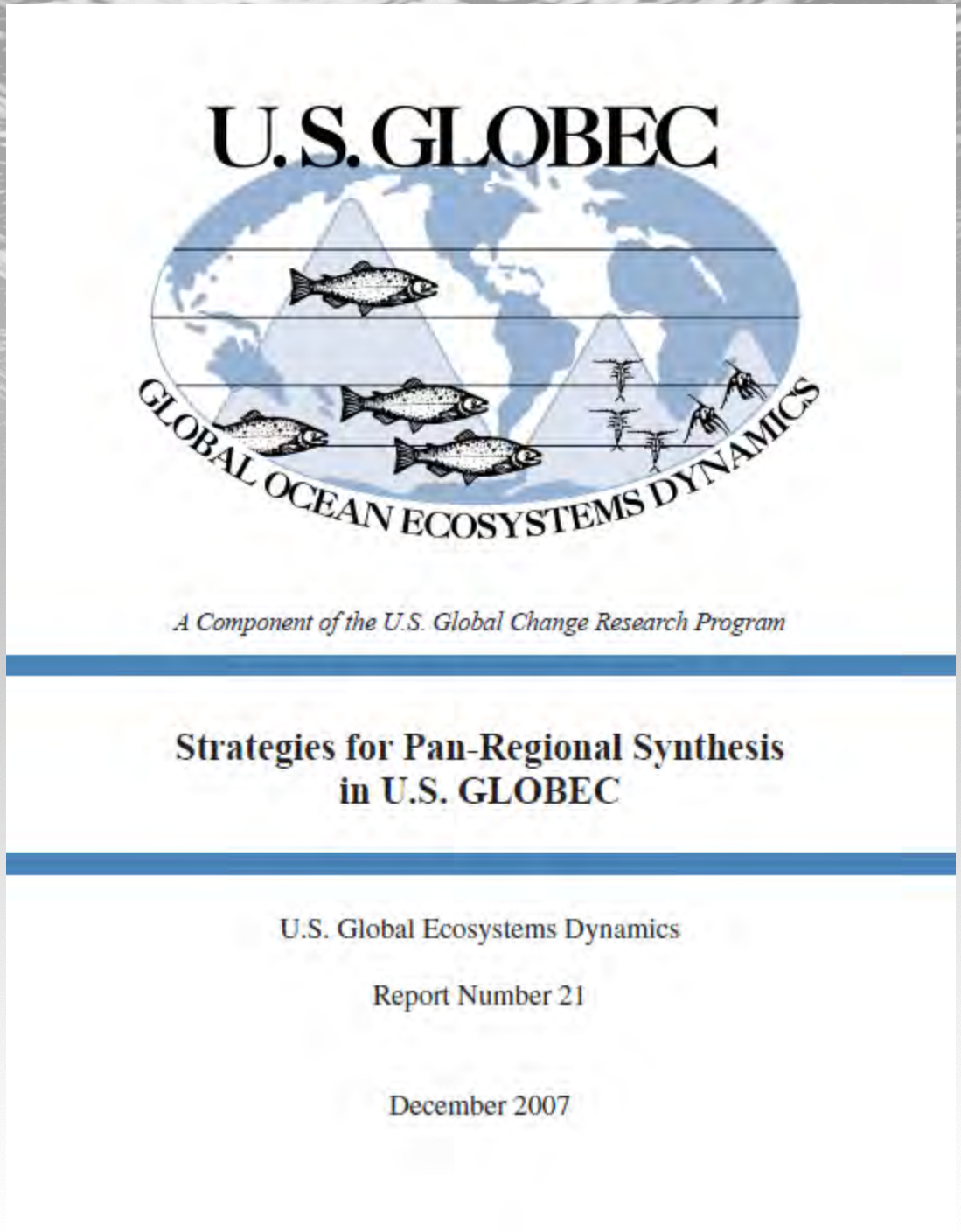
Categories of Research	Projects	Total Funding	%
Lower Trophic Level Productivity	55	$8,207,681	17
Fish and Invertebrates	117	$20,597,567	42
Fish Habitat	19	$4,369,791	9
Marine Mammals	50	$7,791,493	16
Seabirds	26	$4,597,106	9
Humans	21	$1,660,506	3
Other Prominent Issues	16	$1,684,074	3
TOTAL	**304**	**$48,908,218**	

Ecosystem Science Approaches

- Individual projects that address parts of a broader research plan
  - ☑ *easier, hands-off*
  - ⛔ *integration after the fact*

Ecosystem Science Approaches

- New Ideas
- Potential for mismatch



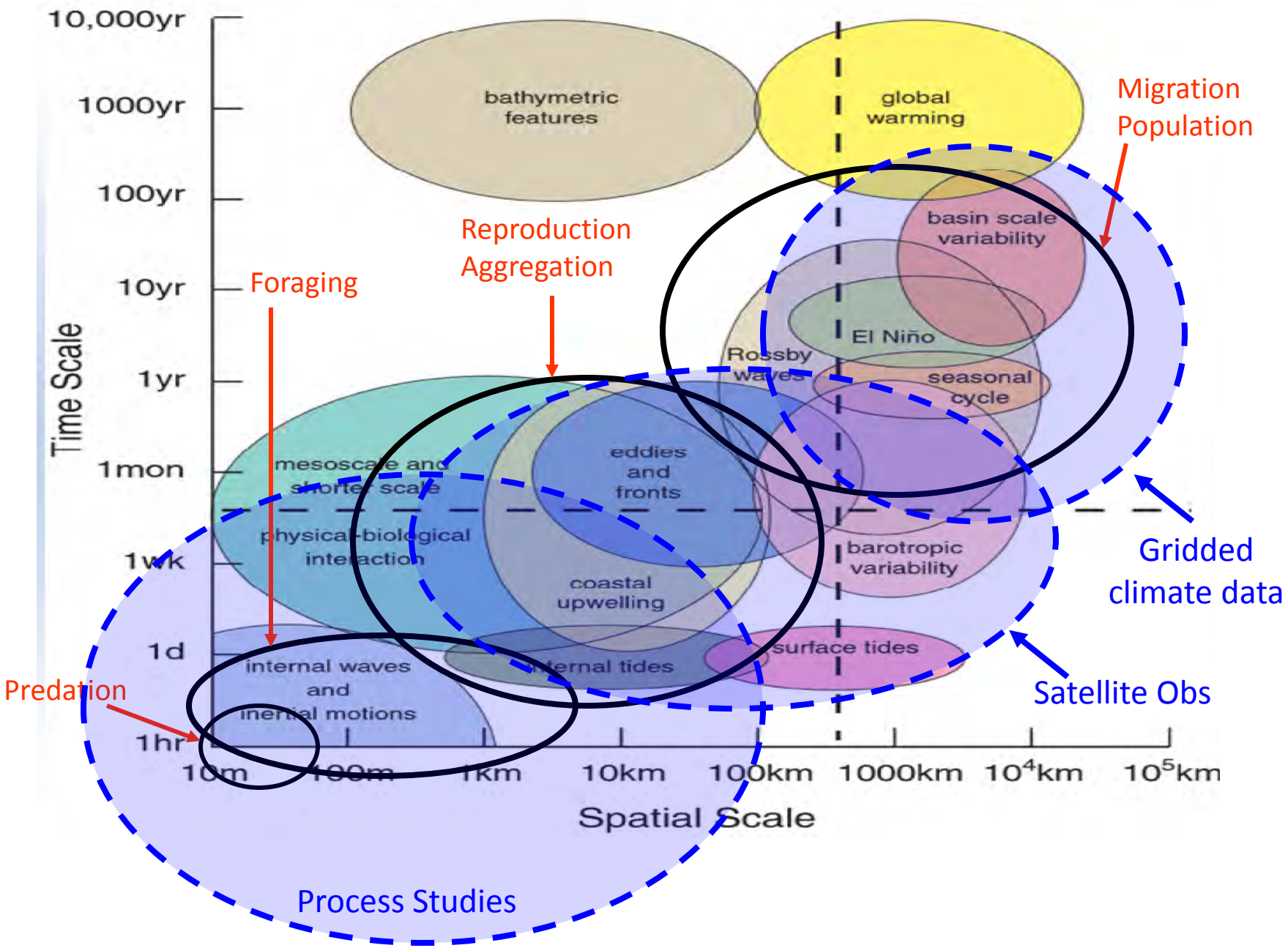
Ecosystem Science Approaches

- Individual projects that address parts of a broader research plan
  - ☑ *easier, hands-off mgmt*
  - ⛔ *integration after the fact*

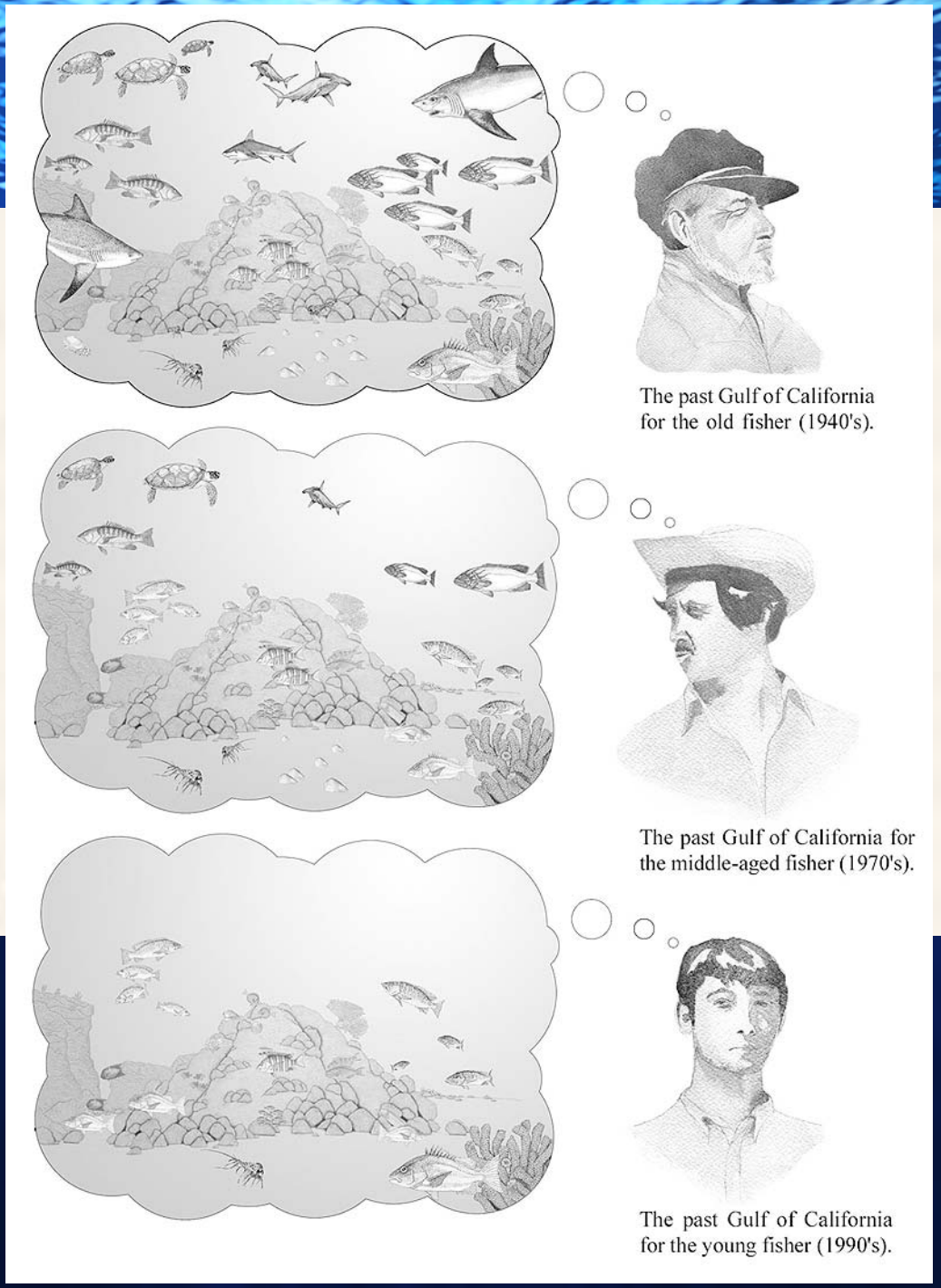
- A fully integrated study that addresses the ecosystem, not its components as its subject
  - ⛔ *harder, more involved project*
  - ☑ *integration, broad question*

