How do we make fisheries management most resilient to future environmental change?

NOAA FISHERIES

Alaska Fisheries Science Center

Seattle, WA

Alan Haynie (with help from the BSIERP / ACLIM Teams)

Office of Science & Technology
Economics & Human Dimensions Program Review

Wednesday, September 27, 2017

Overview

- Bering Sea Project (BSIERP)
- Lessons from BSIERP
- Alaska Climate Integrated Modeling (ACLIM) Project
  - Conceptual model
  - Model integration
  - Socio-economic scenarios

The Bering Sea Integrated Ecosystem Research Program (BSIERP)

Not just a march to the north:

How climate variation affects the Bering Sea pollock trawl and Pacific cod longline fisheries

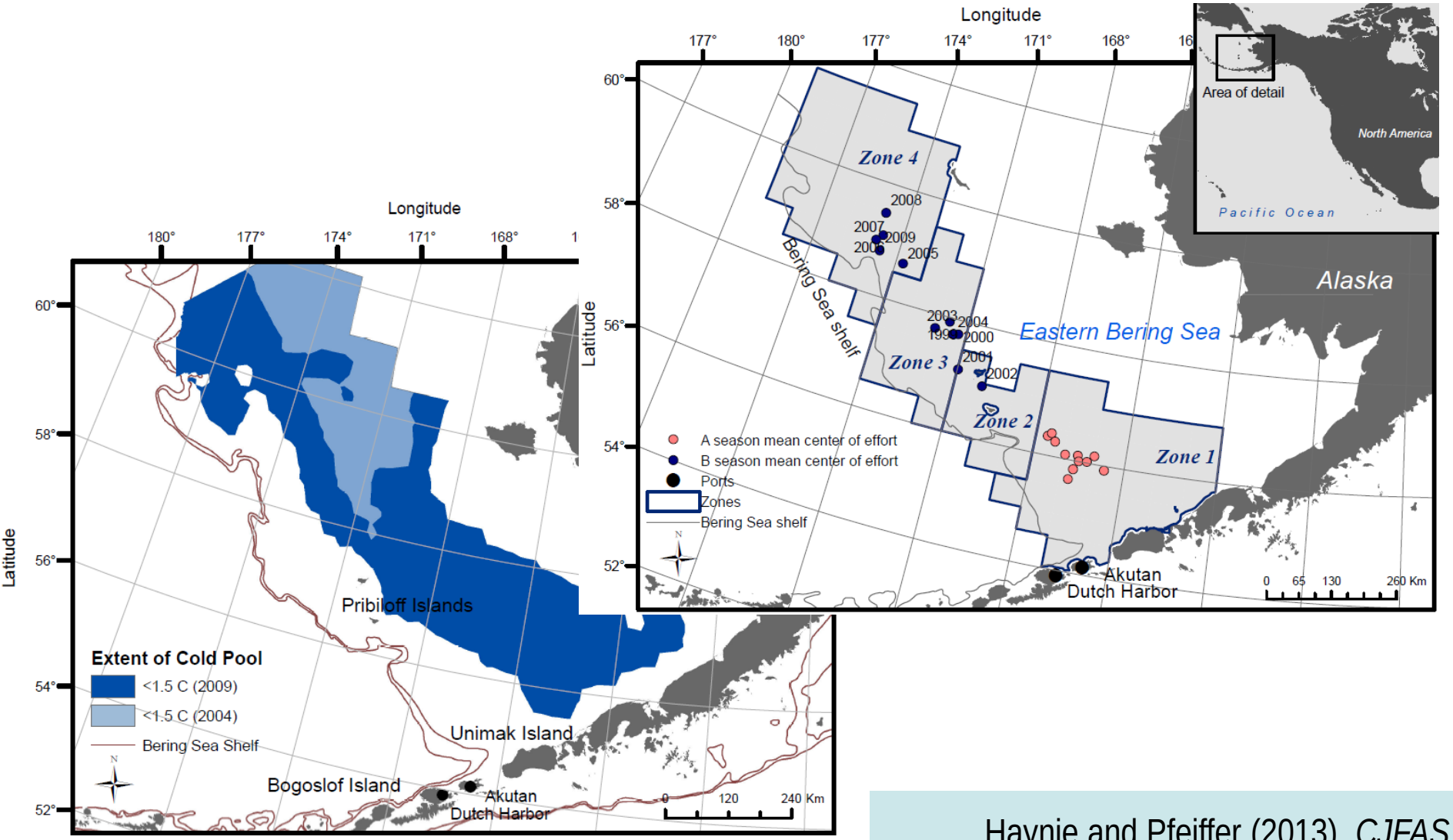
- Alaska Fisheries Science Center
- Seattle, WA

Key Finding # 1: The “march to the north” is not a consistent story for Bering Sea fisheries

- Ecologists have observed a shift of marine species and predicted a transition by fisheries towards the poles (e.g., Cheung et al. 2010; Lehodey et al. 2003; Perry et al. 2005).

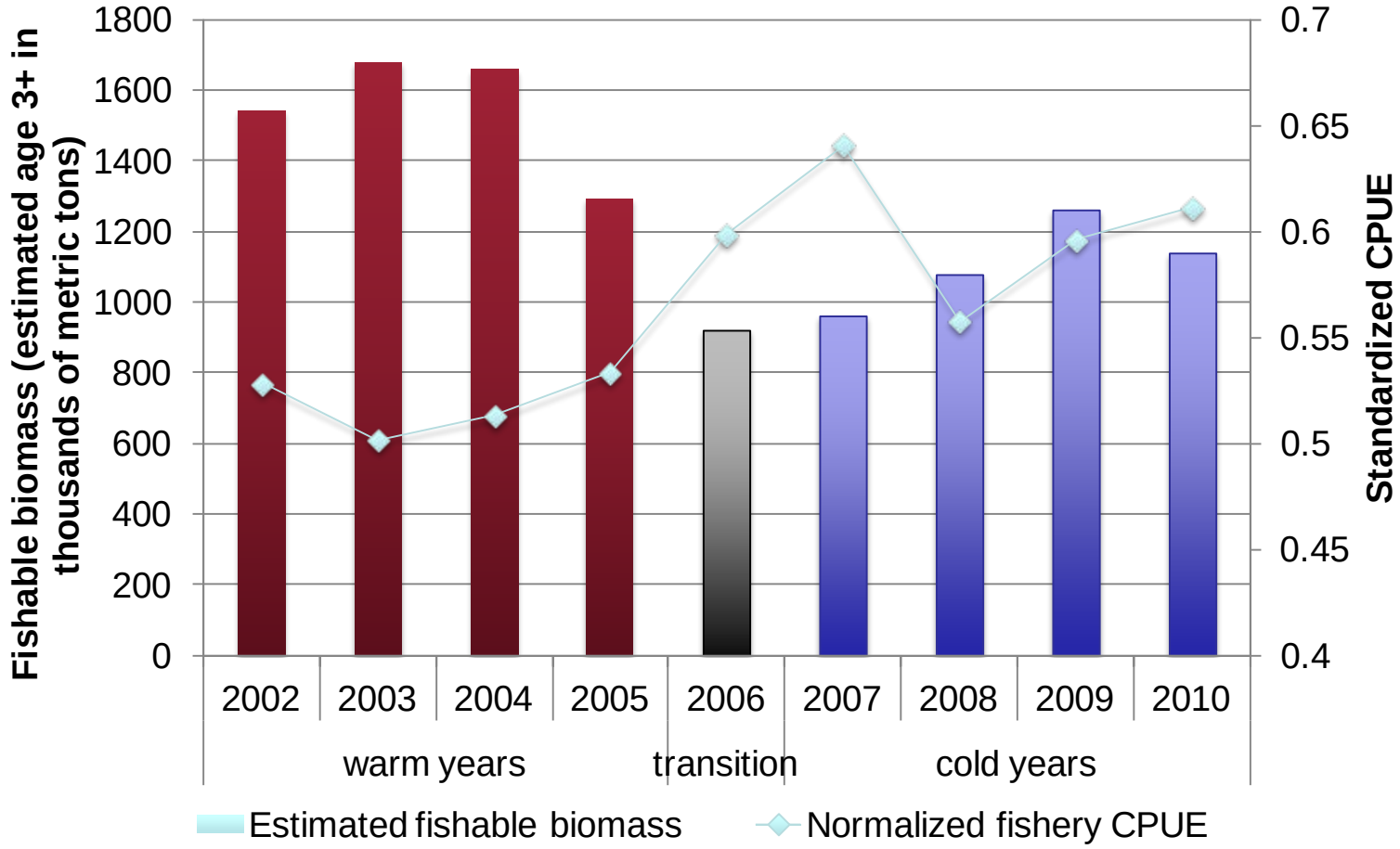
- What happens with fisheries?

