



We Are Watching!
The Long-term Monitoring Program of the
***Exxon Valdez* Oil Spill Trustee Council**

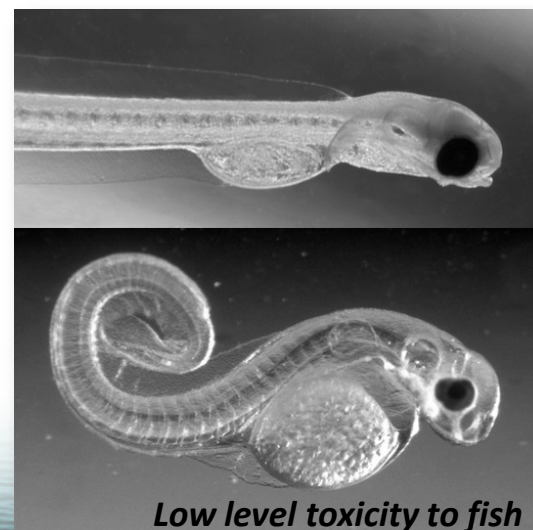
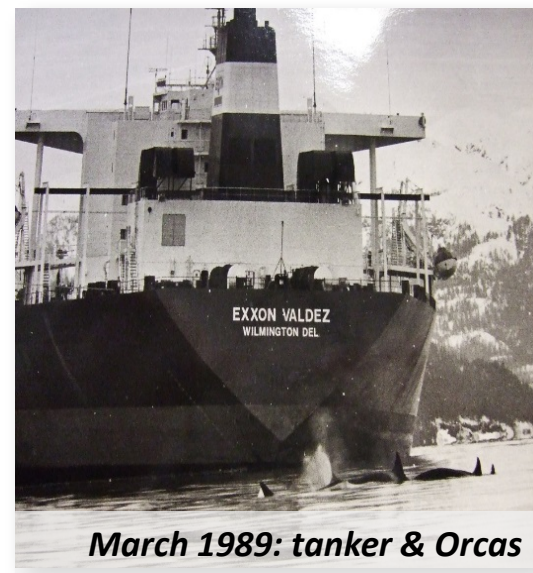
Mandy Lindeberg – NMFS AFSC Auke Bay Laboratories



EVOSTC: A Legacy of Significant Science and Ecosystem Approach

History of Funded Science:

- Injury assessment studies
- Recovery studies
- Ecosystem programs (SEA, APEX, NVP)
- Herring Research & Monitoring
- GOA Long-term Monitoring
Gulf Watch Alaska





Gulf Watch Alaska Program

Overall Goal: Provide sound scientific data and products that inform management agencies and the public about the EVOS-affected regions of the GOA

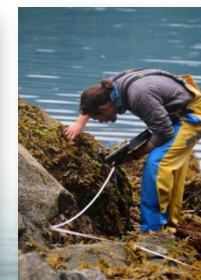
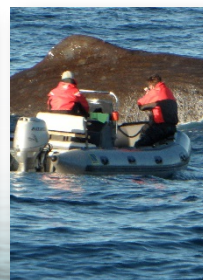
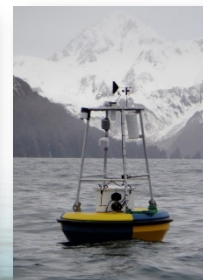
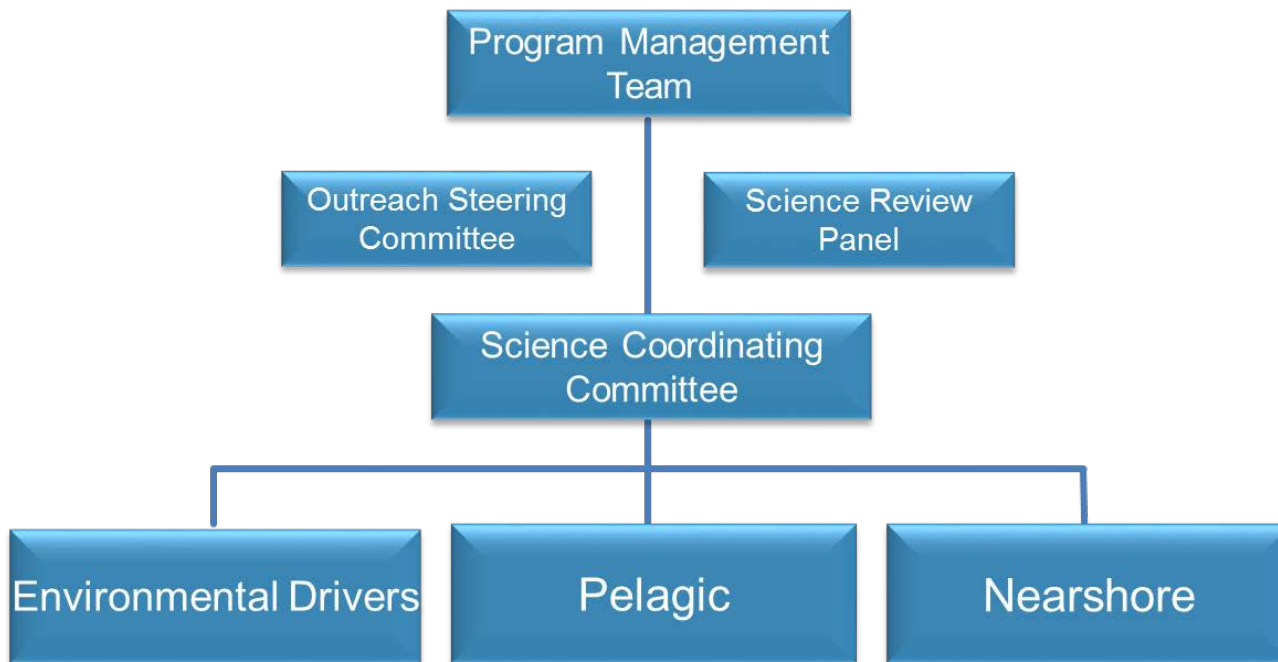
- Objectives:**
- Sustain and build upon existing time series data in EVOS-affected region
 - Monitor key ecosystem components and their potential impacts to injured resources
 - Make current and historical ecosystem data readily available to a wide variety of users
 - Develop science synthesis products to support decision making by management agencies and the public
 - Communicate with regional partners, tribal villages, and management agencies





GWA Program Organization

An Integrated Ecosystem Approach





GWA Components and Scientists

Gulf Watch Alaska Ecosystem Components

Environmental Drivers

- **GAK-1** – Danielson, Weingartner
- **Seward Line** – Hopcroft, Coyle
- **Prince William Sound** - Campbell
- **Kachemak Bay** – Holderied, Shepherd
- **Cont. Plankton Recorder** - Batten

Pelagic Ecosystem

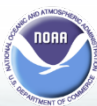
- **Killer Whales** – Matkin
- **Summer Marine Birds** – Kuletz, Kaler
- **Forage Fish** – Arimitsu, Piatt
- **Humpback Whales** – Moran, Straley
- **Winter/Fall Seabirds** - Bishop

Nearshore Ecosystem

- **PWS, Kenai Penin., Kachemak Bay, Katmai**
- **Status of >200 species** – e.g. sea otters, nearshore birds, oyster catchers, intertidal organisms
- Coletti, Esler, Kloecker, Monson, Weitzman, Konar, Iken.