Ecosystem science = anticipate vs. mitigate

Clear Goals: Application


10,000yr
1000yr
100yr
10yr
1yr
1mon
1wk
1d
1hr
Time Scale
10m
100m
1km
10km
100km
1000km
10⁴km
10⁵km
Spatial Scale
bathymetric features
global warming
basin scale variability
El Niño
Rossby waves
seasonal cycle
eddies and fronts
mesoscale and shorter scale physical-biological interaction
barotropic variability
coastal upwelling
surface tides
internal tides
internal waves and inertial motions
Migration
Population
Reproduction
Aggregation
Foraging
Predation
Gridded climate data
Satellite Obs
Process Studies

Shifting Baselines: Changing Seas

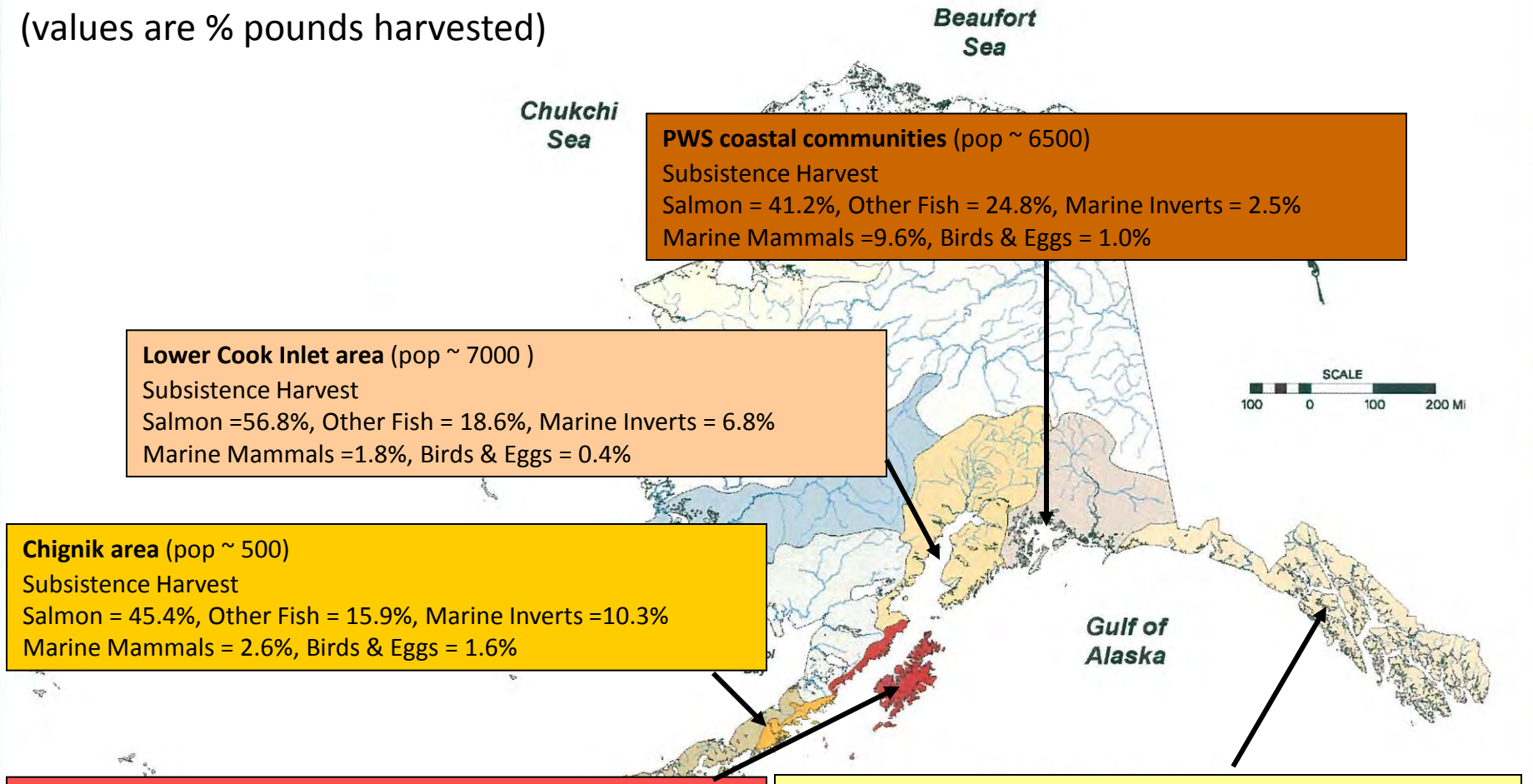


The past Gulf of California for the old fisher (1940's).

The past Gulf of California for the middle-aged fisher (1970's).

The past Gulf of California for the young fisher (1990's).

Subsistence Harvest in GOA Coastal Communities (values are % pounds harvested)



PWS coastal communities (pop ~ 6500)
Subsistence Harvest
Salmon = 41.2%, Other Fish = 24.8%, Marine Inverts = 2.5%
Marine Mammals =9.6%, Birds & Eggs = 1.0%

Lower Cook Inlet area (pop ~ 7000)
Subsistence Harvest
Salmon =56.8%, Other Fish = 18.6%, Marine Inverts = 6.8%
Marine Mammals =1.8%, Birds & Eggs = 0.4%

Chignik area (pop ~ 500)
Subsistence Harvest
Salmon = 45.4%, Other Fish = 15.9%, Marine Inverts =10.3%
Marine Mammals = 2.6%, Birds & Eggs = 1.6%

Kodiak area (pop ~ 13,900)
Subsistence Harvest
Salmon =44.9%, Other Fish = 25.7%, Marine Inverts =7.7%
Marine Mammals =3.1%, Birds & Eggs = 1.0%

Southeast AK coastal communities (pop ~19000)
Subsistence Harvest
Salmon = 22.3%,Other Fish = 28.0%, Marine Inverts=13.7%
Marine Mammals = 2.3%, Birds & Eggs = 0.6%

FUTURE –

Vision

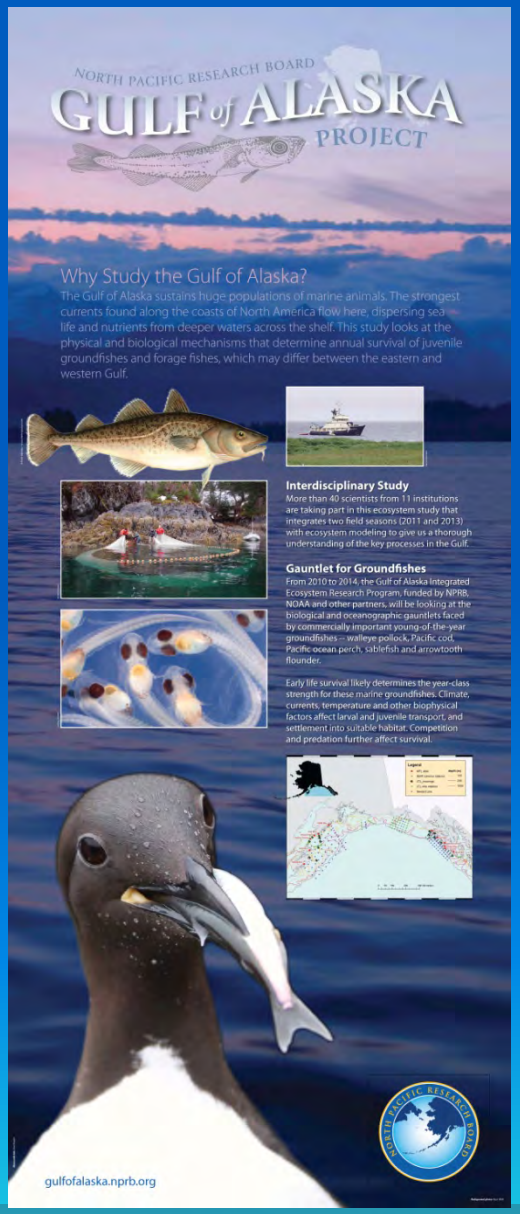
To *understand* and *forecast* responses of North Pacific marine ecosystems to climate change and human activities at basin-wide and regional scales, and to broadly *communicate* this scientific information to Members, governments, resource managers, stakeholders and the public.

Developing risk-based ecological assessments within a policy/management framework to communicate future states of nature, their implications, and uncertainties to decision-makers and society.

Why Study the Gulf of Alaska?

The Gulf of Alaska sustains huge populations of marine animals. The strongest currents found along the coasts of North America flow here, dispersing sea life and nutrients from deeper waters across the shelf. This study looks at the physical and biological mechanisms that determine annual survival of juvenile groundfishes and forage fishes, which may differ between the eastern and western Gulf.

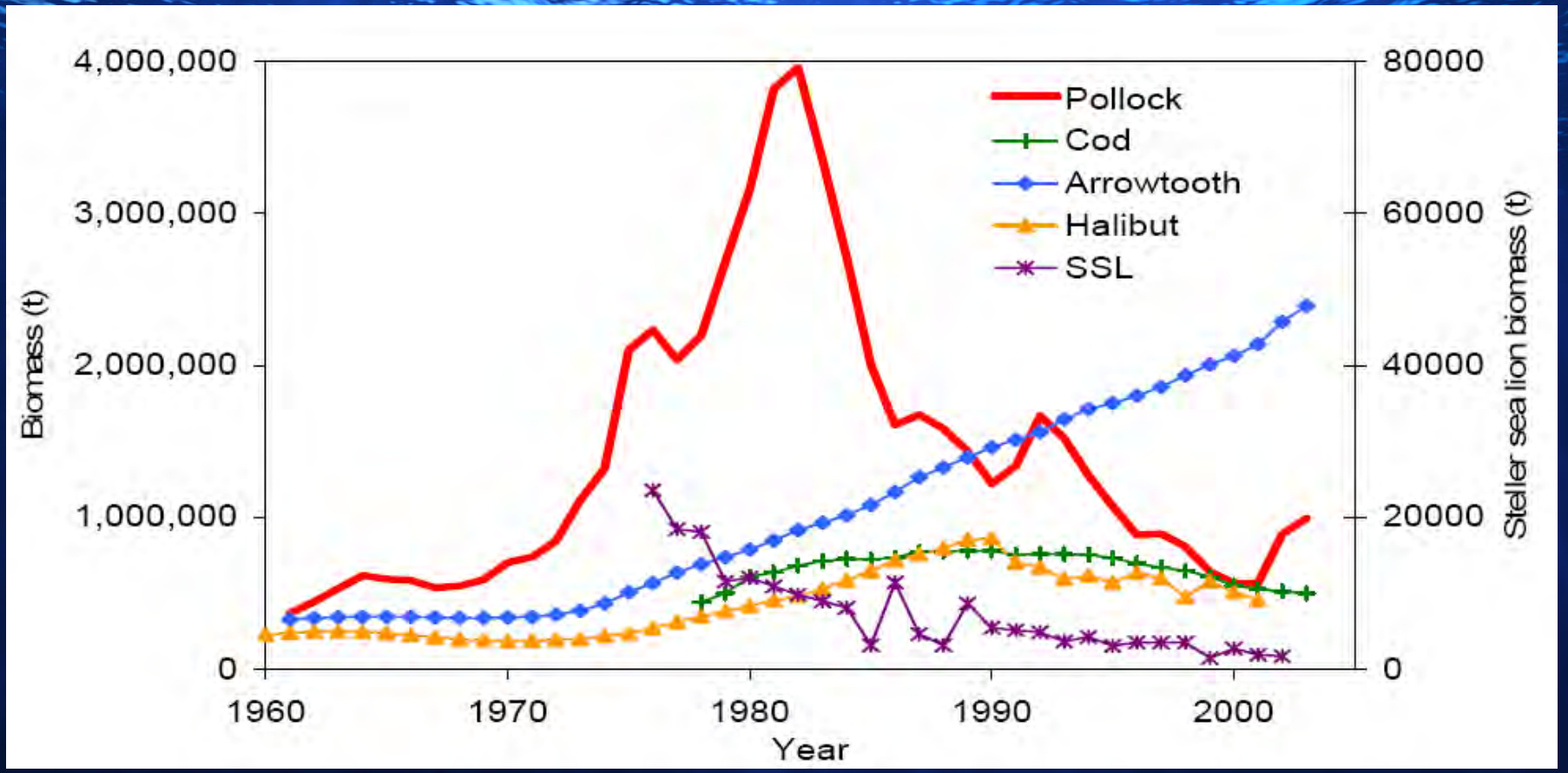
- Interdisciplinary study
  - >40 scientists from 11 institutions
  - 5 years (2010 – 2014)
  - $17.5 million-study
- Gauntlet for groundfishes
  - Sablefish
  - Walleye pollock
  - Pacific ocean perch
  - Pacific cod
  - Arrowtooth flounder