Key Finding #1: The "march to the north" is not a consistent story for pollock catcher processors



Haynie and Pfeiffer (2013), *CJFAS*.

The “march to the north” is not a consistent story for the Pacific cod fishery

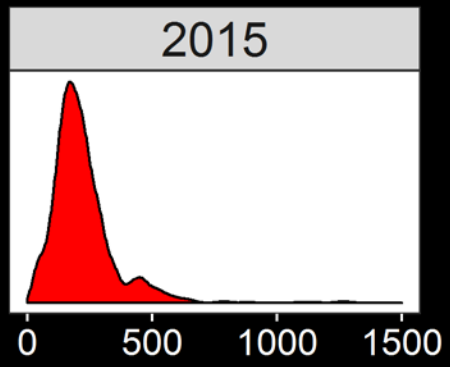


Relationships between fishery CPUE, 1) survey abundance and 2) climate regime.

Key Finding # 2: Fishers can adapt, at a cost

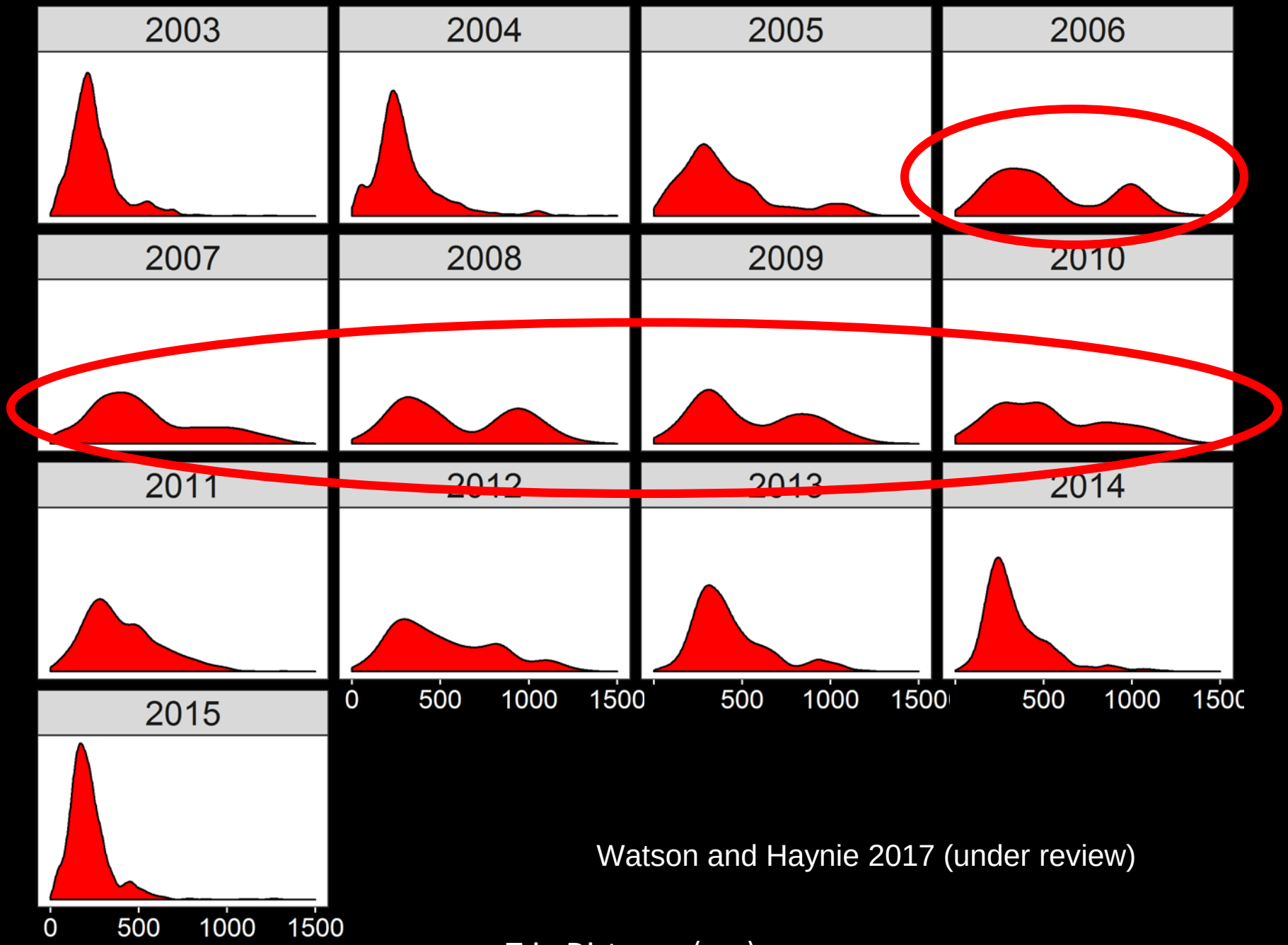
Harvesters have many means by which to adapt to changes in fishing conditions that may be related to climate variation.

- Location
- Timing
- Distance traveled
- Haul/set-level choices (e.g., soak/trawl time, number of hooks).