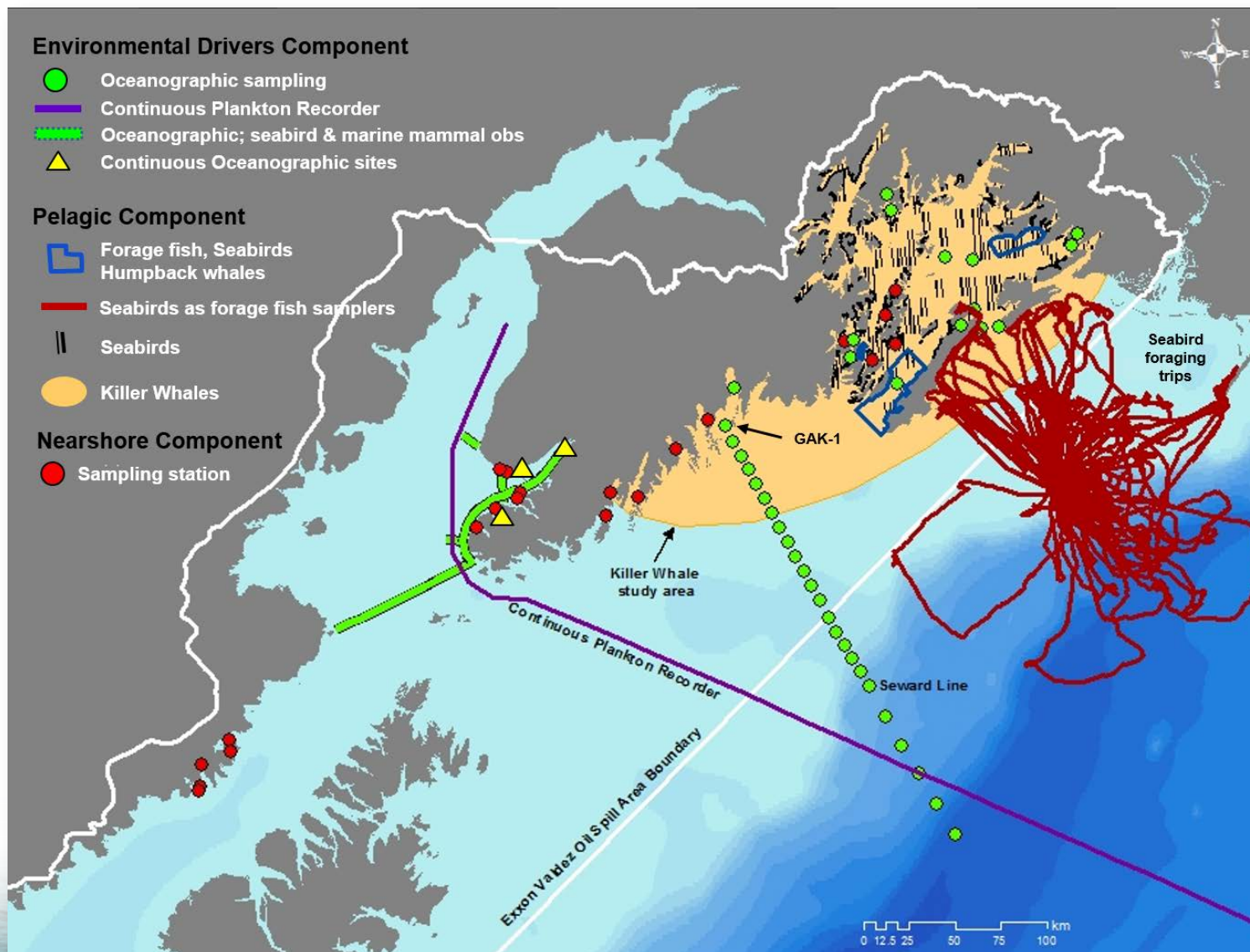


Sir Alister Hardy Foundation for Ocean Science





GWA Monitoring Locations





Environmental Drivers:

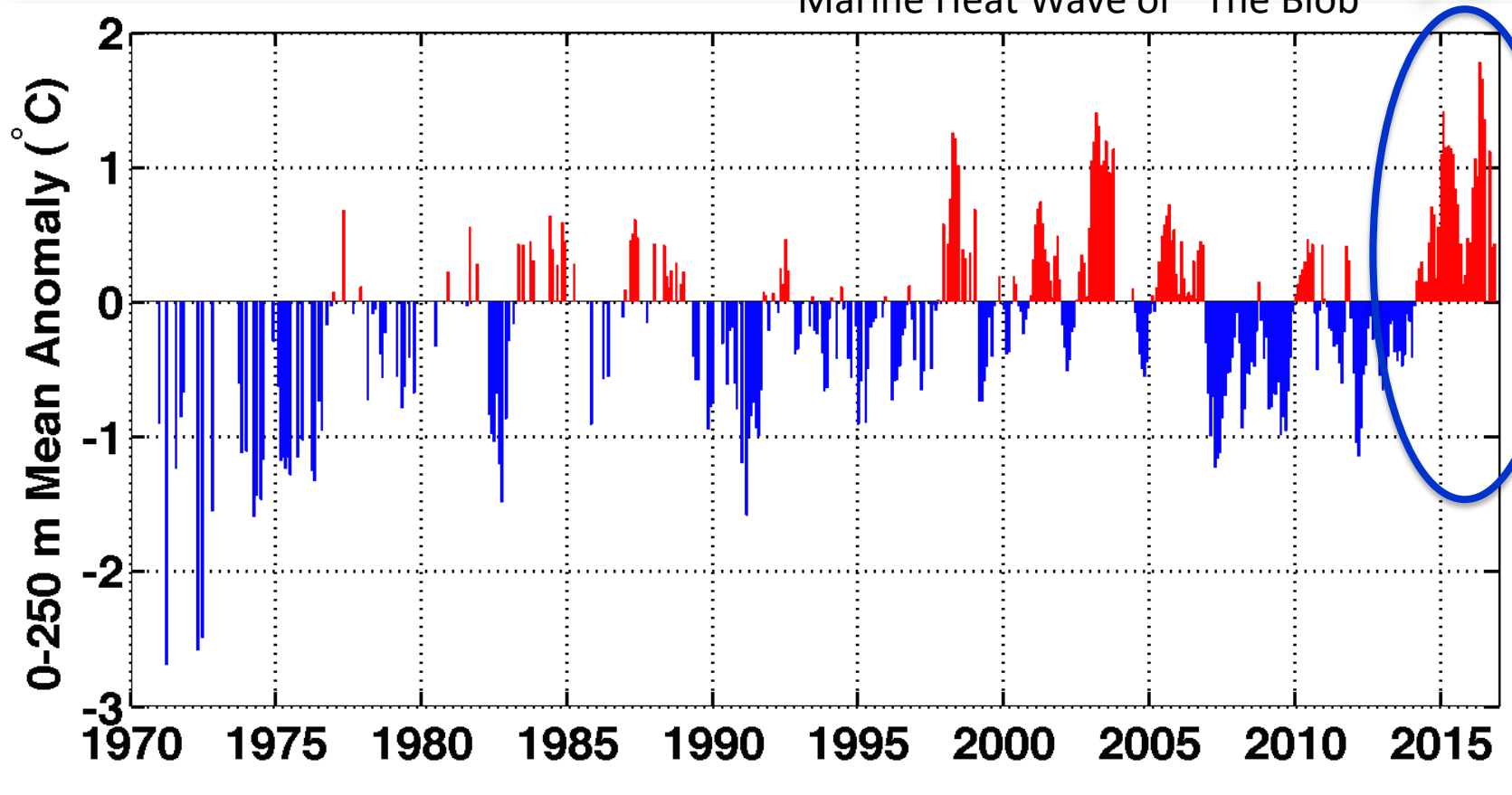
GAK 1 – S. Danielson, T. Weingartner



SHELF:

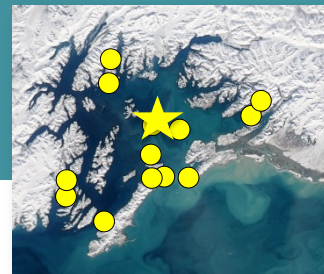
Water Column Temperature Anomaly 1970-2016

Marine Heat Wave or "The Blob"