Tourism
Recreation
Commercial Fishing
Sport Fishing
Subsistence
Airborne contamination
Precipitation
Alaska Current
Eddy
Aleutian Low Pressure
WIND
Continental Shelf Break
Mid-shelf Front
Alaska Coastal Current
Coastal Communities
Freshwater runoff
Fry
Salmon Migration
Adults
Ekman Transport
W
N
Sea Birds
Plankton
Phytoplankton
Zooplankton
Forage Fish
Marine mammals
Turbulence
Photic boundary
Downwelling
Shelf-break Front
Carbon pump
DETRITUS
NUTRIENTS
Large Fish
Lunar forcing
GULF OF ALASKA
Sill
Tidal mixing
Overwintering copepods
Benthic Communities
Continental shelf
Upwelling
"Old carbon" + Nutrients
Deep hole
Alaska Digital Graphics

Mundy 2005

Imperfect knowledge



The Gauntlet

currents

temperature, nutrients

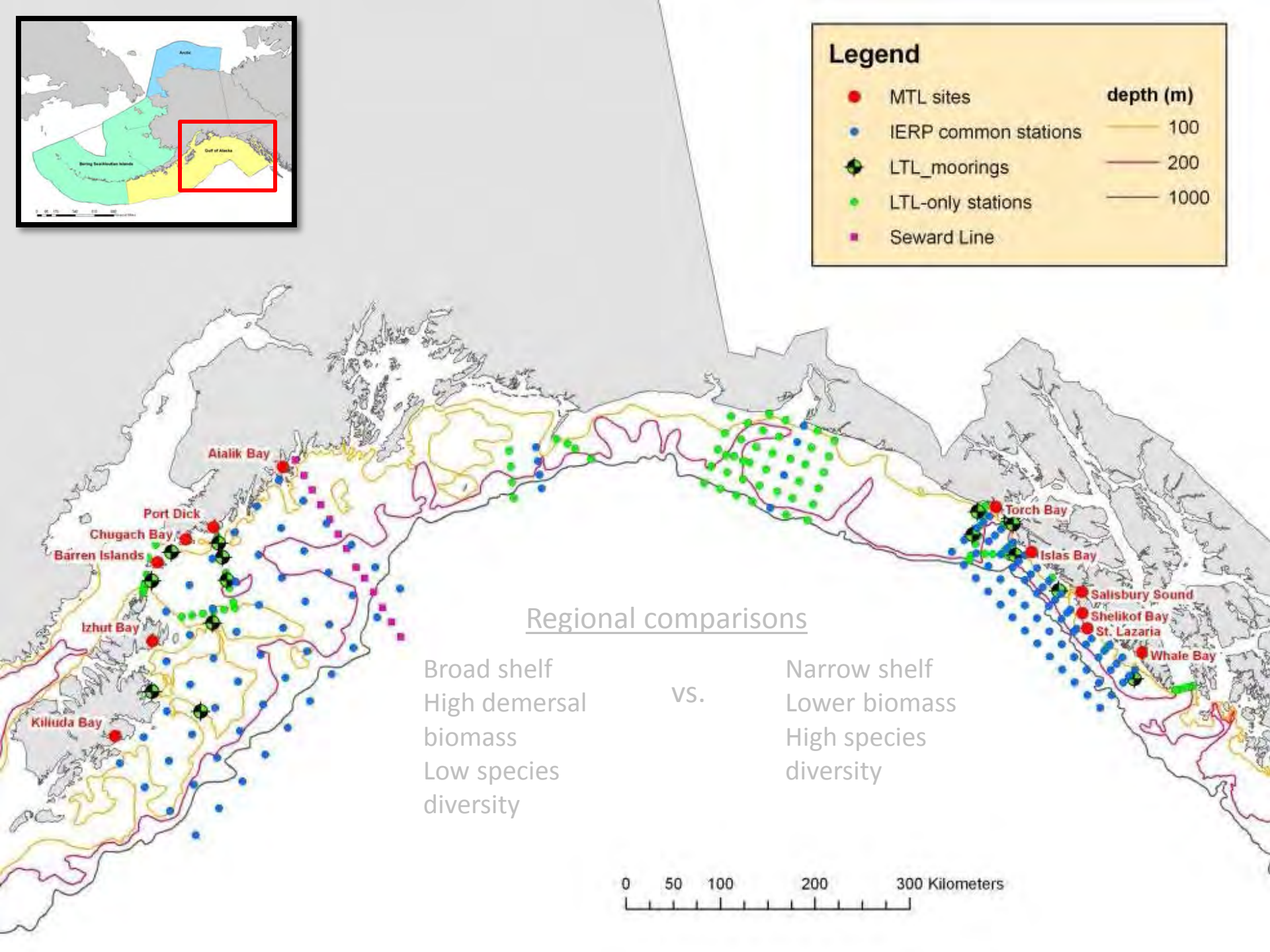
prey, predation

competition

habitat

What factors most affect how the 5 target species of groundfish get from here…

…to here?



Regional comparisons

Broad shelf
High demersal biomass
Low species diversity

vs.