Watson and Haynie 2017 (under review)

Trip Distance (nm)



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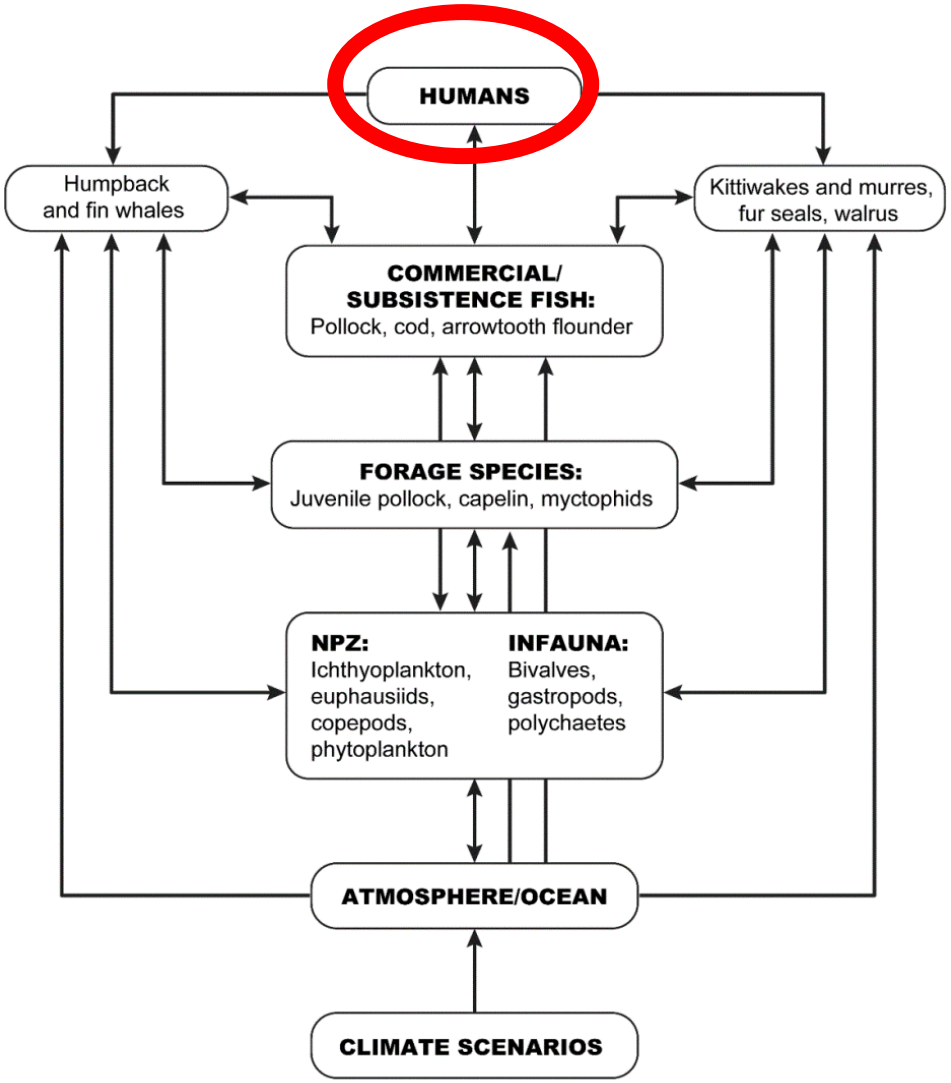
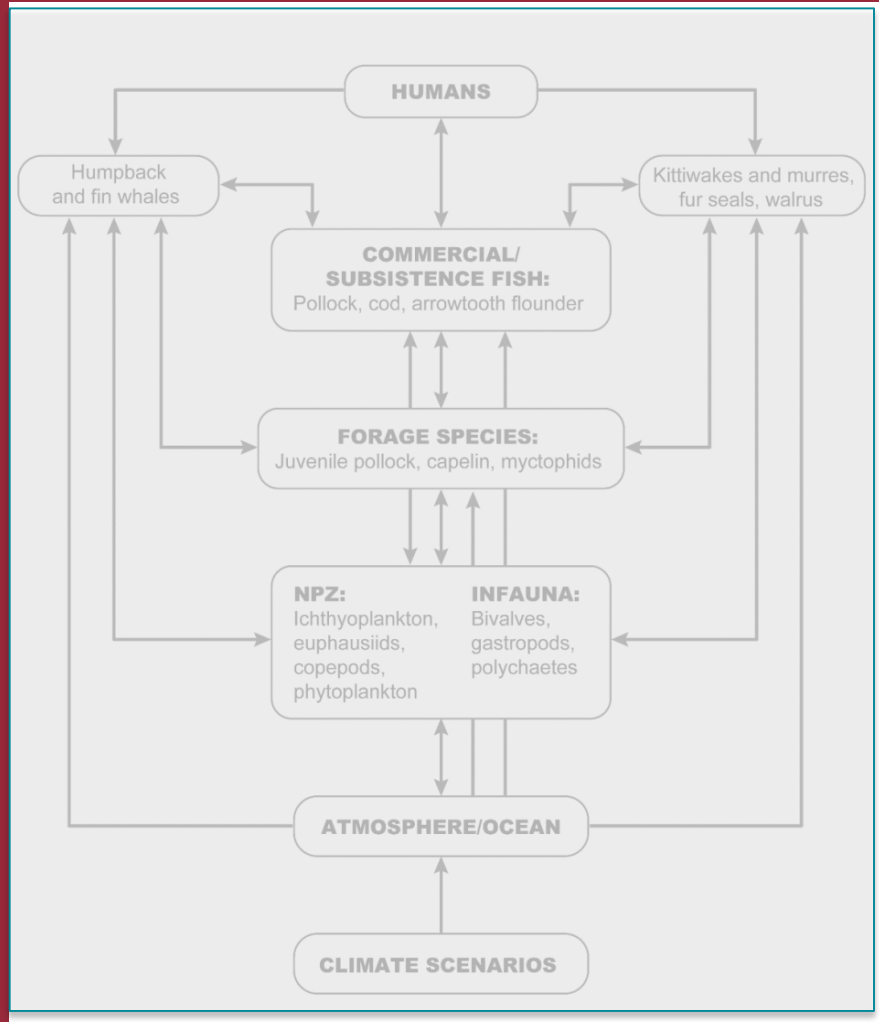


Models of how humans relate to the ecosystem

from Haynie & Huntington 2016

The main Bering Sea Project model



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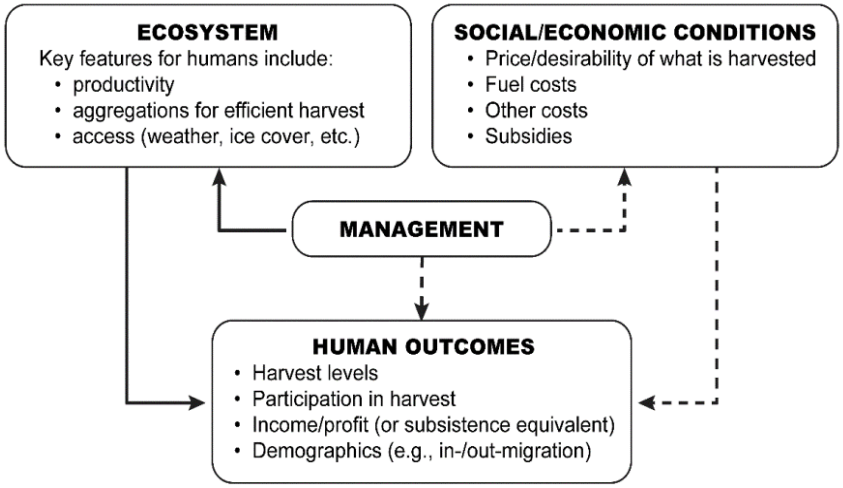

Integration Challenges

- Model timing - everyone wants their models to be functioning well before integration
- Large integrated models are computationally expensive
- It takes time to talk to each other
- Local Traditional Knowledge (LTK) and commercial economic work were challenging to integrate
  - Different relationships to the environment
  - Very different data

Integration is Hard!