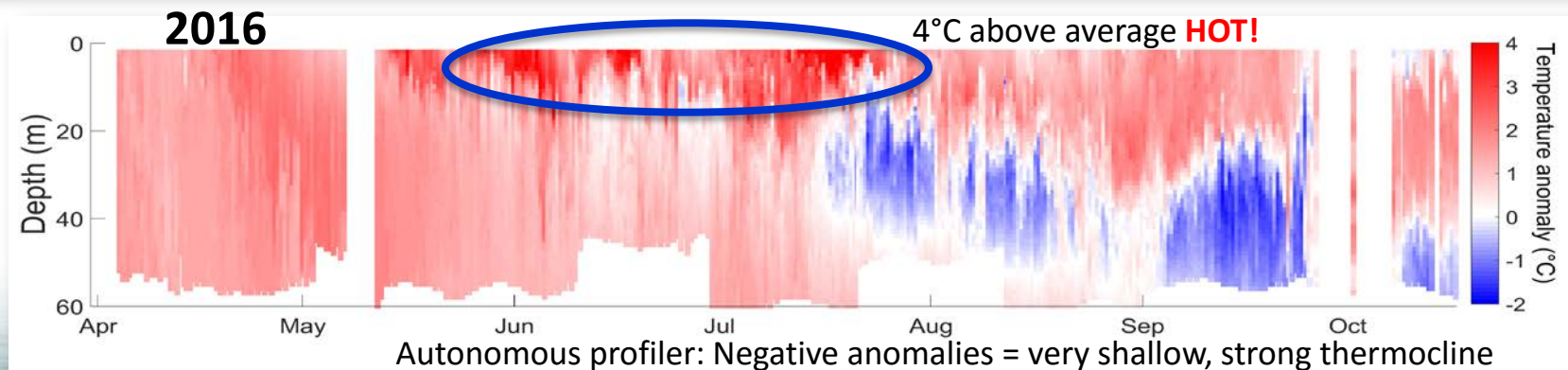
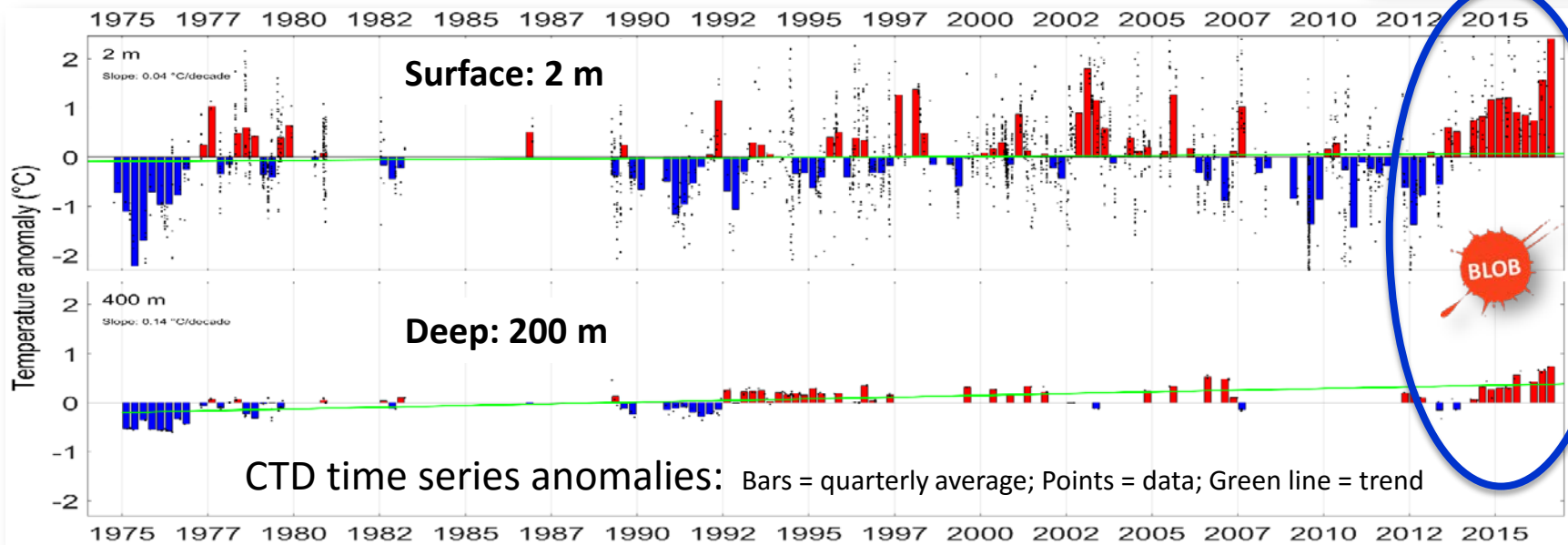




Environmental Drivers: PWS oceanography – R. Campbell



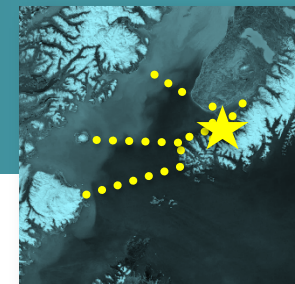
INSIDE WATERS: Temperature Anomalies





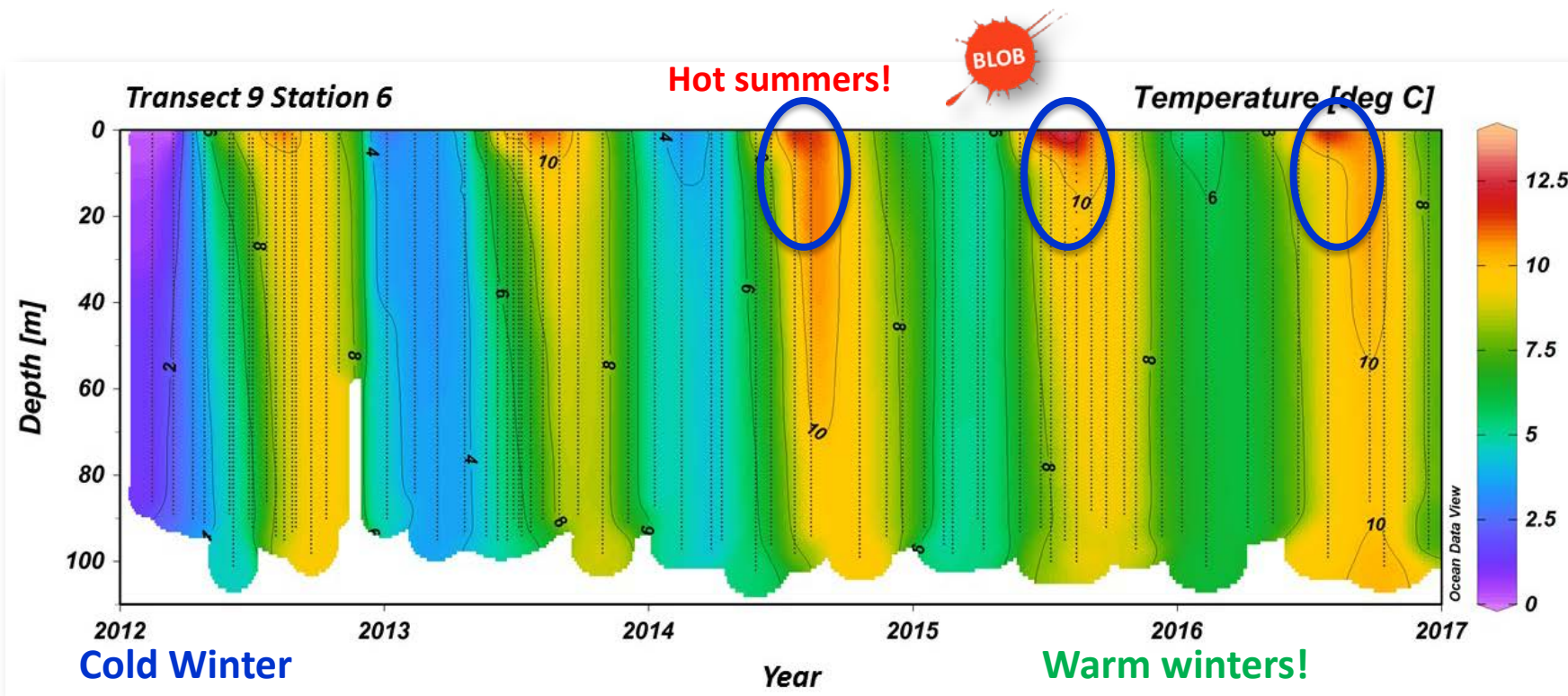
Environmental Drivers:

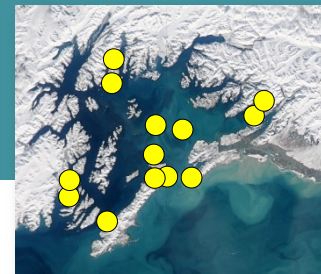
Lower Cook Inlet & Kachemak Bay - Doroff, Holderied