Narrow shelf
Lower biomass
High species diversity

Structure

Management Structure

Data Management Team

Communication, Education & Outreach

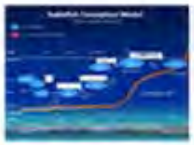
Nora Deans

Gulf of Alaska Board of Investigators –GABI

Jamal Moss

Olav Ormseth

Russ Hopcroft



Sarah Hinckley

Individual Scientists

NPRB Program Office

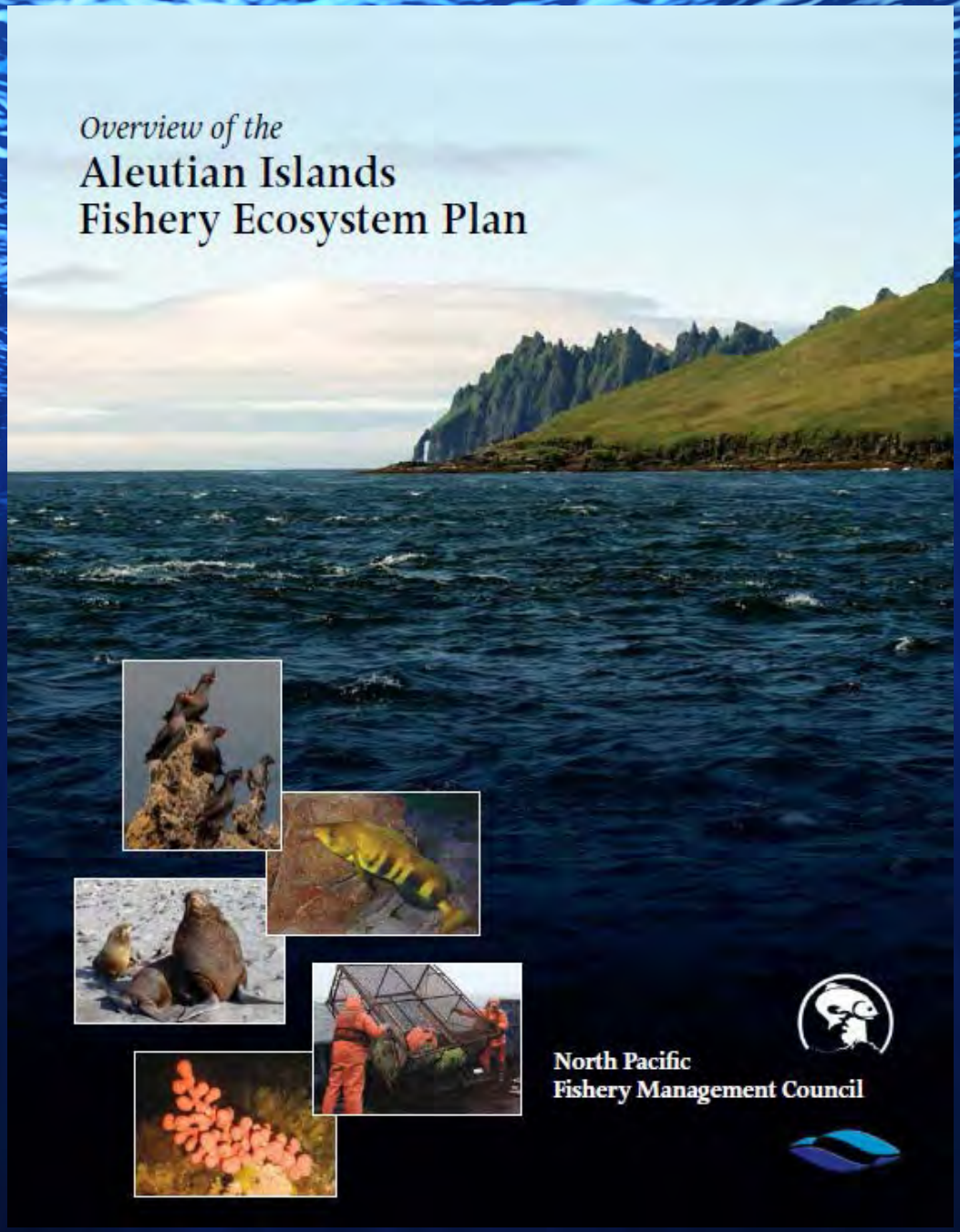
Francis Wiese
Science Director

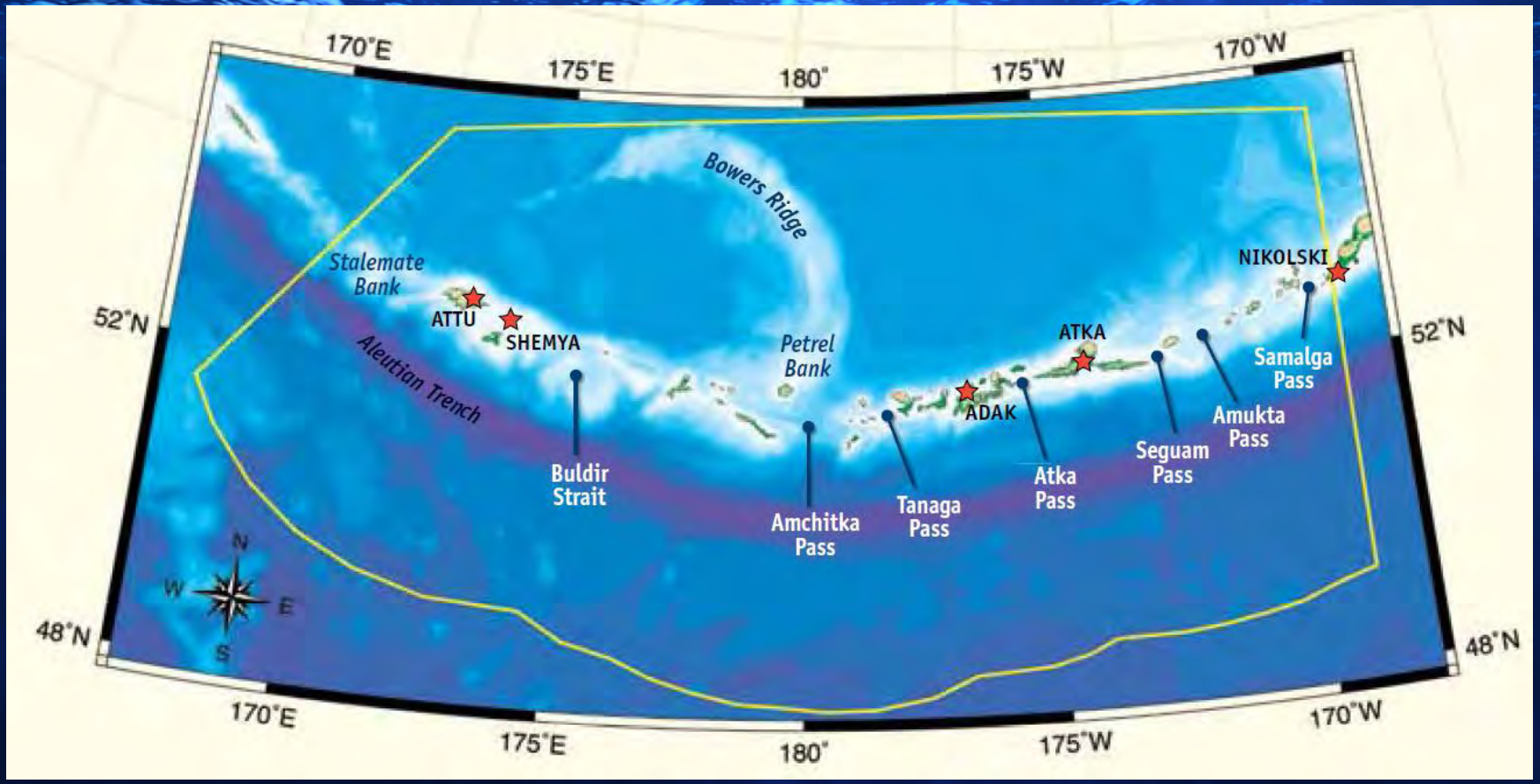
Danielle Dickson
Program Manager

Many individuals cooperate to make this project possible.

Ecosystem Knowledge and Management

Qualitative Risk Assessment

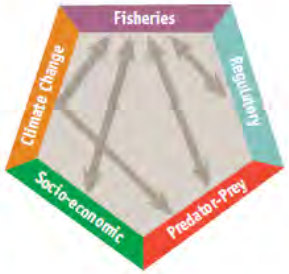




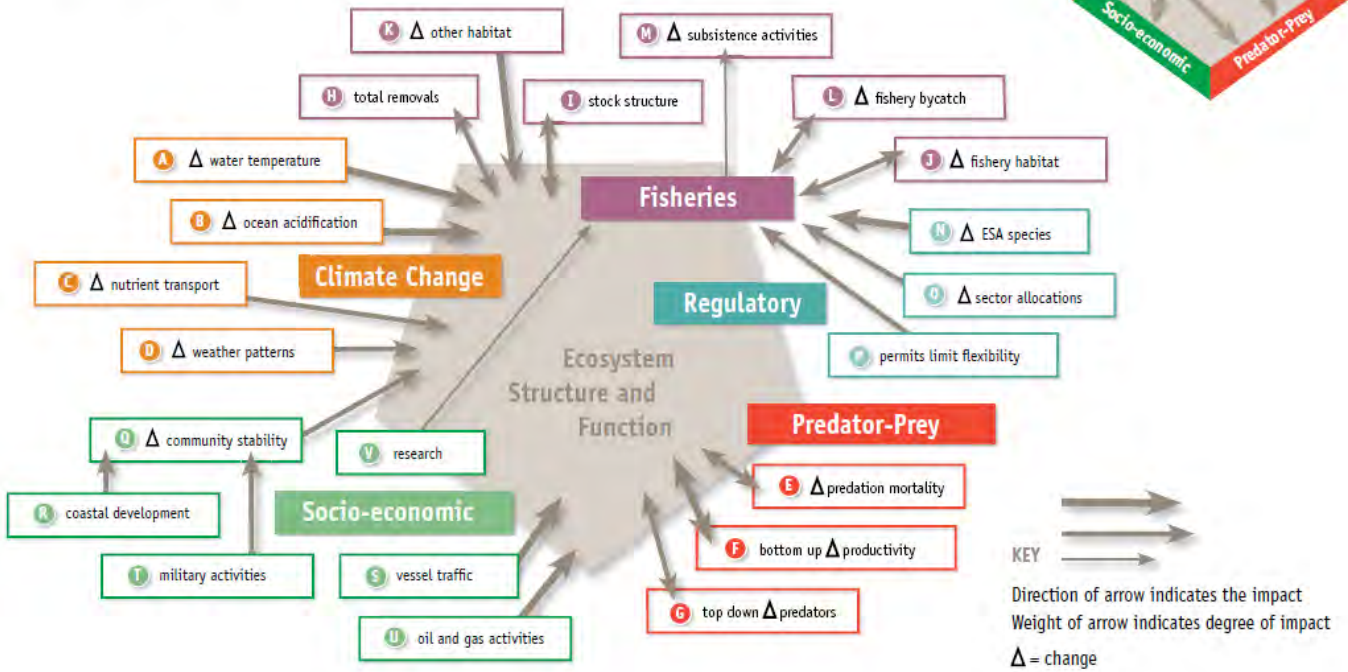
1200 miles (2000km): from Los Angeles to Dallas!

Non-Quantitative Risk Assessment

This first iteration of the Fishery Ecosystem Plan relies on a non-quantitative risk assessment to provide general guidance to the Council on priority areas and issues for management attention and further research and analysis. This process still follows the classic risk assessment framework, but relies on expert opinion and the building of consensus. A quantitative risk assessment may be a part of future iterations of the Fishery Ecosystem Plan.

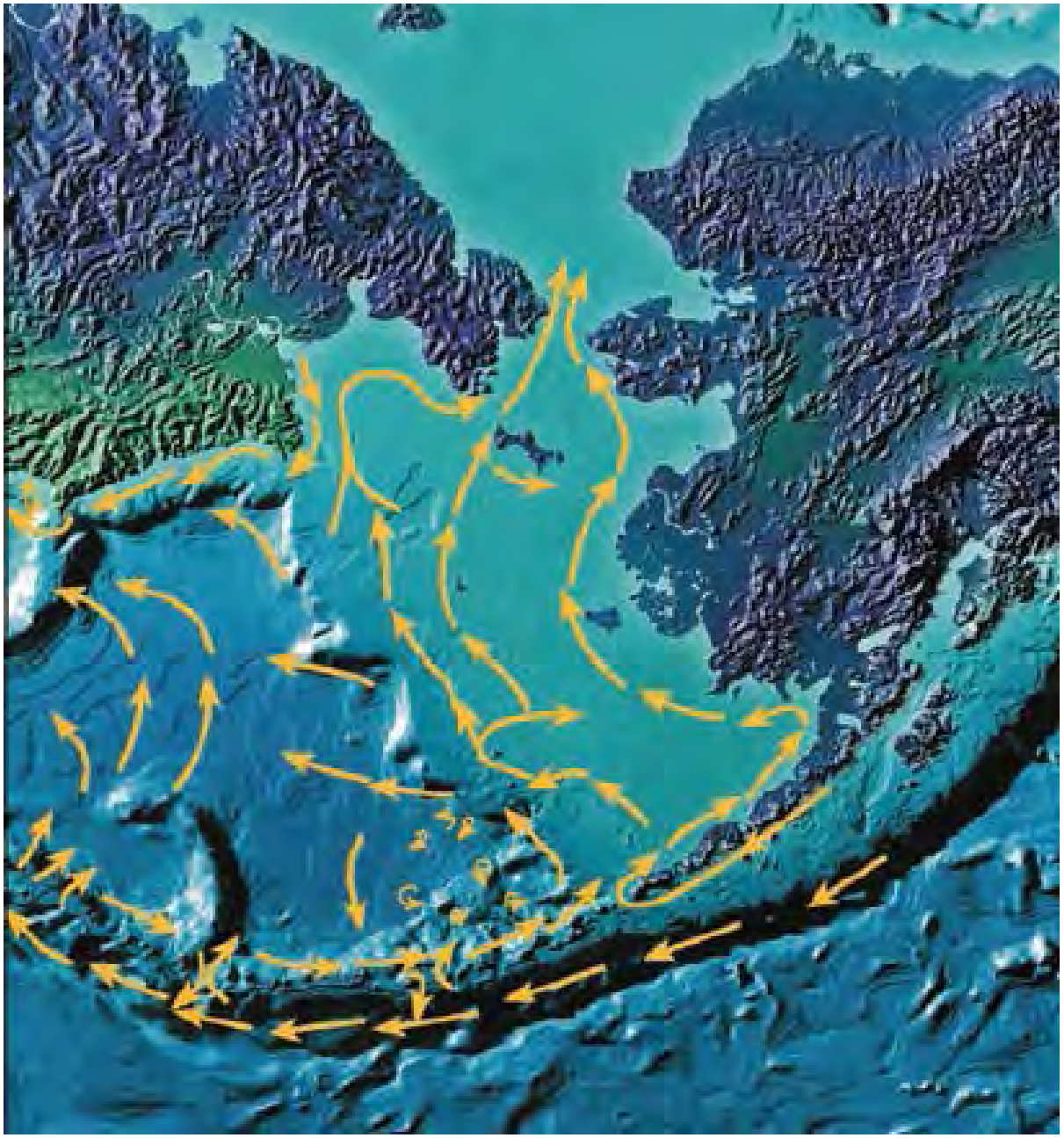


Map of Aleutian Islands ecosystem interactions

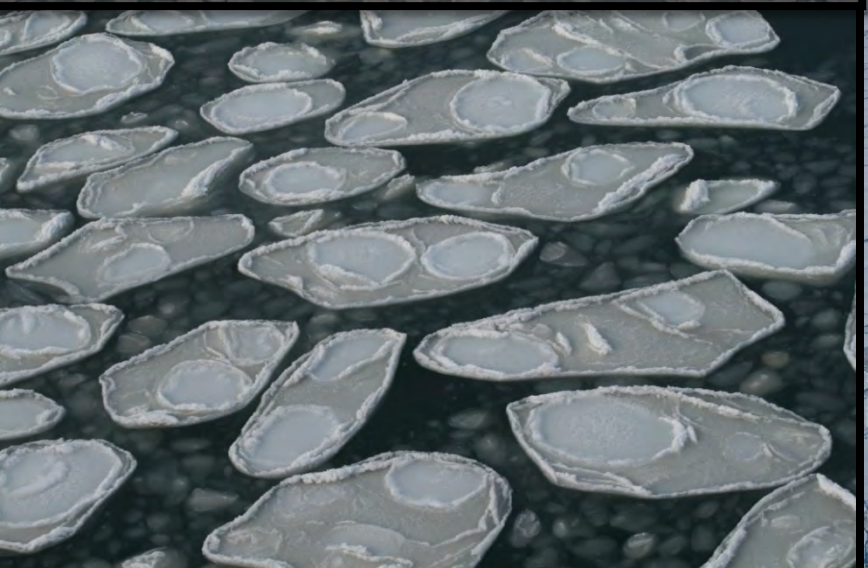


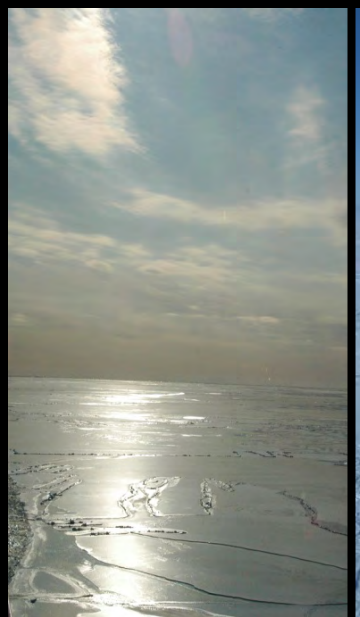
Steps of the Risk Assessment

- What are the key interactions in the Aleutian Islands ecosystem?
- How is risk associated with these interactions currently addressed by managers?
- What else might be done to address any risk? Is further action warranted?
- What indicators should be used to monitor these interactions?
- What are the priority data gaps and research needs for the Aleutian Islands ecosystem?