Don’t Wait

To Integrate !!

Key ACLIM Integration Elements

- Multiple oceanographers, biologists, and economists
- Many collaborations & constant contact
- Strong existing NOAA/UW & NPRB Bering Sea Project relationships
- Connect now – then iterate & improve

The Alaska Climate Integrated Modeling (ACLIM) Team


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ACLIM: Alaska Climate Integrated Modeling Project

Anne Hollowed[1], Kirstin Holsman[1], Alan Haynie[1], Stephen Kasperski[1], Jim Ianelli[1], Kerim Aydin[1], Trond Kristiansen[2], Al Hermann[3], Wei Cheng[3], André Punt[4], Jonathan Reum[4], Amanda Faig[4]

1 Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center NMFS/NOAA
2 Institute of Marine Research, Norway
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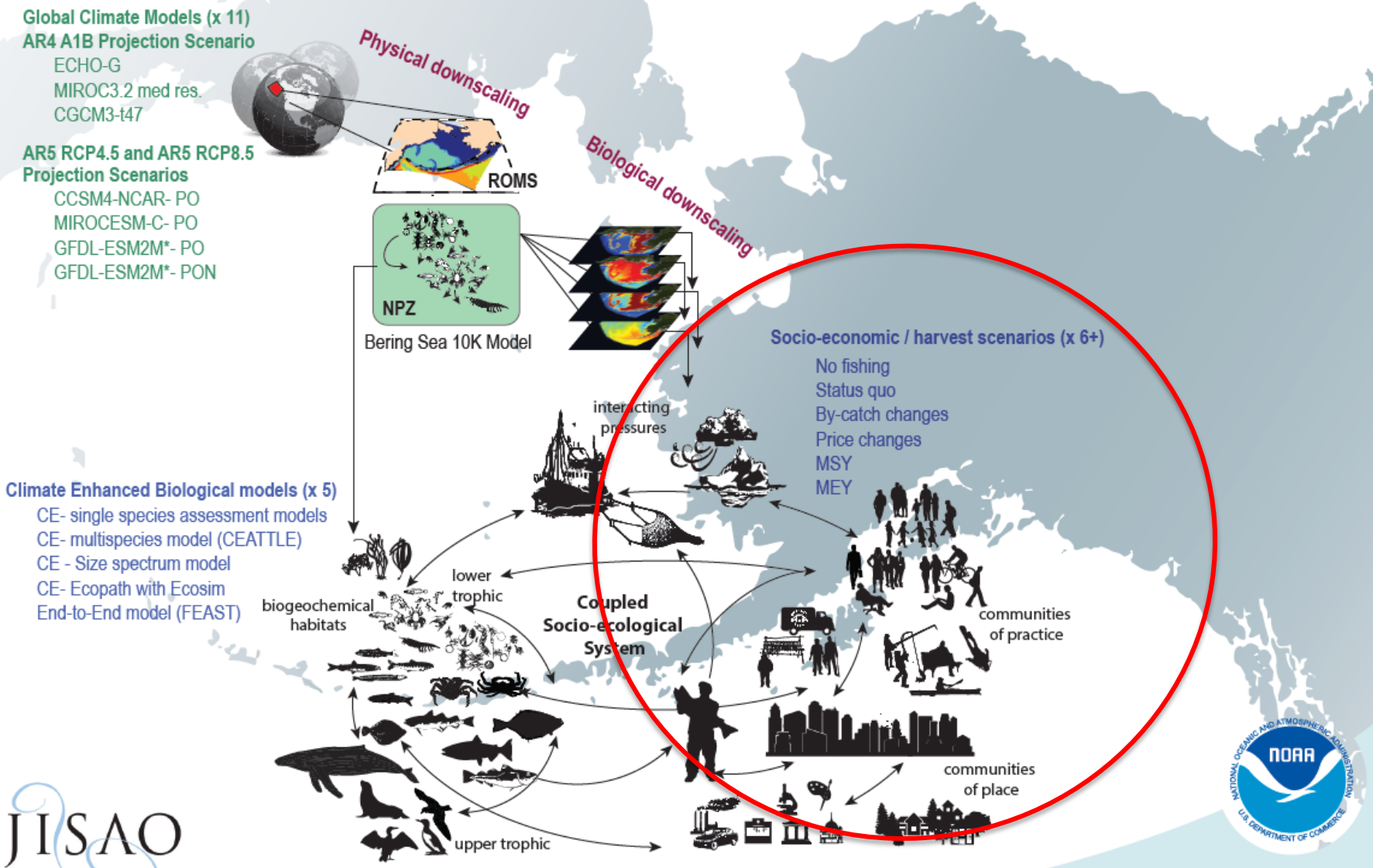