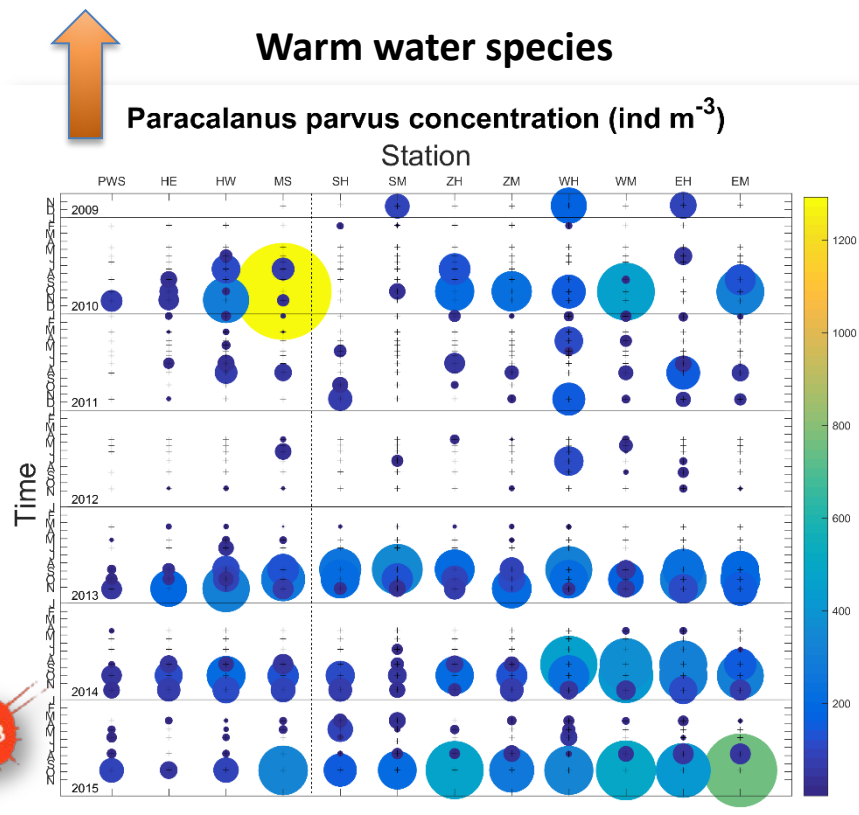
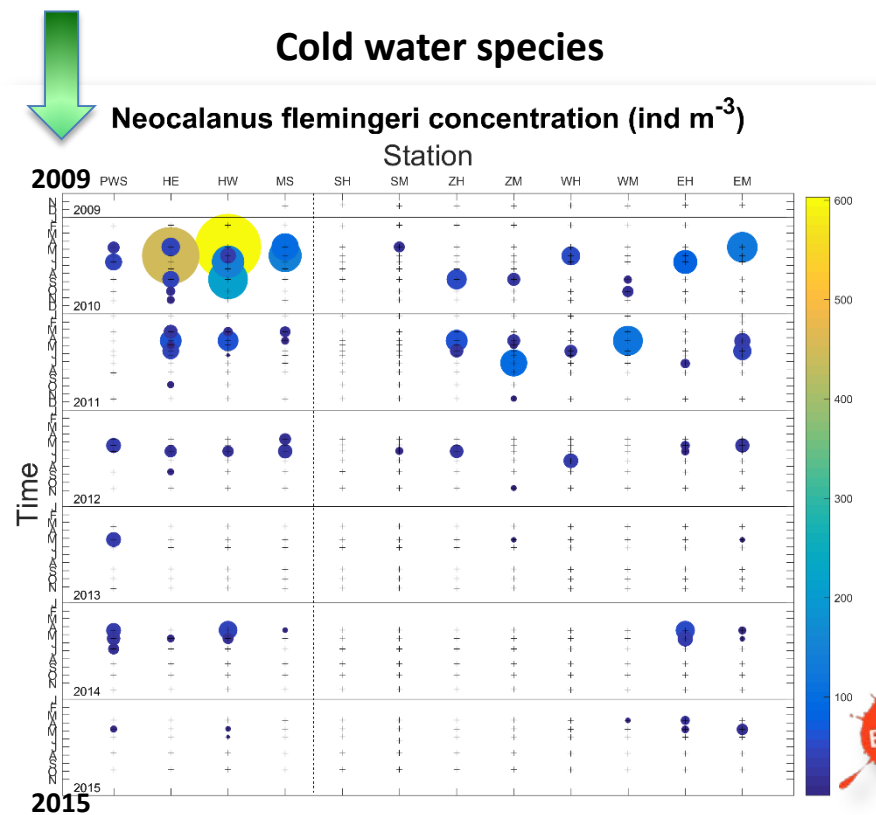
INSIDE WATERS:

2012-2016 Kachemak Bay Water Temperature Profiles





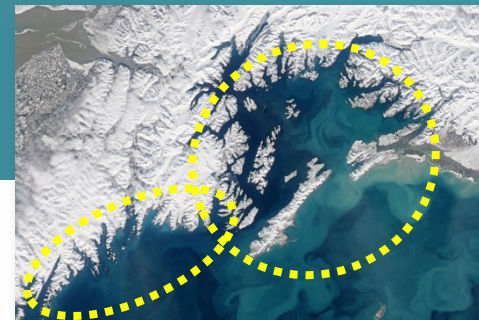
INSIDE WATERS: Change in Plankton Assemblages (2009-15)



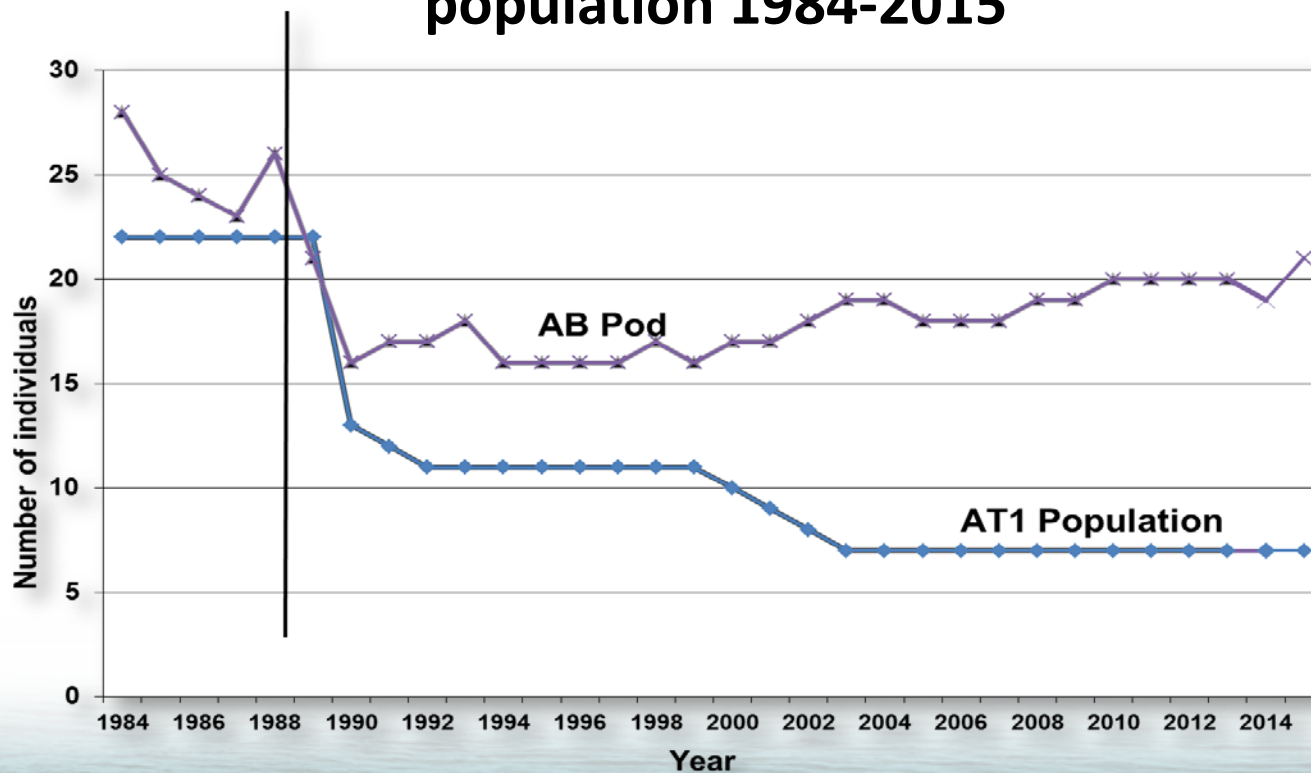
Note: a few examples, but many changes in many species