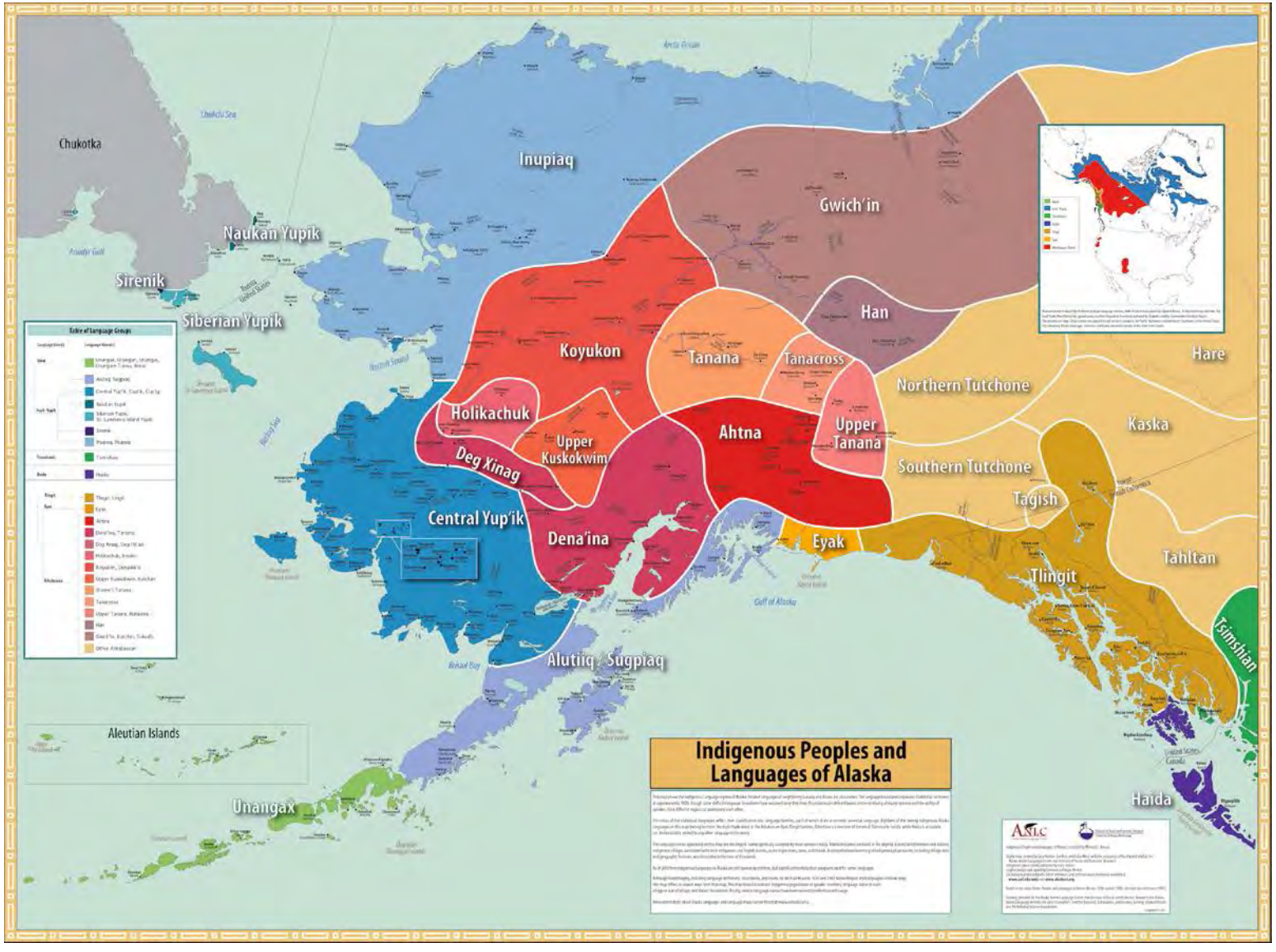


ICE





PEOPLE

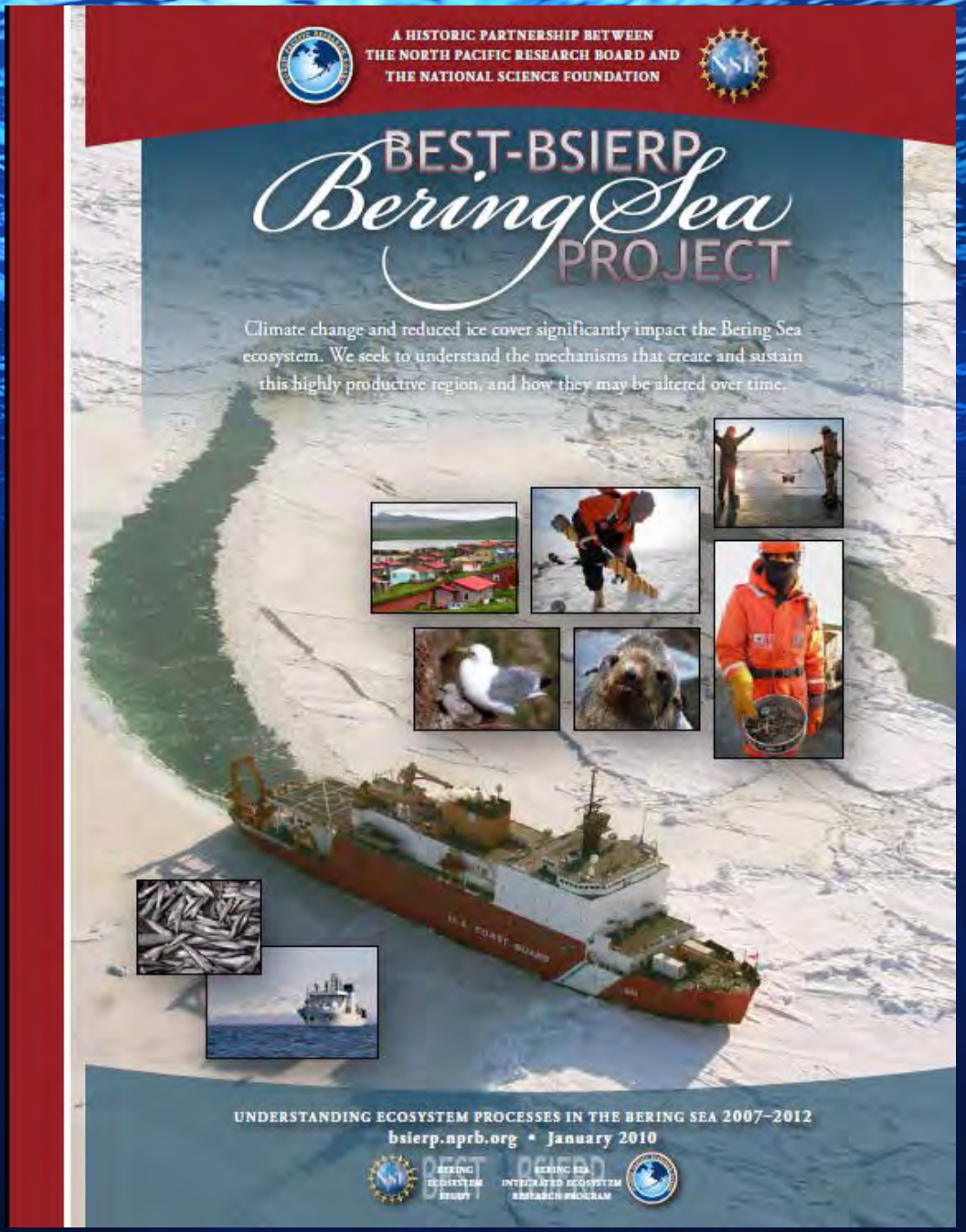

Chukotka
Inupiaq
Naukan Yupik
Sirenik
Siberian Yupik
Gwich'in
Han
Koyukon
Tanana
Tanacross
Hare
Northern Tutchone
Holikachuk
Upper Kuskokwim
Ahtna
Upper Tanana
Kaska
Deg Xinag
Southern Tutchone
Tagish
Central Yup'ik
Dena'ina
Eyak
Tahltan
Tlingit
Tsimshian
Alutiiq / Sugpiaq
Aleutian Islands
Unangax
Haida
Table of Language Groups
Indigenous Peoples and Languages of Alaska

Subsistence Life-style

- 55,000 people on or in the Bering Sea
- 25 million pounds of subsistence foods

The Bering Sea Project

2007-2013



24,205
person-days
of fieldwork
completed

- NSF and NPRB in partnership
- In-kind support from NOAA and USFWS
- 100 PIs, dozens of institutions, small army of students, collaborators, technicians, field and ship crews…

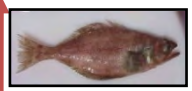
Integration

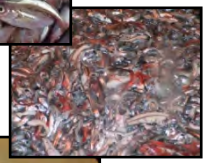
Humans

Humpback and fin whales

Commercial/subsistence fish: Pollock, cod, arrowtooth flounder

Kittiwakes and murres, fur seals, walrus

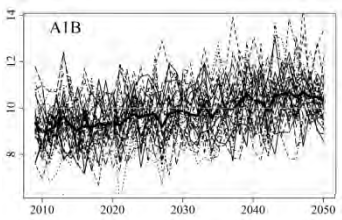




Forage species: Juvenile pollock, capelin, myctophids

NPZ: Ichthyoplankton, euphausiids, copepods, phytoplankton

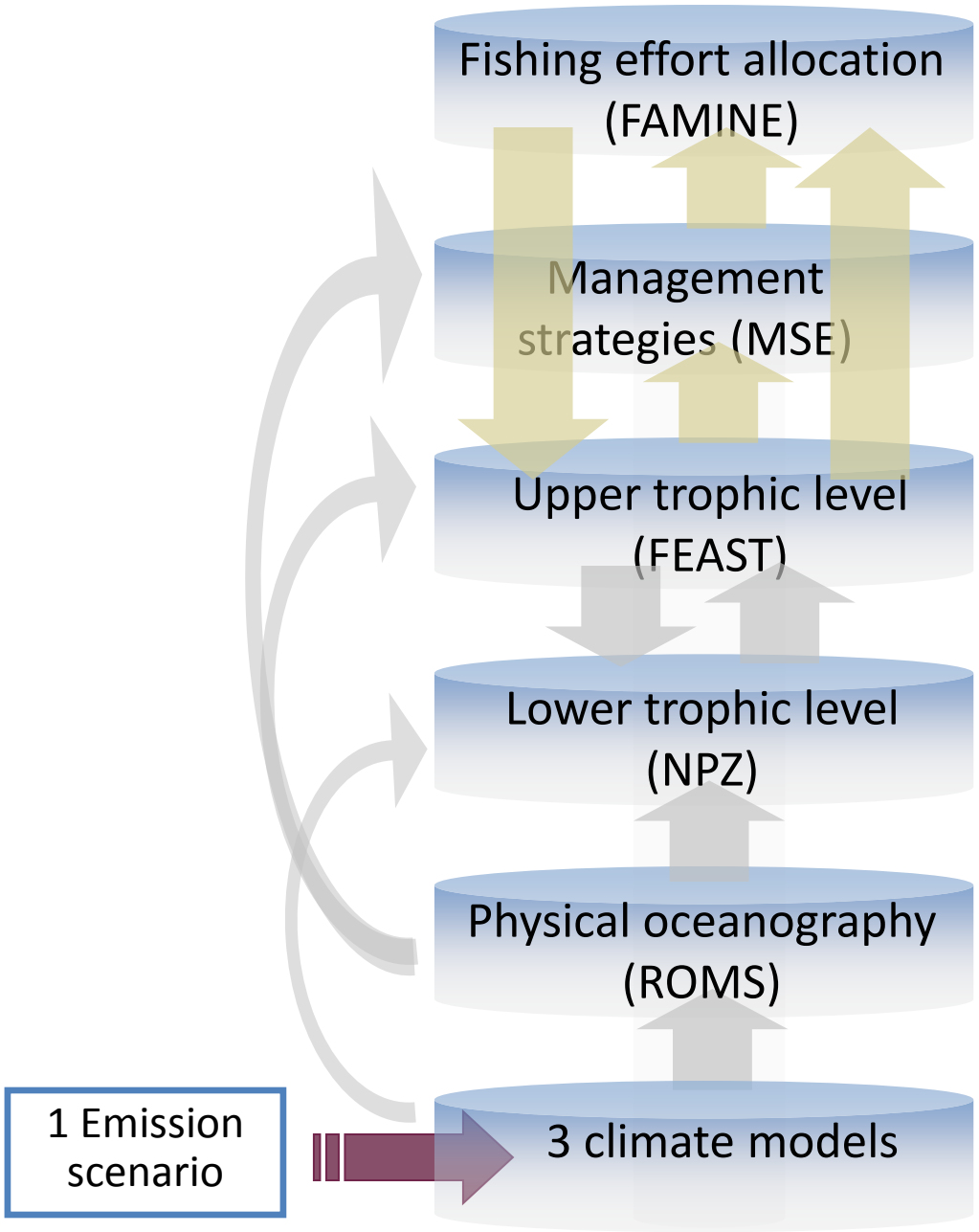
Infauna: Bivalves, gastropods, polychaetes