ACLIM: Alaska Climate Integrated Modeling Project

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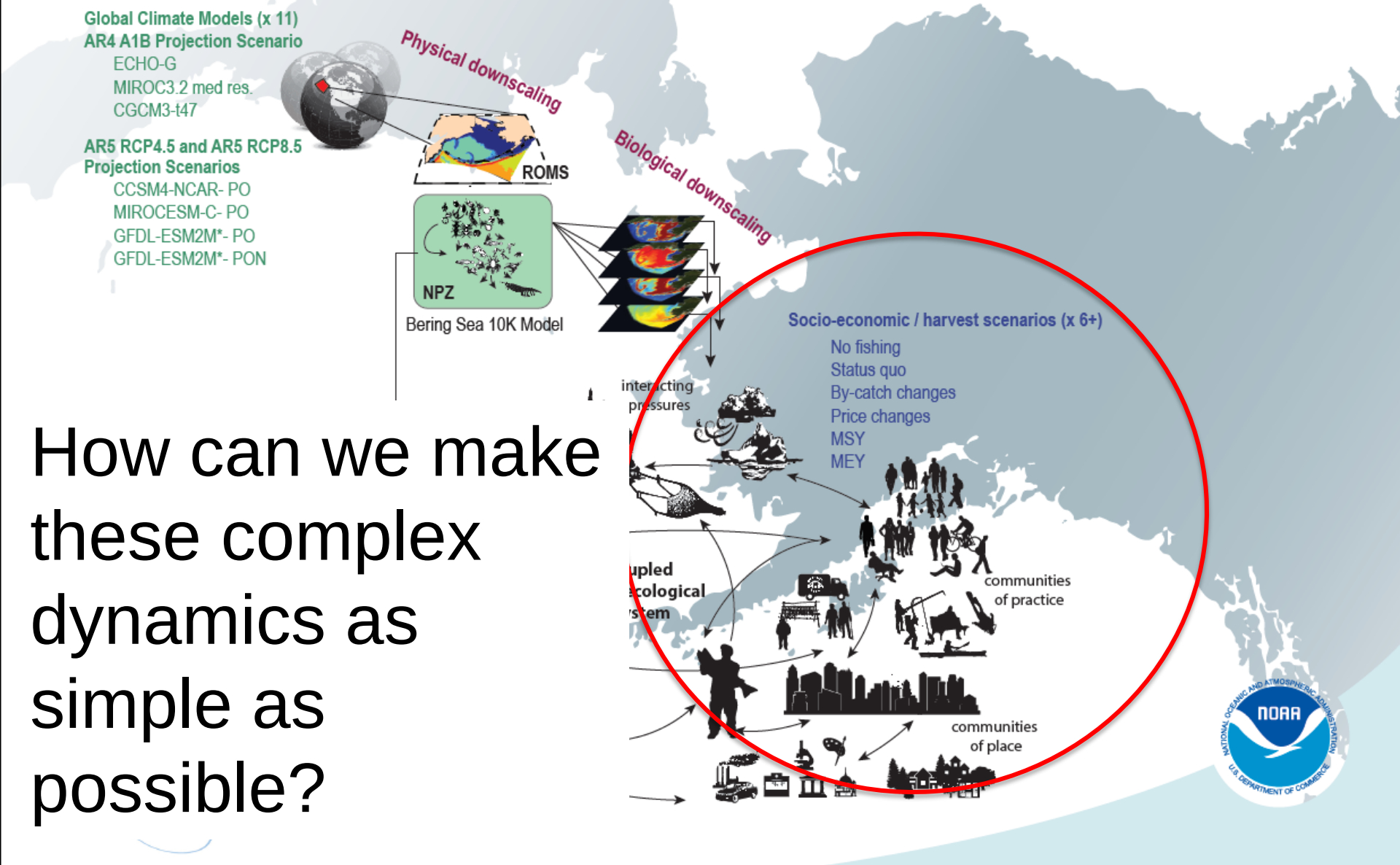
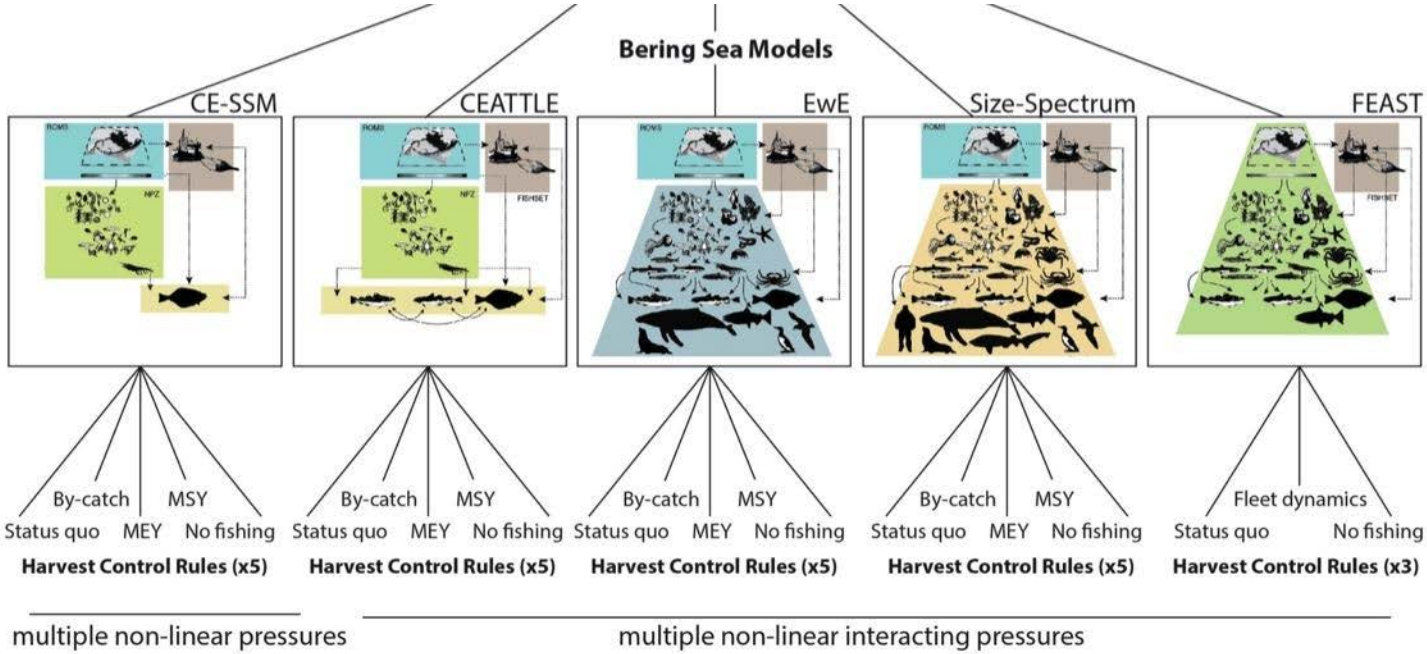


How can we make these complex dynamics as simple as possible?



ACLIM utilizes economic models of different complexity

- Effort response to abundance
- Maximum economic yield (MEY)
- Bycatch & price sensitivities
- Spatial models of fleets

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Alaska CLIMate Project

Anne Hollowed (AFSC, SSMA/REFM)
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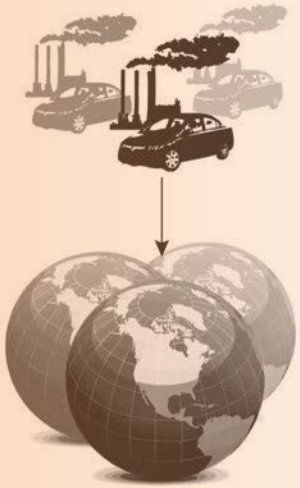
Trond Kristiansen (IMR, Norway)
Al Hermann (UW JISAO/PMEL)
Wei Cheng (UW JISAO/PMEL)
André Punt (UW SAFS)

FATE: Fisheries & the Environment
SAAM: Stock Assessment Analytical Methods
S&T: Climate Regimes & Ecosystem Productivity