Pelagic Ecosystem: Killer Whales – *Matkin & Olsen*

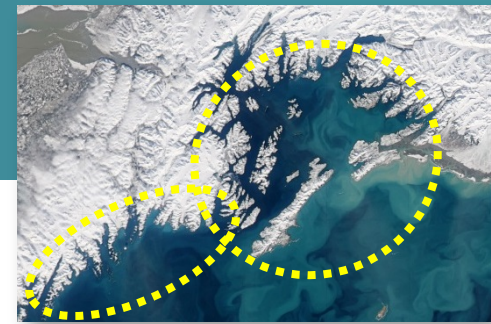


Numbers of whales in AB pod and AT1 population 1984-2015





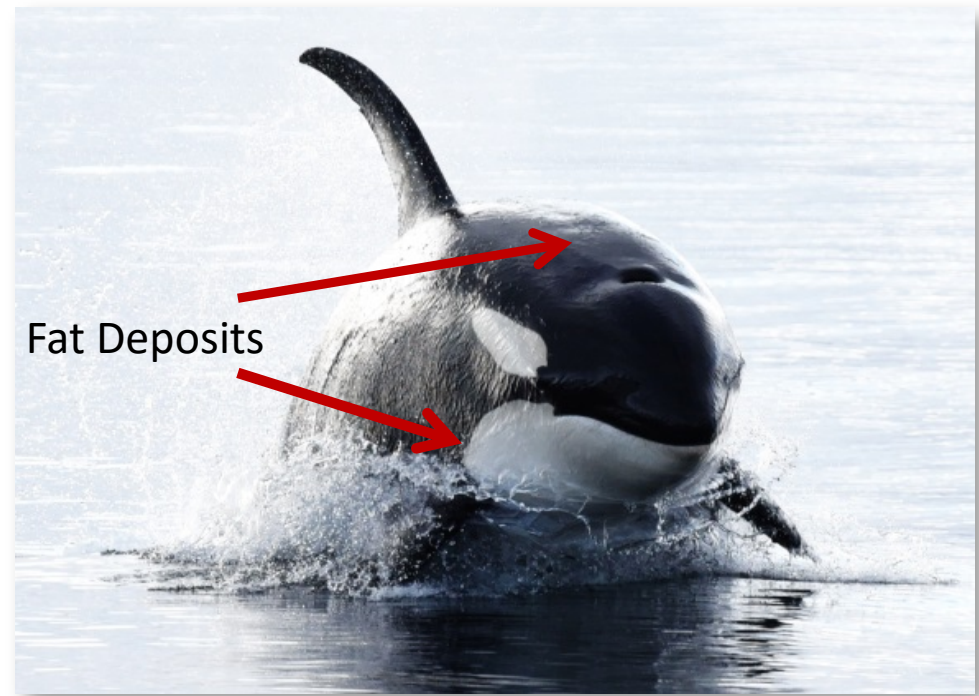
Pelagic Ecosystem: Killer Whales – *Matkin & Olsen*



Recent Observations

Feeding conditions:

- 2015 Coho up – whales with “doughnut” heads (fat), socializing
- 2016 Coho down – whales not so fat, no fall social groups, likely feeding out of PWS/KF, over at Copper River





Pelagic Ecosystem:

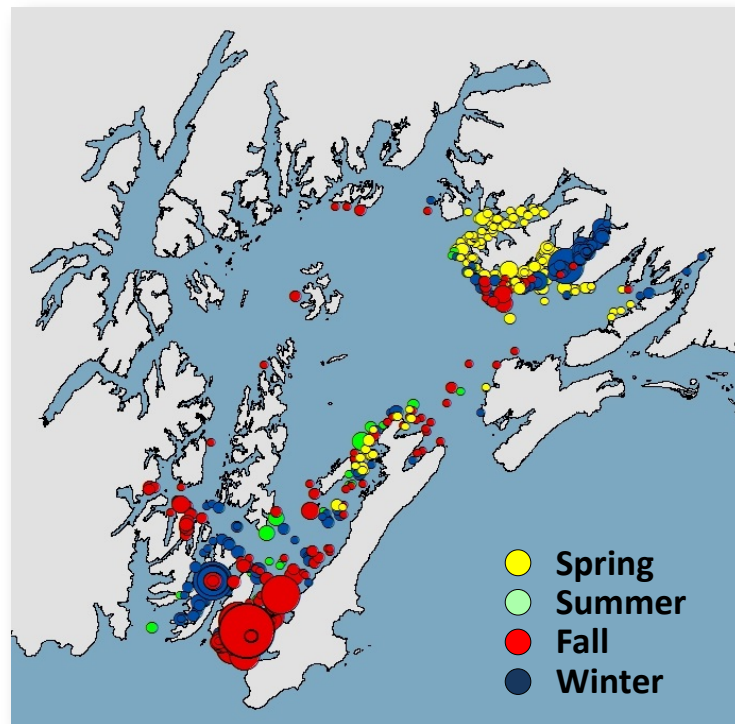
PWS Humpback whales – Moran & Straley



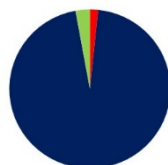
Abundance, Distribution, and Diet



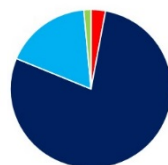
- Preliminary population estimate of 465 (95% CI; 405-552)
- Movements follow herring, primary prey
- Herring failing, whale diet changing
- May be reaching carrying capacity



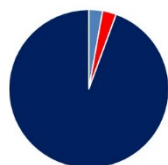
- Herring
- Krill
- Pollock
- Unknown
- Forage fish (may include herring)
- Unknown Zooplankton



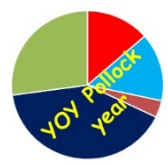
2007



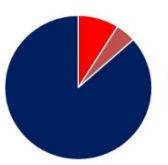
2008



2011



2012



2013



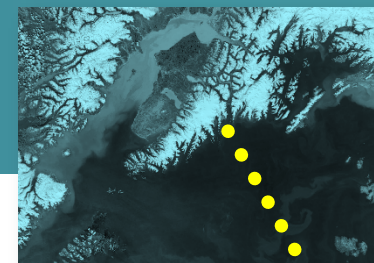
2014



2015



Pelagic Ecosystem: Marine Birds – Kuletz & Kaler



SHELF: Seward Line & PWS 2007-2015

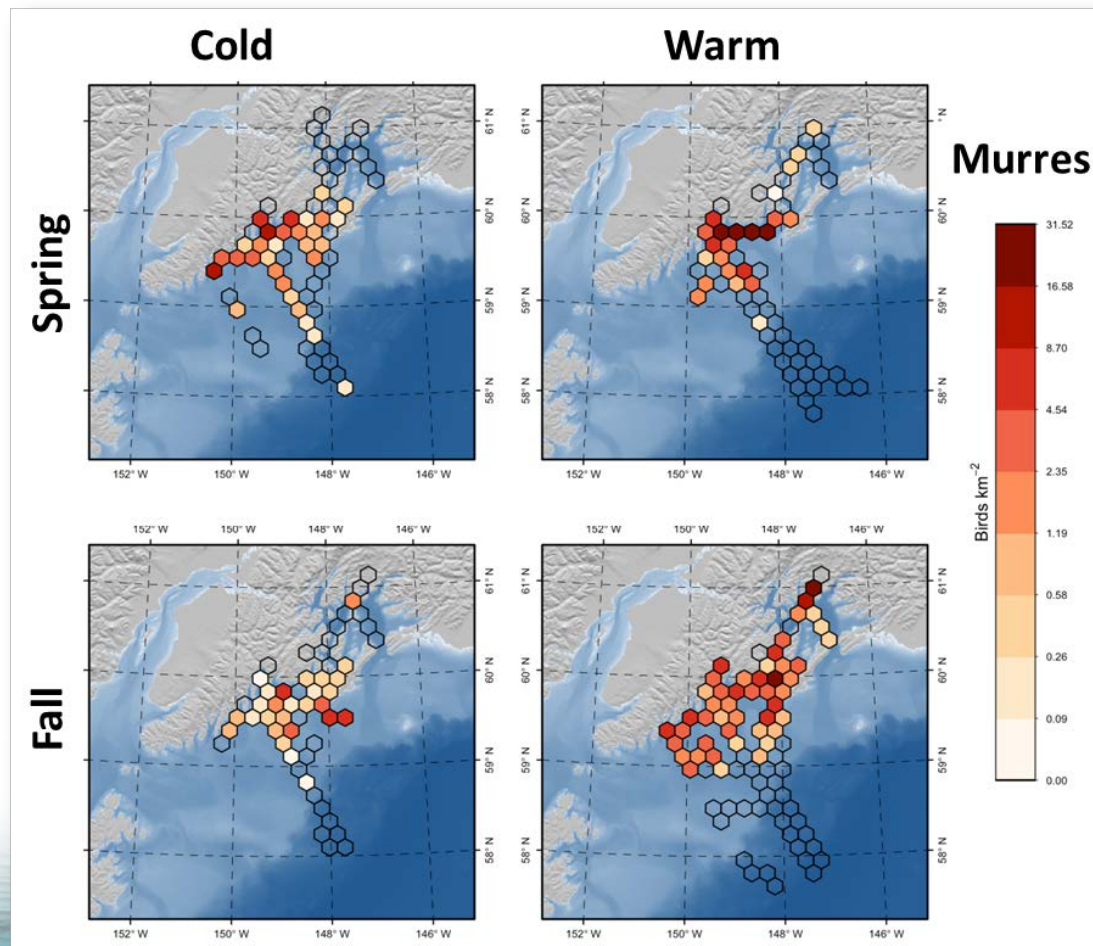
Shifts in seabird distribution under different temperature regimes