Atmosphere/ocean

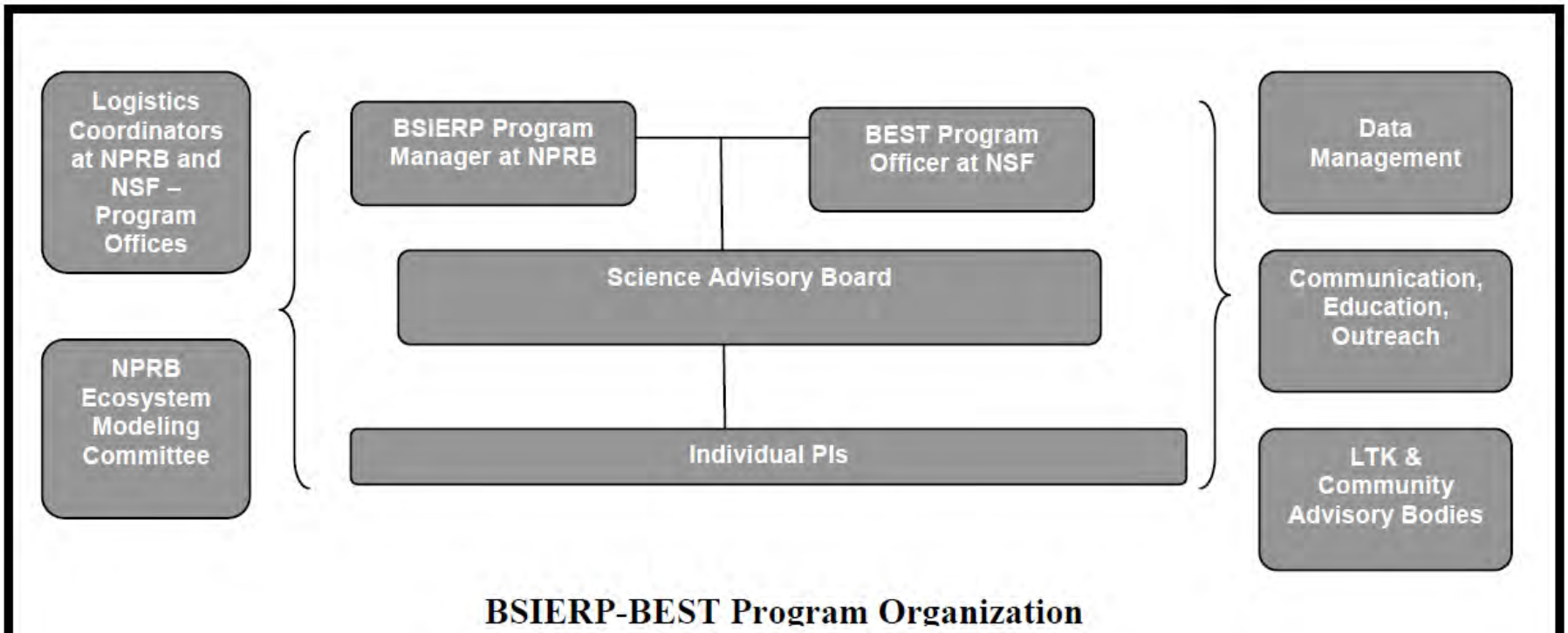
Climate Scenarios

Vertically-Integrated, Coupled Ecosystem Model



Cast of Characters

Structure



BSIERP-BEST Program Organization

Ecosystem Based Management

Ecosystem Indicators Approach

APPENDIX C

Ecosystem Considerations for 2011

Edited by:
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Reviewed by:
The Plan Teams for the Groundfish Fisheries of the
Bering Sea, Aleutian Islands, and Gulf of Alaska

November 15, 2010
North Pacific Fishery Management Council
605 W. 4th Avenue, Suite 306
Anchorage, AK 99301

The Arctic

Ecosystem Management Examples

Precautionary Approach

Fishery Management Plan

for Fish Resources
of the Arctic Management Area

North Pacific Fishery Management Council
605 W. 4th Avenue, Suite 306
Anchorage, Alaska 99501

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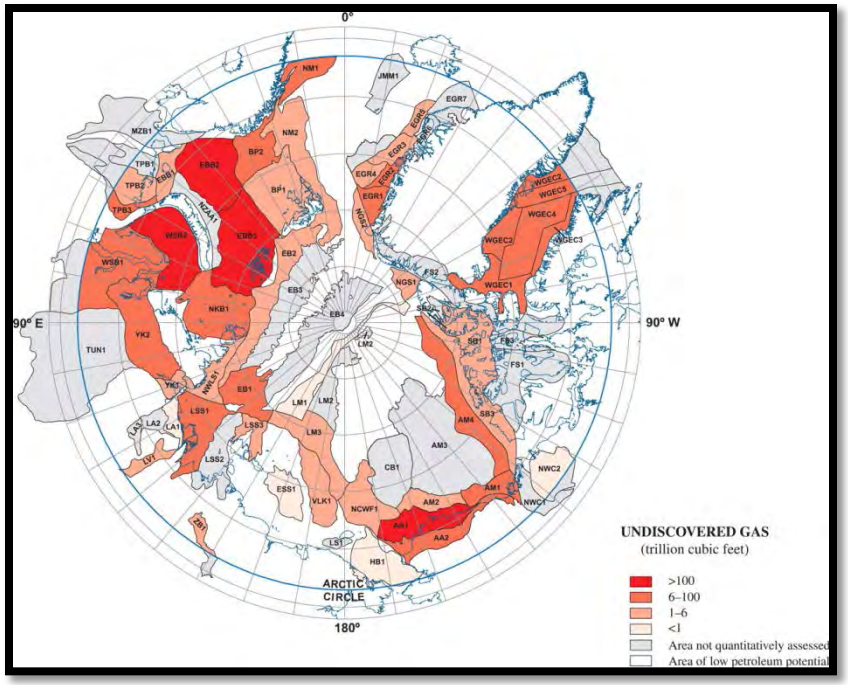
FAX: (907) 271-2817

August 2009


0°
90° E
90° W
180°
ARCTIC CIRCLE
UNDISCOVERED GAS
(trillion cubic feet)
>100
6–100
1–6
<1
Area not quantitatively assessed
Area of low petroleum potential


UNITED STATES
NORTH AMERICA
Atlantic Ocean
Arctic Ocean
Rotterdam
EUROPE
Northeast Passage
8,452 MILES
RUSSIA
Suez Canal
Pacific Ocean
ASIA
Yokohama
CHINA
Southerly route
12,894 MILES
AFRICA
Indian Ocean
Source: The Russian Ministry of Transport
THE NEW YORK TIMES

Arctic Research

- 25 Projects totaling $3.25M since 2002
  - *contaminants, subsistence, whales, data rescue, sea ice*
  - *projects.nprb.org*

Arctic Synthesis and Information Needs

PacMARS
Pacific Marine Arctic Regional Synthesis

Pacific Marine Arctic Regional Synthesis

Synthesis of Arctic Research (SOAR)

Distributed Biological Observatory (DBO)

Pacific Arctic Group (PAG)

Chesapeake Biological Laboratory (CBL)

North Pacific Research Board (NPRB)

Research Leads

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Dr. Lee Cooper

University of Maryland Center for Environmental Science

Principal Investigators

Dr. Bodil Bluhm

Dr. Steve Okkonen

Dr. Sveta Yamin-Pasternak

Ms. Gay Sheffield

PacMARS

The Pacific Marine Arctic Regional Synthesis (**PacMARS**) is a research synthesis effort underwritten by the North Pacific Marine Research Institute to assemble by mid-year 2013 up-to-date written documentation that contributes to understanding the Pacific-influenced coastal shelf ecosystem of the Arctic Ocean. Our study area extends from Saint Lawrence Island in the Bering Sea through Bering Strait into the Chukchi and Beaufort Seas and our objective is to compile the best available knowledge from local communities, peer-reviewed social and natural sciences, as well as less readily available knowledge sources.

Background

As seasonal sea ice declines in much of the Arctic and reached record minima in 2012, oil and gas exploration is increasing, and additional ship traffic is also using Bering Strait, perhaps a portend of changes to come if the Northern Sea Route along the north coast of Russia becomes a practical ice-free route between Asia and Europe, reducing shipping costs significantly. The Northwest Passage through the Canadian Arctic has also become ice-free several times in recent summers, a significant change. All of the Arctic countries, including Russia, the United States, Canada, and Denmark (Greenland) are exploring the limits of their arctic continental shelves in order to advance claims under the Law of the Sea Treaty.

Within this context of environmental and likely socio-economic changes, wildlife populations and human communities are adjusting to these shifts in seasonal sea ice coverage and climatic warming that has been much more obvious than at lower latitudes. Subsistence hunting patterns in the Arctic are changing, and it is also clear that many organisms, from plankton to top predators may be changing their migration and foraging patterns. Productivity is also forecast to change as sea ice declines and penetration of sunlight into open water increases.

Goals

goal is to provide guidance for scientific research needs in the region, as well as to

Meetings

PacMARS PI Meeting

September 24-25, 2012

Annapolis, MD

Contact Information

Agenda (DRAFT)