Future Climate Scenarios

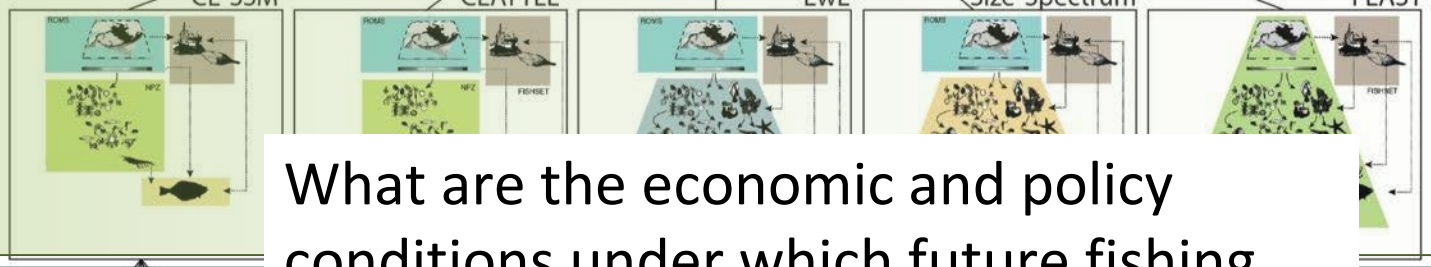


IPCC Scenarios (x3)
AR4 A1B
AR5 RCP6.0
AR5 RCP8.5

Global Climate Models (x 11)
ECHO-G (AR4 A1B)
MIROC3.2 med res. (AR4 A1B)
CGCM3-t47 (AR4 A1B)
CCSM4-NCAR- PO (AR5 RCP 6.0 & 8.5)
MIROCESM-C- PO (AR5 RCP 6.0 & 8.5)
GFDL-ESM2M*- PO (AR5 RCP 6.0 & 8.5)
GFDL-ESM2M*- PON (AR5 RCP 6.0 & 8.5)

Climate-enhanced Models

Bering Sea Models



What are the economic and policy conditions under which future fishing will occur?

Fishing Scenarios

By-catch | MSY
Status quo | MEY | No fishing
Harvest Control Rules (x5)

By-catch | MSY
Status quo | MEY | No fishing
Harvest Control Rules (x5)

By-catch | MSY
Status quo | MEY | No fishing
Harvest Control Rules (x5)

By-catch | MSY
Status quo | MEY | No fishing
Harvest Control Rules (x5)

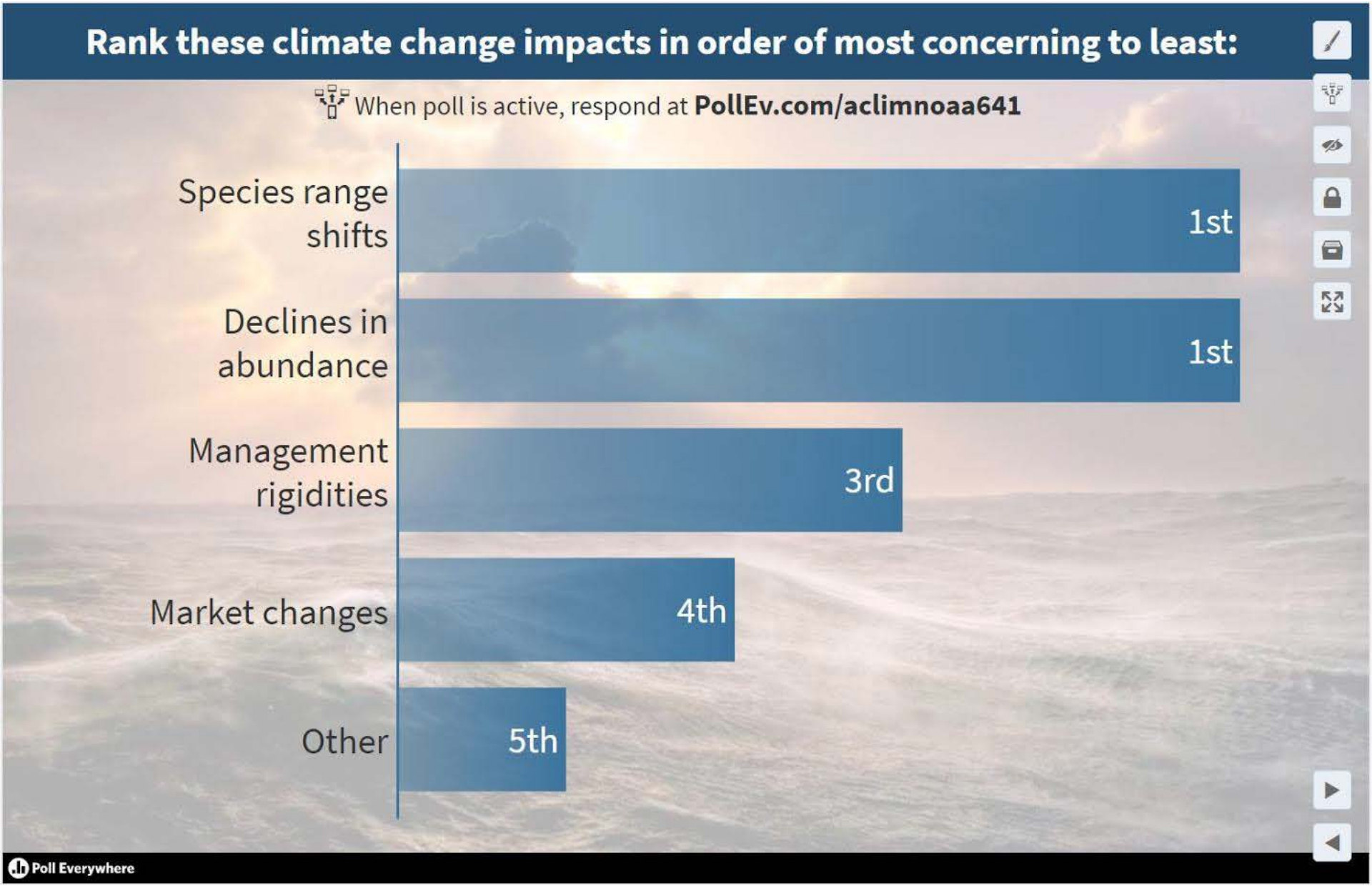
Fleet dynamics
Status quo | No fishing
Harvest Control Rules (x3)

multiple non-linear pressures

multiple non-linear interacting pressures

February & October 2017 ACLIM workshop with North Pacific Fishery Management Council Stakeholders

- Presentations about ACLIM project
- Interactive questions
- Discussion of stakeholder priorities related to climate change


Rank these climate change impacts in order of most concerning to least:
When poll is active, respond at PollEv.com/aclimnoaa641
Species range shifts
1st
Declines in abundance
1st
Management rigidities
3rd
Market changes
4th
Other
5th
Poll Everywhere

The ICES/PICES Workshop on Economic Modelling of the Effects of Climate Change on Fish and Fisheries (WKSICCME_Econ)