All species

- **Warm** = Higher densities; fall
- **'Inshore'** seabirds most influenced by GOA conditions
- **'Offshore'** species always in Outer/Off-shelf (fulmars, storm-petrels, albatrosses)



T. Zeller, USFWS





Pelagic Ecosystem:

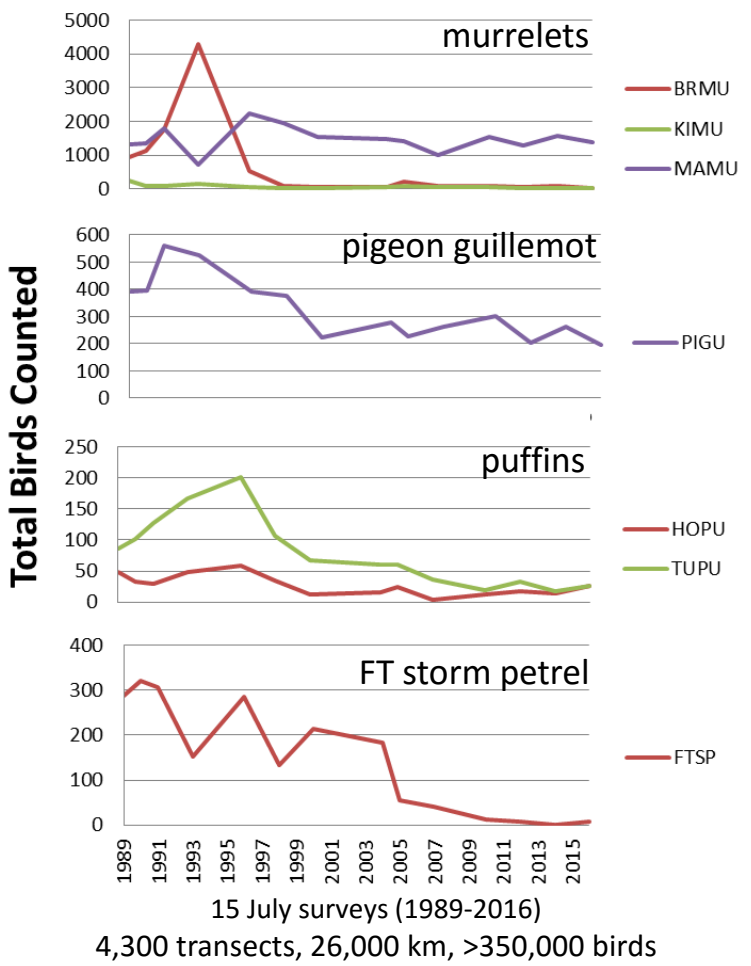
PWS Marine Birds – *Kaler, Kuletz, Cushing, Labunski*



INSIDE WATERS: Summer Marine Bird Surveys

Pelagic foragers declining

Recent Observations:



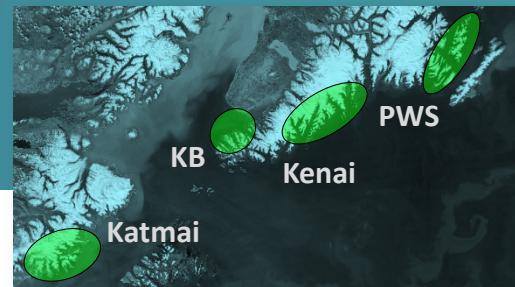
- 2014, 2016 marine bird survey data followed trends, pelagic species numbers remained low since at least 2005
- Largest murre wreck ever reported in AK, 2015-2016
- Complete reproductive failure of PWS Black-legged Kittiwake in 2016, not seen in 32 yrs (D. Irons, unpubl data)



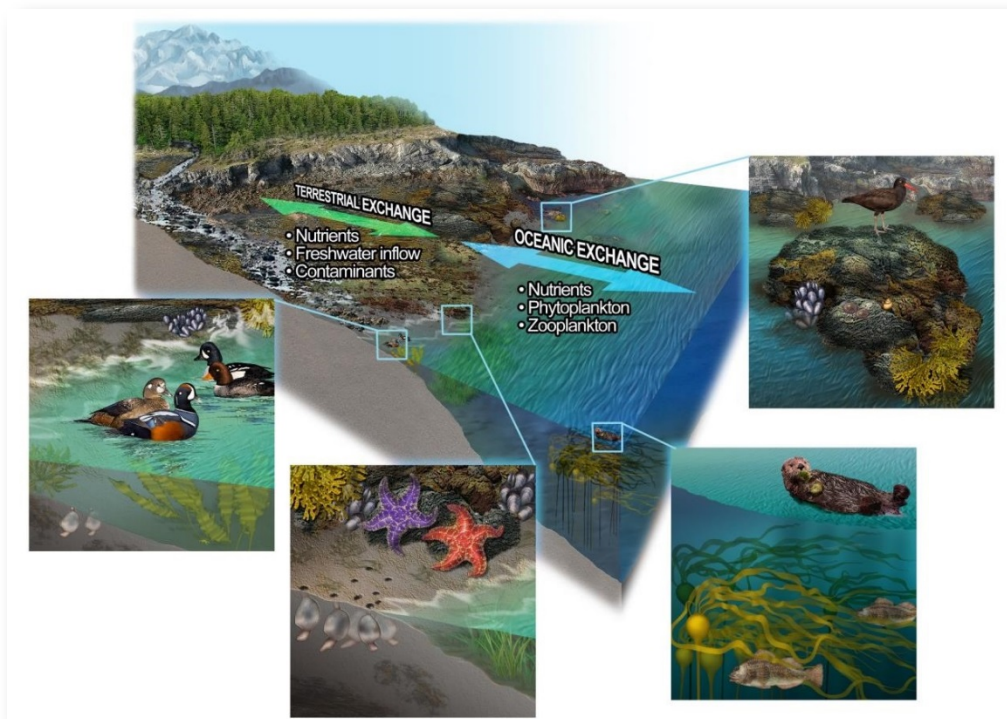


Nearshore Ecosystem:

Coletti, Esler, Iken, Kloecker, Konar, Monson, Weitzman, Bodkin, and Ballachey



Patterns in the Nearshore



Spatially nested design:

To determine if changes are due to local, regional, or broad GOA-wide drivers

Monitoring the Nearshore Food Web

Nearshore Predators

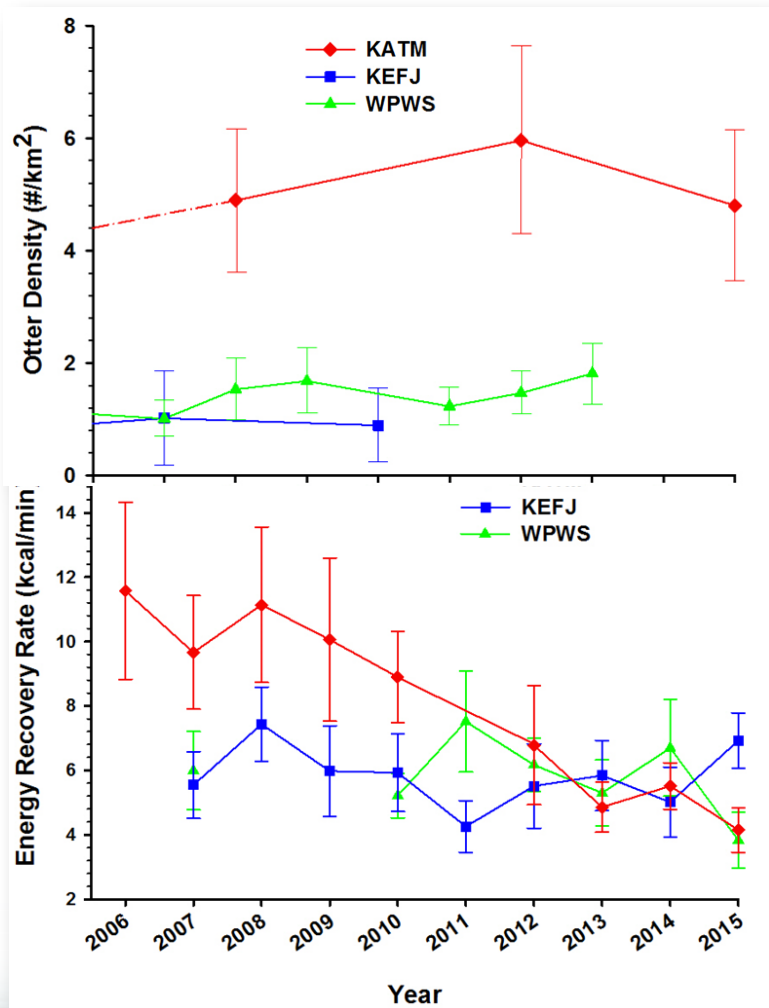
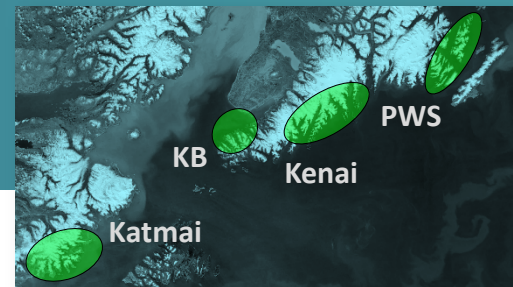
Primary Benthic Consumers

Primary Producers

Environmental Variation

General findings: Patterns of variability differed across metrics, with some fluctuating synchronously at broad spatial scales and others showing site-specific variation

Nearshore Ecosystem:

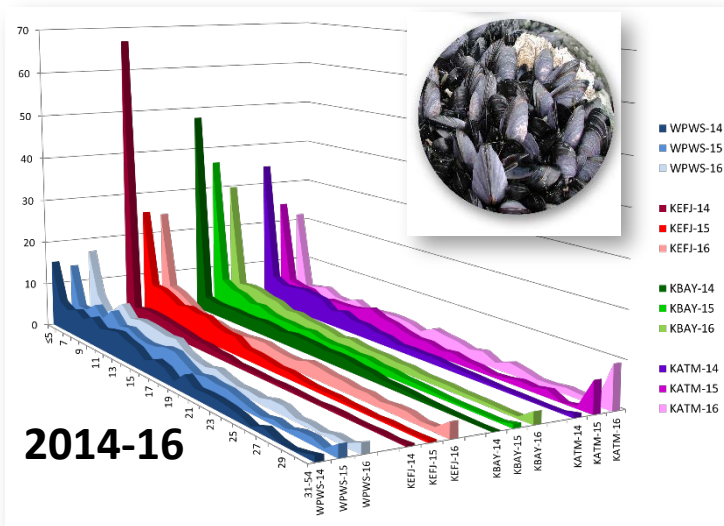


e.g. Patterns of a Major Predator: Sea Otters (2006-2015)



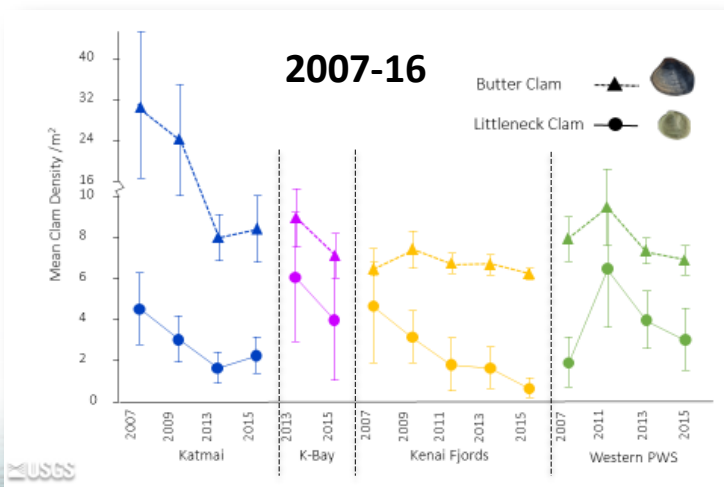
- **KATMAI** densities have increased with declining energy recovery rates, suggesting a food-limited state.
- **KENAI** densities and energy recovery rates have been stable, indicating population at carrying capacity
- **PWS** pre-spill; may be reaching carrying capacity

Nearshore Ecosystem:



e.g. Patterns of Primary Benthic Consumers

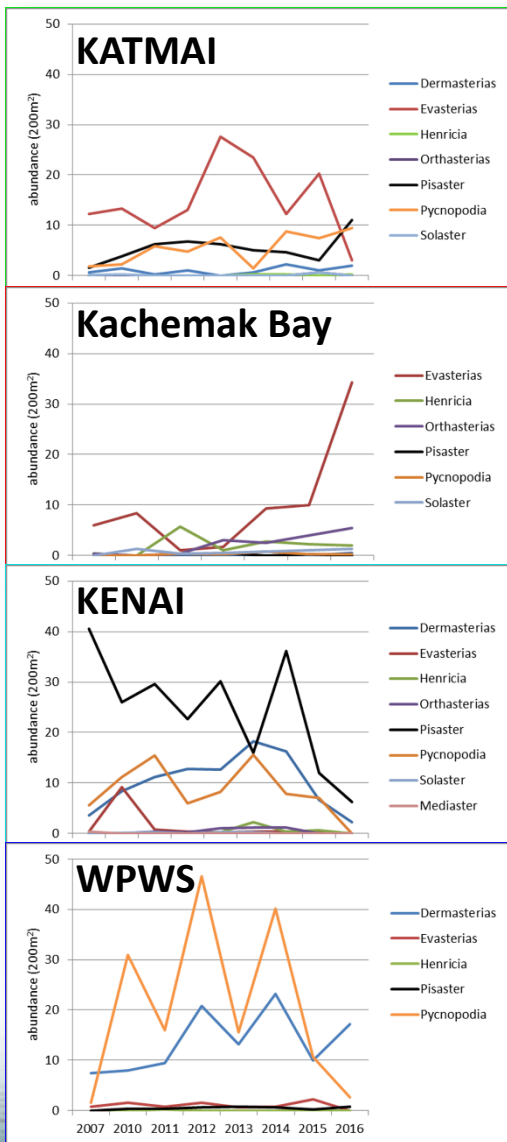
- **Mussels**
factors operating across the northern GOA and local drivers were affecting mussel survival and subsequently abundance



- **Clams**
In general densities are declining in all regions but they are known to be highly variable, influenced by both top-down and bottom-up drivers



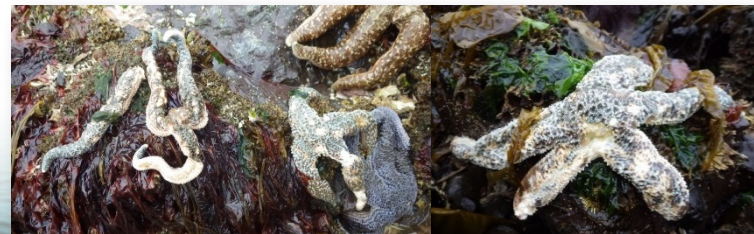
e.g. Patterns of a Benthic Apex Predator - Sea Stars



- **KATMAI** dominated by *Evasterias* in all years except for the last sampling year (2016).
- * **KACHEMAK BAY** had overall low densities in the early years but later, *Evasterias* became the dominant genus.
- **KENAI** had the highest diversity of sea stars of all the regions, dominated by *Pisaster* in most years but all were declining over time.
- * **Western PWS** had the lowest diversity of sea stars.