DC Metro Area Map

Annapolis Area Map

Annapolis Visitor Website

Joint PacMARS & SOAR Community Meeting

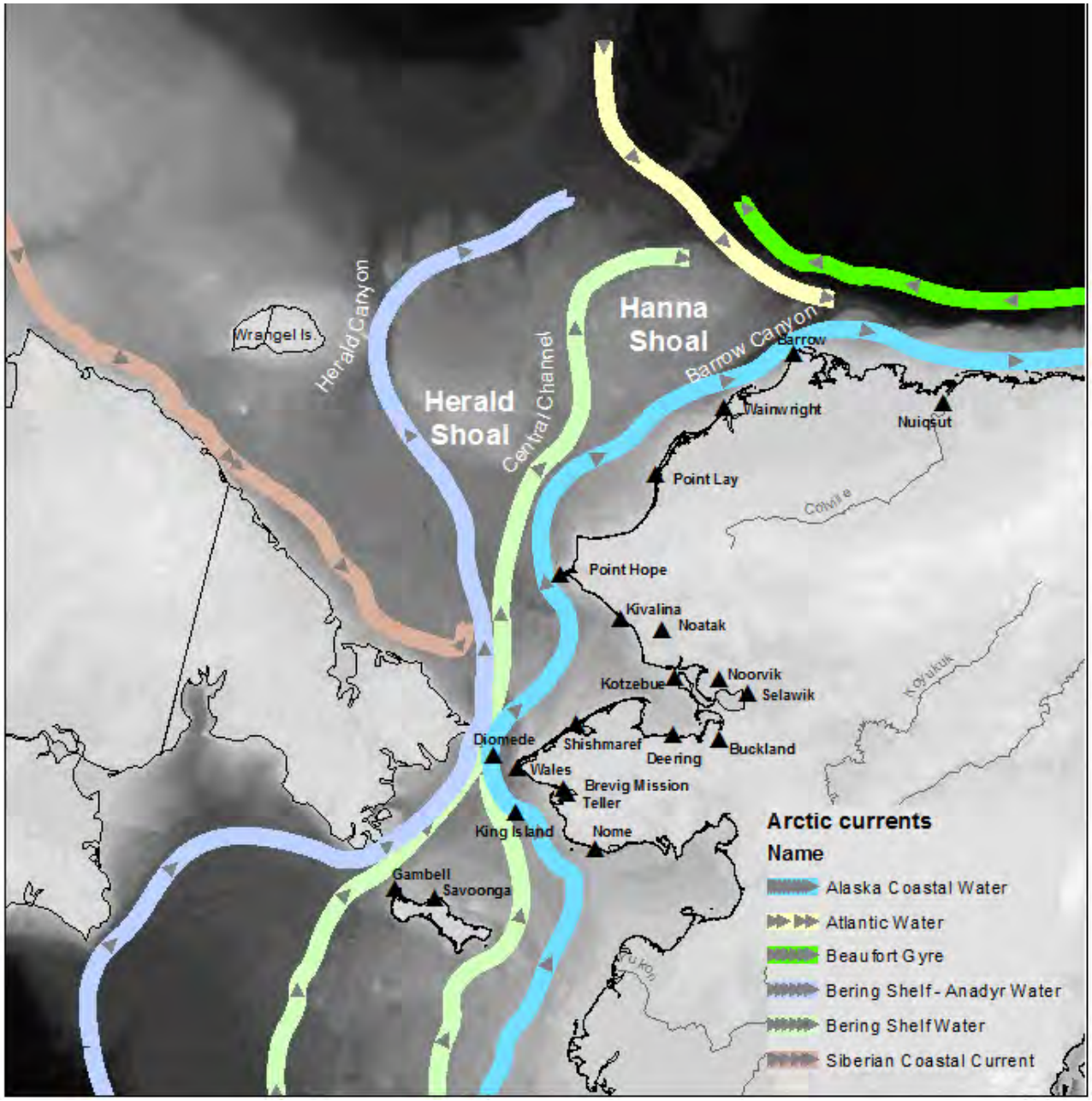
There will be a joint PacMARS and SOAR OPEN COMMUNITY MEETING on Saturday, January 20, 2013 just prior to the Alaska Marine Science Symposium (Jan. 21-25) in Anchorage, Alaska.

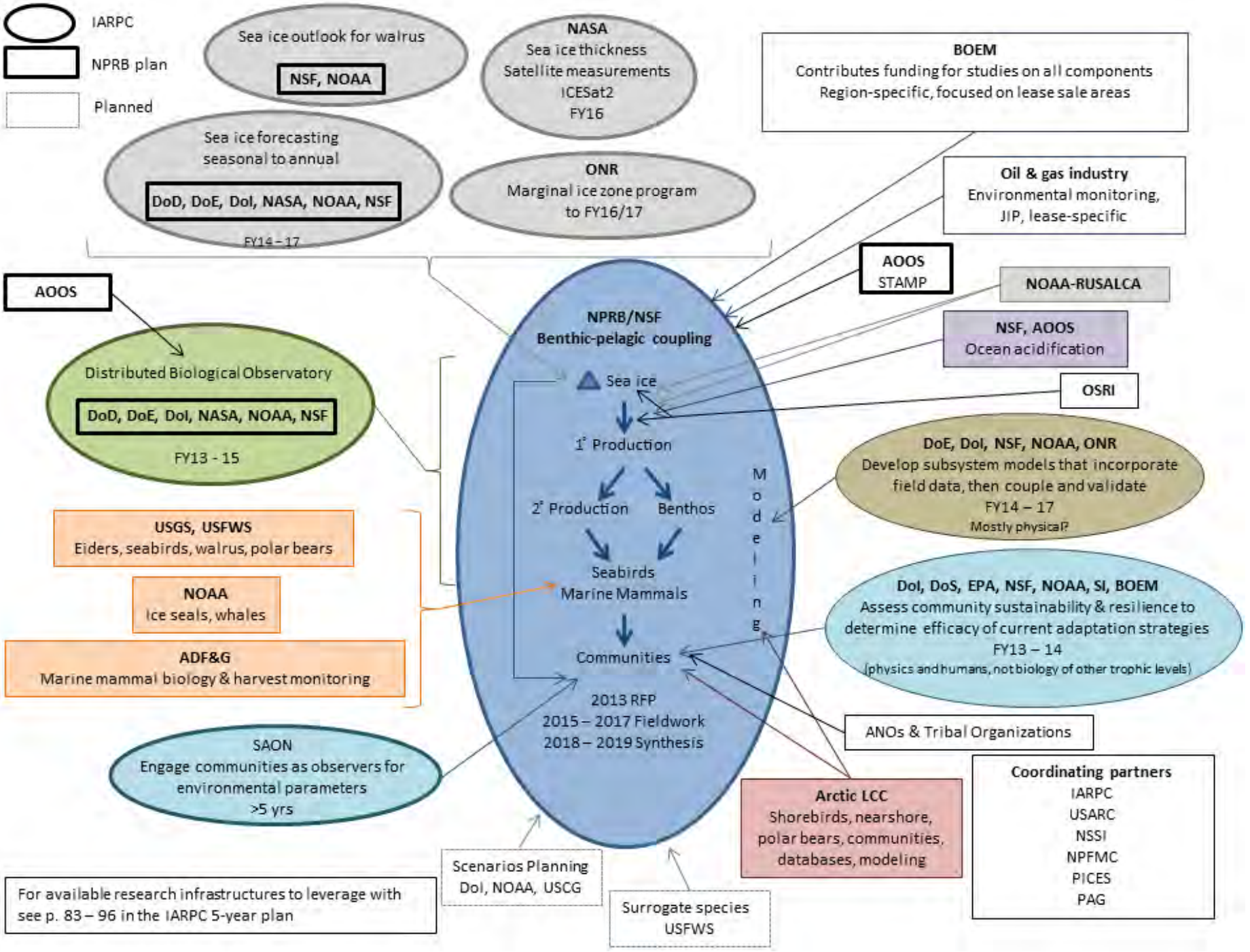
The purpose of this open meeting is to update the community on the PacMARS

THE PACIFIC-ARCTIC GATEWAY ECOSYSTEM STUDY

Science and Implementation Plan

September 2012


Wrangel Is.
Herald Canyon
Herald Shoal
Central Channel
Hanna Shoal
Barrow Canyon
Barrow
Wainwright
Nuiqsut
Point Lay
Colville
Point Hope
Kivalina
Noatak
Kotzebue
Noorvik
Selawik
Kobuk
Diomede
Shishmaref
Deering
Buckland
Wales
Brevig Mission
Teller
King Island
Nome
Gambell
Savoonga
Yukon
Arctic currents
Name
Alaska Coastal Water
Atlantic Water
Beaufort Gyre
Bering Shelf - Anadyr Water
Bering Shelf Water
Siberian Coastal Current


IARPC
NPRB plan
Planned
Sea ice outlook for walrus
NSF, NOAA
NASA
Sea ice thickness
Satellite measurements
ICESat2
FY16
BOEM
Contributes funding for studies on all components
Region-specific, focused on lease sale areas
Sea ice forecasting
seasonal to annual
DoD, DoE, DoI, NASA, NOAA, NSF
FY14 – 17
ONR
Marginal ice zone program
to FY16/17
Oil & gas industry
Environmental monitoring,
JIP, lease-specific
AOOS
AOOS
STAMP
NOAA-RUSALCA
NPRB/NSF
Benthic-pelagic coupling
NSF, AOOS
Ocean acidification
Distributed Biological Observatory
DoD, DoE, DoI, NASA, NOAA, NSF
FY13 - 15
Sea ice
OSRI
1° Production
DoE, DoI, NSF, NOAA, ONR
Develop subsystem models that incorporate
field data, then couple and validate
FY14 – 17
Mostly physical?
2° Production
Benthos
Modeling
USGS, USFWS
Eiders, seabirds, walrus, polar bears
NOAA
Ice seals, whales
Seabirds
Marine Mammals
DoI, DoS, EPA, NSF, NOAA, SI, BOEM
Assess community sustainability & resilience to
determine efficacy of current adaptation strategies
FY13 – 14
(physics and humans, not biology of other trophic levels)
ADF&G
Marine mammal biology & harvest monitoring
Communities
2013 RFP
2015 – 2017 Fieldwork
2018 – 2019 Synthesis
ANOs & Tribal Organizations
SAON
Engage communities as observers for
environmental parameters
>5 yrs
Arctic LCC
Shorebirds, nearshore,
polar bears, communities,
databases, modeling
Coordinating partners
IARPC
USARC
NSSI
NPFMC
PICES
PAG
Scenarios Planning
DoI, NOAA, USCG
Surrogate species
USFWS
For available research infrastructures to leverage with
see p. 83 – 96 in the IARPC 5-year plan

Ocean Ecosystem Research Planning and Outreach

Nora L. Deans, Francis K. Wiese, Tom Van Pelt and Carrie Eischens,
North Pacific Research Board, 1007 West Third Avenue, Suite 100, Anchorage, Alaska 99501 www.nprb.org

Ecosystem Research Planning

Climate change and reduced ice cover could significantly impact the Arctic, Bering Sea and Gulf of Alaska, home to millions of seabirds, fishes, marine mammals and the humans whose ancestors have lived here for thousands of years. **Planning and implementing multi-disciplinary research that addresses these issues and includes stakeholders is integral to the sustainability of our ocean ecosystems.** Each fall, NPRB solicits proposals investigating the research priorities of the NPRB, based on the NPRB *Science Plan* and research needs and priorities of stakeholders, such as resource managers, agencies, fisheries and Alaska communities.

Stakeholder input is gathered through:

- requests for research priorities from national and state agencies and institutions;
- a public web-based interface (http://www.nprb.org/proposals/suggestion.html);
- information gathered at scientific conferences and from peer-reviewed literature;
- the NPRB Advisory and Science Panels and Board members

Successful proposals are chosen based on scientific merit, pressing fisheries and ecosystem management needs and budgetary constraints. At the annual Alaska Marine Science Symposium co-sponsored and organized by NPRB, more than 1,100 researchers come together from all over the world to share their latest findings on research in Alaska's seas.

Integrated Ecosystem Research

NPRB also supports integrated ecosystem research programs to understand how Alaska's marine ecosystems are changing, from benthos to atmosphere and everything in between. Researchers also study the socio-economic impacts of a changing marine ecosystem on humans and communities, incorporating local and traditional knowledge. Currently, NPRB supports a $52 million program in the Bering Sea in partnership with the National Science Foundation involving more than 100 scientists (beringnprb.org), and one focused on the Gulf of Alaska with NOAA and other partners (www.gulfofalaska.org) with more than 40 scientists working across disciplines. To ensure synthesis across disciplines, and between observational and ecosystem modeling scientists, researchers meet annually.

Communicating Ecosystem Research

Communicating about how we are learning about the changes that scientists and Alaska Natives are witnessing firsthand is the subsequent challenge when talking about such complex marine ecosystems. NPRB starts by putting faces on the stories, knowing that many people relate to other people more easily than to concepts. Among lessons learned, NPRB has found that when field scientists share the excitement and obstacles of conducting research in remote, icy seas firsthand, via web blogs and multimedia and visits to coastal communities, their stories grip the attention of diverse audiences, inspiring interest in these remote seas and giving scientists new tools for communicating about science.

The mission of the North Pacific Research Board is to build a clear understanding of the North Pacific, Bering Sea, and Arctic Ocean ecosystems that enables effective management and sustainable use of marine resources.