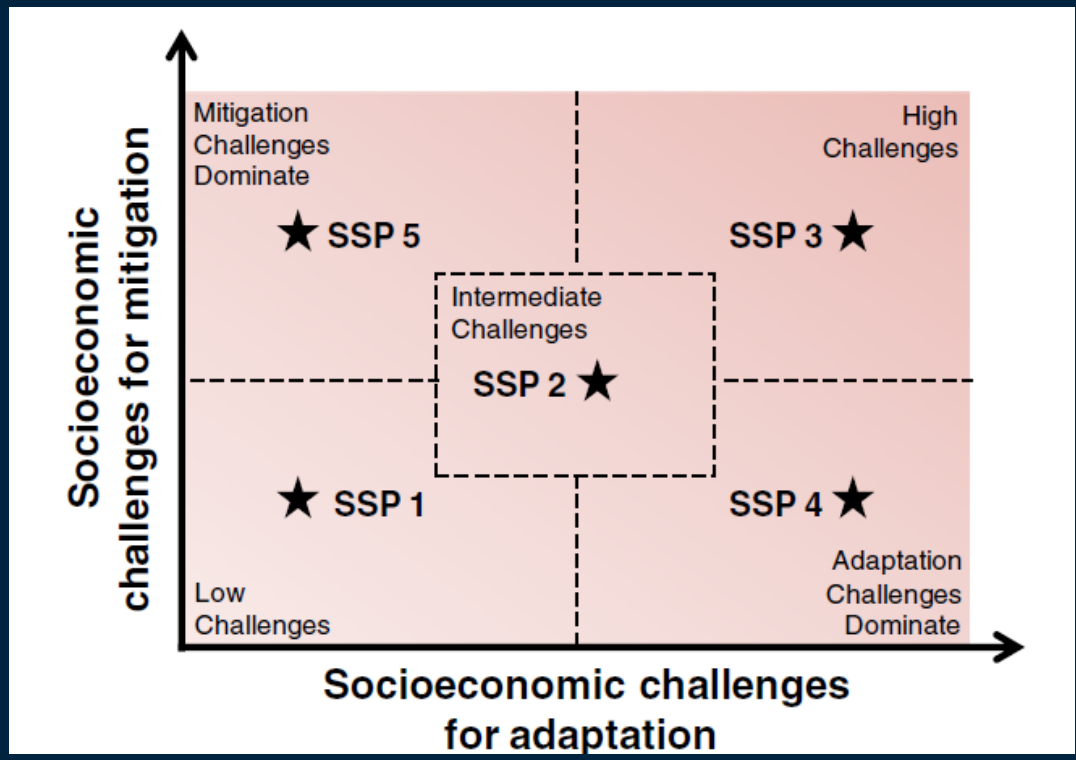
- June 3-4, 2016 in Brest, France connected to MSEAS meeting
- ~35 people
- Mixture of economists, other social scientists, and biologists

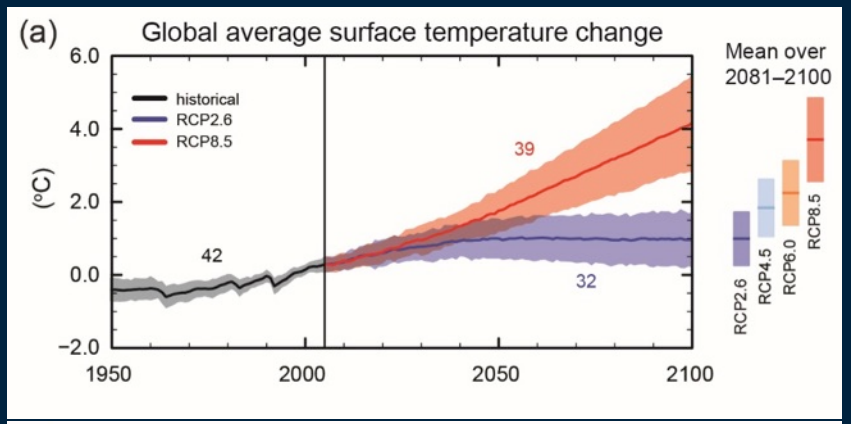
Brest June 2016 ICES/PICES workshop

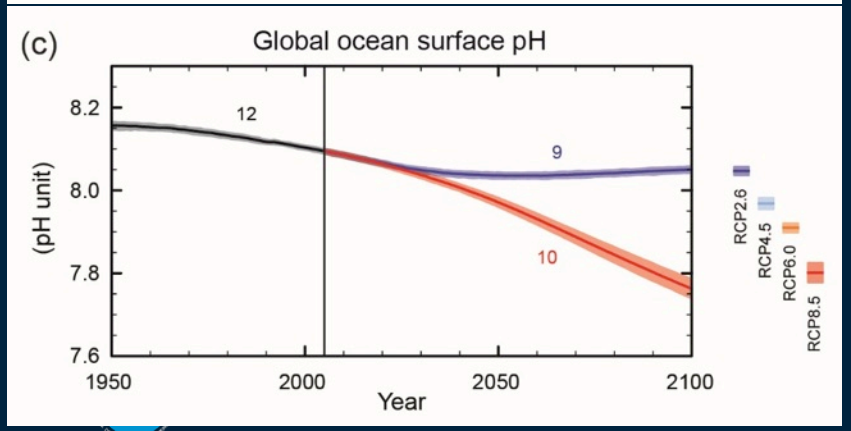
- representative future fishing and ecosystem scenarios
- fisheries management policies
- models of fishery behaviour that can be used to project the implications of different climate models