* Sea Star Wasting Disease



Recap of Findings

2014-2016: Marine Heat Wave

- **ENVIRONMENTAL DRIVERS:**
 - Temperature – warm water anomaly present throughout all GWA regions, to depth
 - Primary productivity – decline of cold water species, warm water species persist
- **PELAGIC ECOSYSTEM:**
 - Declining populations – seabirds, forage fish
 - Change in behavior, distribution, diets
 - Die offs and Unusual Mortality Events
- **NEARSHORE ECOSYSTEM:**
 - Highly variable patterns among key trophic species driven by local and Gulf-wide influences
 - Disease – sea stars coincides with heat wave



Scientists affectionately call the marine heat wave the “Warm Blob”



Watching, Collaborating



Alaska Regional Stranding Network

"Gulf Watch Alaska has provided invaluable assistance to the NOAA Fisheries Alaska Region Stranding Network. In the summer of 2017, separate crews collected photos, measurements and samples from two stranded humpback whales in geographically challenging locations in Prince William Sound.

In view of the 2015 Large Whale Unusual Mortality Event as well as ongoing shifts in the marine environment, tracking and collecting data from stranded large whales has become of even greater importance, and the efficient and thorough data collection of the Gulf Watch crews was deeply appreciated."



Scientists conducting necropsy on humpback whale

Mandy Migura and Dr. Kate Savage
NOAA NMFS Alaska Region Stranding Coordinators



Watching, Collaborating



New Sighting!

"Thanks to NOAA Alaska Fisheries Science Center, the EVOSTC, and the Prince William Sound Science Center for providing fast-track funding and logistics that made it possible to have a seabird observer onboard the NOAA R/V Oscar Dyson Juvenile Walleye Pollock and Forage Fish Survey. "

An unusual observation resulted from the survey, the first record of a Nasca booby in Alaskan waters, typically only seen in the southeastern Pacific Ocean."

Dr. Kathy Kuletz

USFWS Migratory Bird Management

Supervisory Wildlife Biologist / Seabird Coordinator



A Nasca Booby (*Sula granti*) first sighting approximately 20 km east of the Barren Islands, Alaska. August 2017.



GWA Data and Publications

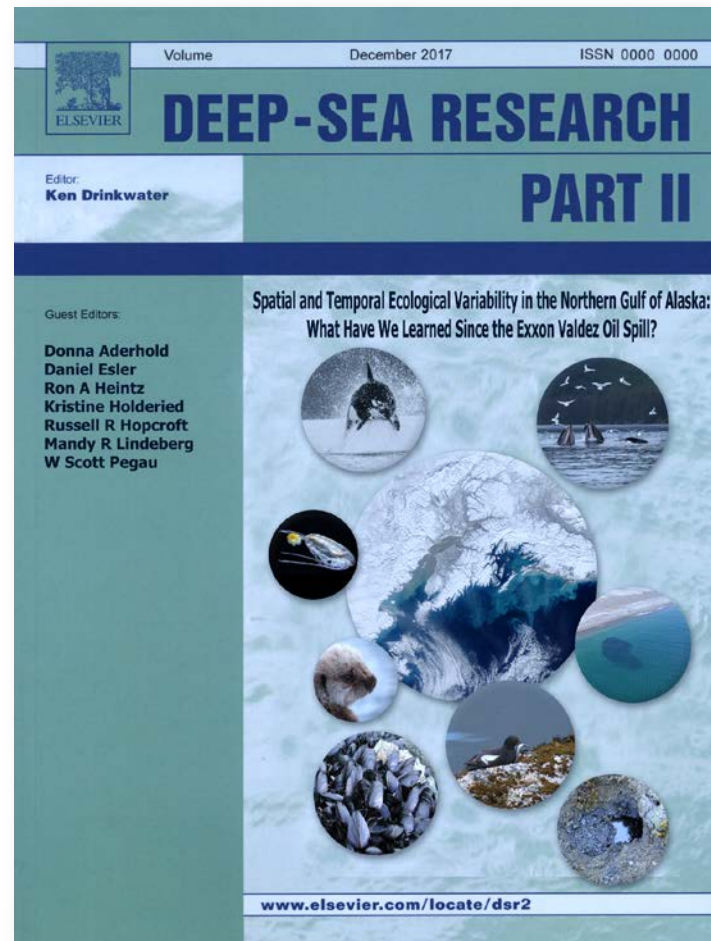
Special Issue Forthcoming:

Spatial and Temporal Ecological Variability in the Northern Gulf of Alaska: What Have We Learned Since the Exxon Valdez Oil Spill?

- 19 Peer Reviewed papers
- GWA and HRM contributions
- Special issue release Jan. 2018.

Published Datasets:

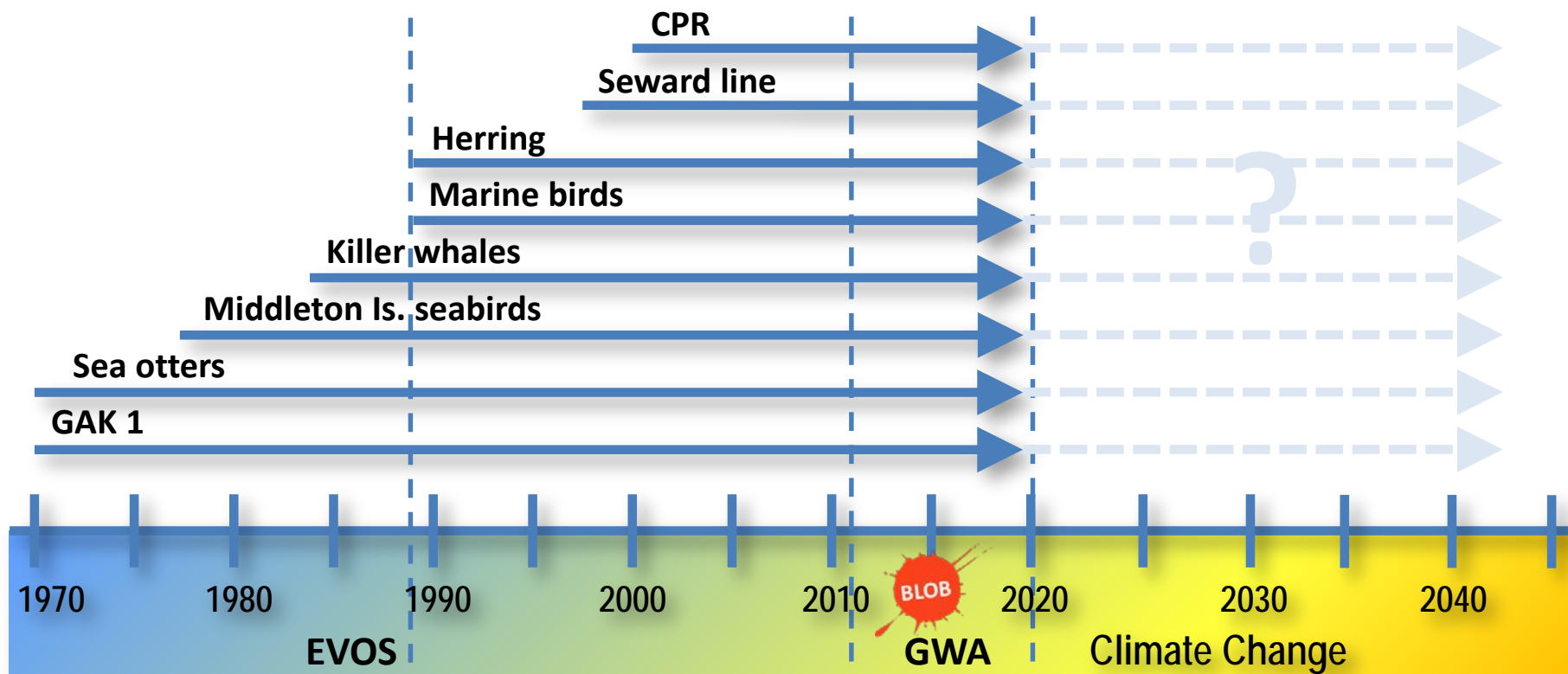
- 45 datasets publicly available through DataONE online





GWA and Future Monitoring

Legacy Datasets in the Northern GOA



Uniquely situated to capture change at multiple ecosystem levels

“We are now monitoring the unusual”



GWA Crew

Thank You!