Sharing Research

We've created a multi-faceted program to share our stories using a variety of media:

- **Websites for NPRB and ecosystem programs**
- **Scientists' blogs, tweets, photography galleries**
- **Podcasts, Google Ocean, Twitter**
- **Publications**
- **Research at a glance (synopses)**
- **Magazine-style research summaries**
- **Posters**
- **Displays**
- **Newspaper articles**
- **Press clippings**
- **National TV broadcasts**
- **Film**
- **Videos**
- **Photographers and artists**
- **Radio journalists**
- **Science writers**
- **Community events**
- **Teachers at sea**

Communication


North Pacific Research Board
Project Synopsis

PROJECT 312

Ice seal bio-monitoring in the Bering-Chukchi Sea region

ICE SEALS: COOL CRITTERS

WHY WE DID IT

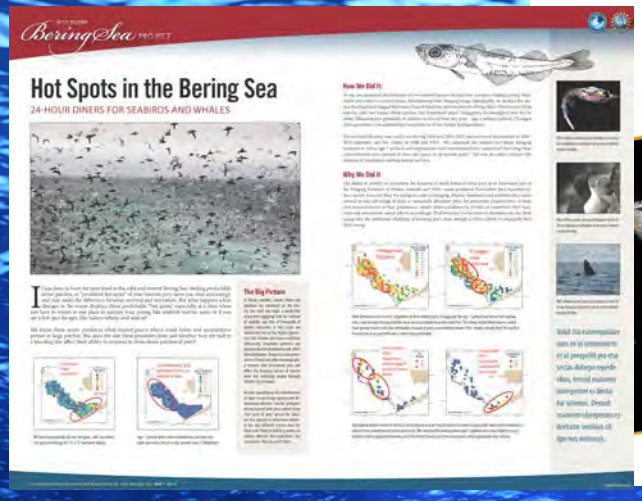
HOW WE DID IT

The Big Picture

This study found that ice seal populations in northern Alaska are in relatively good health, with high reproductive rates and seemingly stable populations. Ice seals are important to Native communities in coastal Alaska and to the marine ecosystem. By working with local communities, we can monitor the status and health of these seal populations.

NPRB Research Interest

Our research addressed NPRB's interest in understanding the trophic level dynamics of the Bering and Chukchi seas. Changes in the persistence and distribution of sea ice are likely to be shown by changes in seal distribution, condition and/or


Bering Sea Project

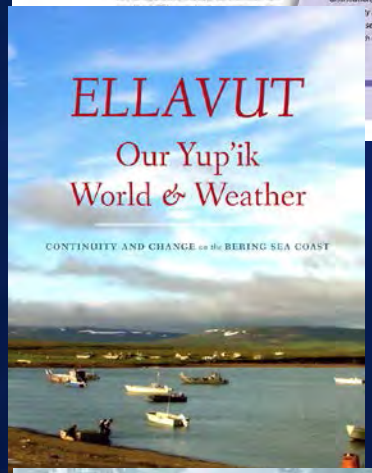
Hot Spots in the Bering Sea

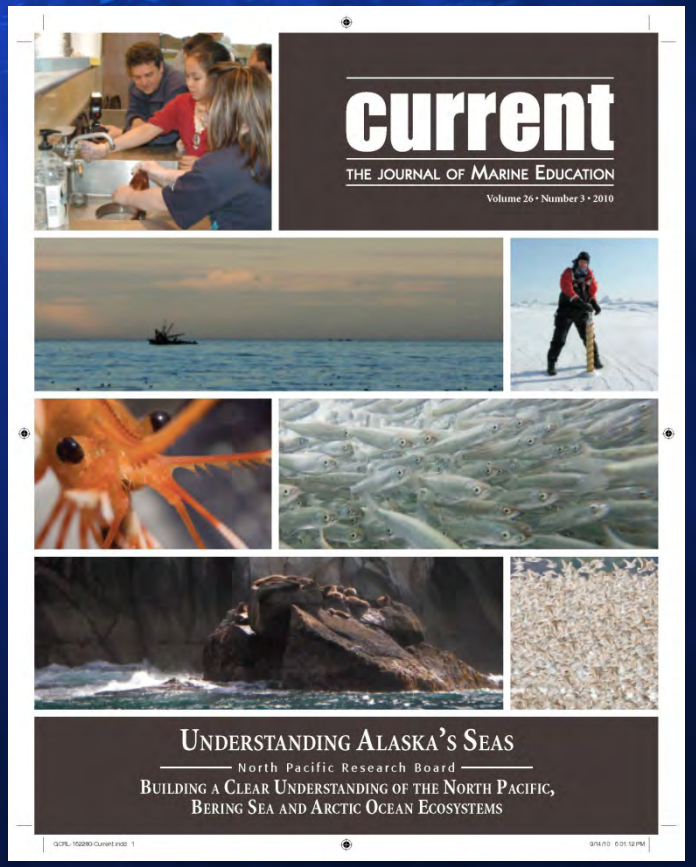
24-HOUR DINERS FOR SEABIRDS AND WHALES

How We Did It

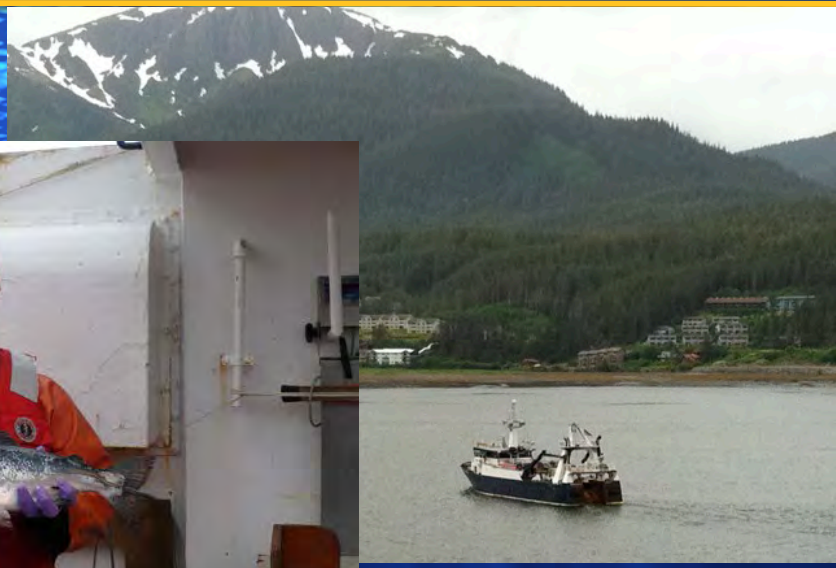
Why We Did It

The Big Picture





Field Research Blogs



The Bering Sea Ecosystem Workshop

A Model for Transforming Ecosystem Science into Educational Resources

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ECOSYSTEM WORKSHOP MODEL

Bering Sea Project Outreach

In October 2010, the North Pacific Research Board (NPRB) partnered with three other organizations – Alaska's Center for Ocean Sciences Education Excellence (COSEE-Alaska), the Arctic Research Consortium of the U.S. (ARCUS) and the Monterey Bay Aquarium Research Institute (MBARI) EARTH program – to bring together 15 teachers and scientists for a professional development workshop to share the outcomes of the Bering Sea Project. This landmark, $56 million ecosystem study is a partnership between NPRB and National Science Foundation (NSF) with inkind support from NOAA, U.S. Fish and Wildlife Service and others (http://beringnprb.org).

Educators from all over the country and in remote communities participated in the field seasons of the six-year study, working side-by-side with scientists through the PolarTREC (Teachers and Researchers Exploring and Collaborating) and NOAA Teacher-at-Sea programs.

Integrated Approach

Reflecting the integrated nature of the study, we worked across our organizations to convene Bering Sea Project scientists and educators, including those from Alaska coastal communities to:

- **Share study outcomes**
- **Engage scientists in outreach**
- **Enrich educators' understanding of Alaska's seas**
- **Create educational resources**
- **Help educators integrate western science with traditional knowledge**

We used the Bering Sea Project scientific hypotheses as a guide, and drew upon the model of the Monterey Bay Aquarium's EARTH workshops (http://www.mbari.org/EARTH/), which uses data in the classroom. Educators and researchers presented to and learned from each other. Specifically:

- **Scientists shared ecosystem study hypotheses and findings and collaborated on resource development;**
- **Educators shared insights with scientists on how to communicate with students and the public; and,**
- **A scientist who is also an educator facilitated the workshop, working across disciplines and between the scientific and educational cultures.**

OUTCOMES

Working side-by-side, scientists and educators created resources that bring research into classrooms. These online resources can be utilized by educators in classrooms throughout the United States.

Impacts on Scientists

The researchers learned how to communicate with educators and students and watched the interest in their research blossom among teachers. Many created lasting partnerships, leading to repeat classroom and community visits and sustaining collaborations, including participation in St. Paul's annual Bering Sea Days science outreach event on the Pribilof Islands. In the words of one of the scientists:

"What surprised me… the teacher presentations were a whole lot more engaging than the scientists."

Impacts on Teachers

Teachers and informal educators found great value in these first-hand learning experiences with scientists. Educators took the scientists' datasets and the deeper content knowledge they gained and refined existing lessons or created new educational materials. Teachers who had participated in a single research project with a scientist onboard a research cruise broadened their understanding to encompass the interdisciplinary and modeling approaches and results of the ecosystem study.

Educators were also able to combine place-based and culturally relevant perspectives of those teaching in Bering Sea communities with the perspective of what would be engaging to students in other parts of the U.S. They also formed partnerships that continued after the workshop, including an exchange between students on St Paul and students on the island of Maui, Hawaii, which culminated in the St. Paul students making a field trip to Hawaii. In the words of the educators:

"The follow-up discussion with the scientist was most helpful in understanding more about their research and findings."

"They gave me new ways to help summarize their work to a variety of kids…"

RESOURCES

Educational resources created during the workshop were posted as a comprehensive Bering Sea Ecosystem Collection hosted through ARCUS' PolarTREC Learning Resources database at http://www.polartrec.org/collections/bering-sea-ecosystem.

We shared the workshop as a model with more than 2,500 educators and scientists through a special issue of the peer-reviewed journal *Current: Journal of Marine Education*: Volume 27 Number 1, Spring 2013, available through the National Marine Educators Association.

We also presented the results during the 2011 Alaska Marine Science Symposium. Formal workshop evaluation reports are posted on the COSEE-Alaska website at http://www.coseealaska.net/resources/coseepublications/.

EXTENDING THE MODEL

To help scientists share ocean research ongoing in Alaska's vast marine ecosystems – the Arctic Ocean, Bering Sea/Aleutian Islands and Gulf of Alaska – we refined the initial workshop model and brought together regional partners.

Gulf of Alaska

We expanded the model to the Gulf of Alaska Project (http://gulfofalaska.nprb.org) during the summer of 2011. Twenty-two educators, including informal educators, traveled to a remote research lab as part of an official EARTH workshop. The resulting online resources are posted at the website http://www.mbari.org/earth/2011/EARTH2011.html and were shared in a presentation given at the 2012 Alaska Marine Science Symposium.

Arctic

A workshop focused on the Arctic Ocean ecosystem will be held in Barrow in May 2012, with a focus on Arctic research and traditional knowledge, building upon the North Slope Borough's landmark curriculum that incorporates an Inupiaq learning framework.

Working side-by-side, scientists and educators created resources that bring research into classrooms.

Integrated Approach to Outreach for Ecosystem Research

NPR Encounters Radio Program

Arctic Ecosystem Teacher Workshop in Barrow May 19-23, 2012 Traditional Knowledge

Lessons Learned

Planning:

- Clear tangible scientific goals
- If applied science: include stakeholders in program design/implementation as early as possible
- Leverage: $
- Integration as part of design
- Manage expectations
- Ecosystem science implementation: an experiment!

Implementation:

- Integrated review – components match objectives
- Central program office
- Data Management critical and always slower and more expensive than you think
- Democratically elected leads (e.g. SAB, GABI)
- You need one or more intellectual heroes
- Face time, social events

Lessons Learned

Communication

- Make it fun and attractive and people will want to be part of it
- Facilitate frequent internal communications (SharePoint, Facebook, Listserver, PI calls, etc.)
- Report out to funders, stakeholders, public and science community
- Tell stories

Synthesis

- Part of initial funded design
- Synthesize as you go: YEAR1! – staggered approach
- Circle back to beginning objectives (e.g Road Map)
- Close-out Plan

What do we really need to further our understanding?


Thank you