Integrating Concepts of IPCC 2014

Management Options
O' Neill et al. 2014. Climate Change 122:387-00

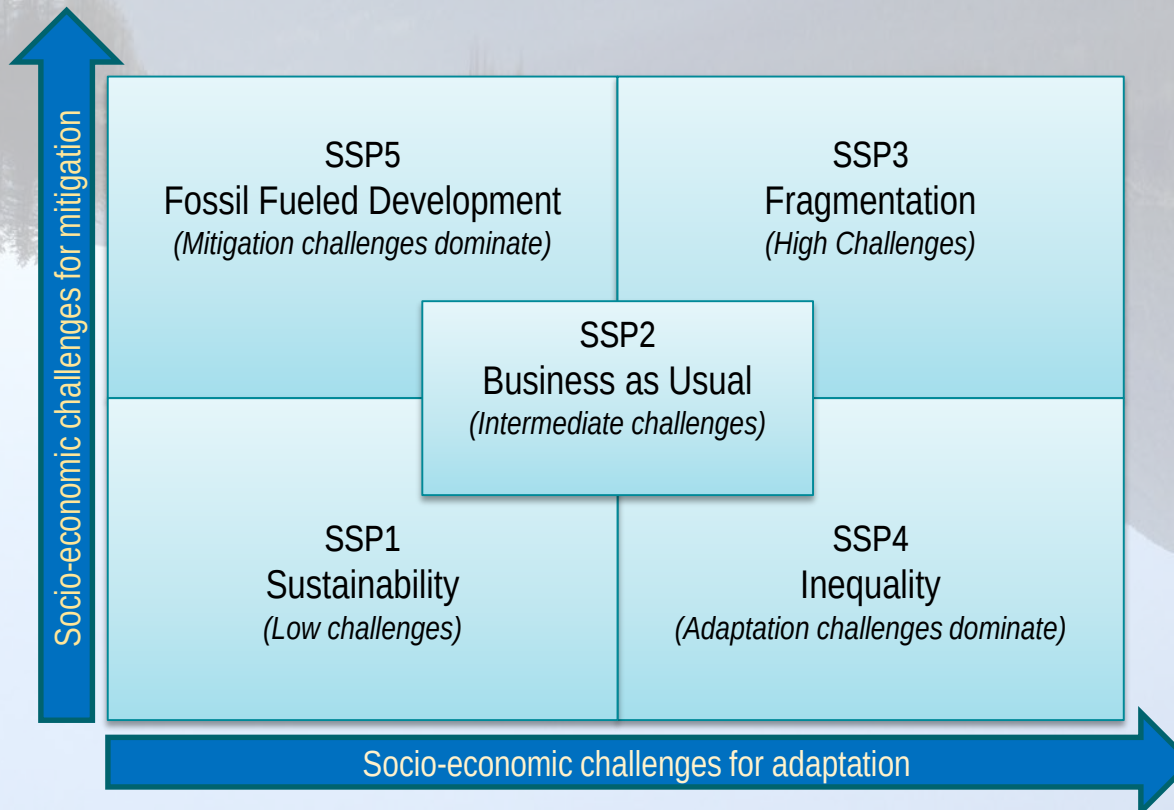


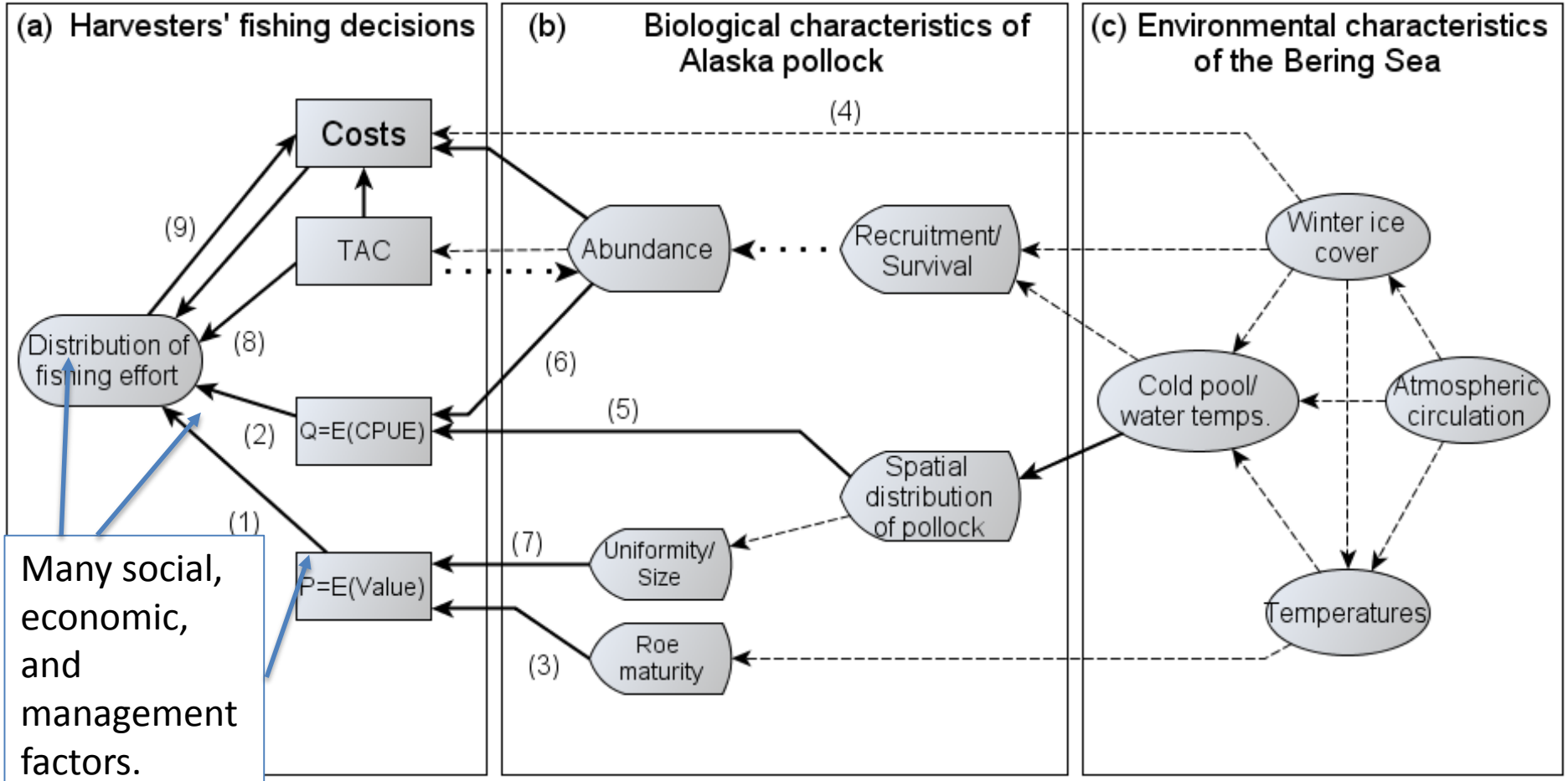




IPCC AR5 WG 1 synthesis report: https://www.ipcc.ch/report/graphics/index.php?t=Assessment%20Reports&r=AR5%20-%20WG1&f=SPM

What do the IPPC Shared Socioeconomic Pathways (SSPs) mean for managers, fishing companies, and harvesters?





Many social, economic, and management factors.

Haynie and Pfeiffer 2013 *CJFAS*

Essential Elements	Why this might increase	Why this might decrease
Fish prices	Driven by consumer demand, income and/or scarcity	Driven by fishing and aquaculture demand or smaller populations of valuable species
Change in relative price of premium fish	Concentrated wealth interacting with scarcity (e.g., high prices for halibut)	Increased value of protein for humans or input to aquaculture
Number of species fished	Markets may develop	Environmental change may lead to the decline of some species
Fishing and processing costs	Increased fuel costs or carbon tax. Land or labor costs may increase.	Improved or more selective fishing or processing technology
Priority on conservation values or other uses of resources	Change in demand or strength of conservation measures	Change in weak stock policies; change in the Endangered Species Act
Increase in protection for fishing communities	Additional concern about preserving the distribution of fishing opportunities	Less interest or ability by inhabitants to live in remote, resource-based areas; more large fishing vessels.
Revenue volatility	If species are unable to adapt to changing climate; global economic factors	Better management or long-term investment strategies; global economic factors

Can we simplify this further?

Type of Change
Fish prices
Change in relative price of premium fish
Number of species fished
Fishing and processing costs
Priority on conservation values or other uses of resources
Increase in protection for fishing communities
Revenue volatility

Type of Change
Fish prices
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Increase in protection for fishing communities
Revenue volatility

Can we simplify this further?

- Net Trip Revenue
- Skill in selective harvesting
- Flexibility of fishing opportunities

A key wrinkle in the BSAI: Management under the Ecosystem Cap

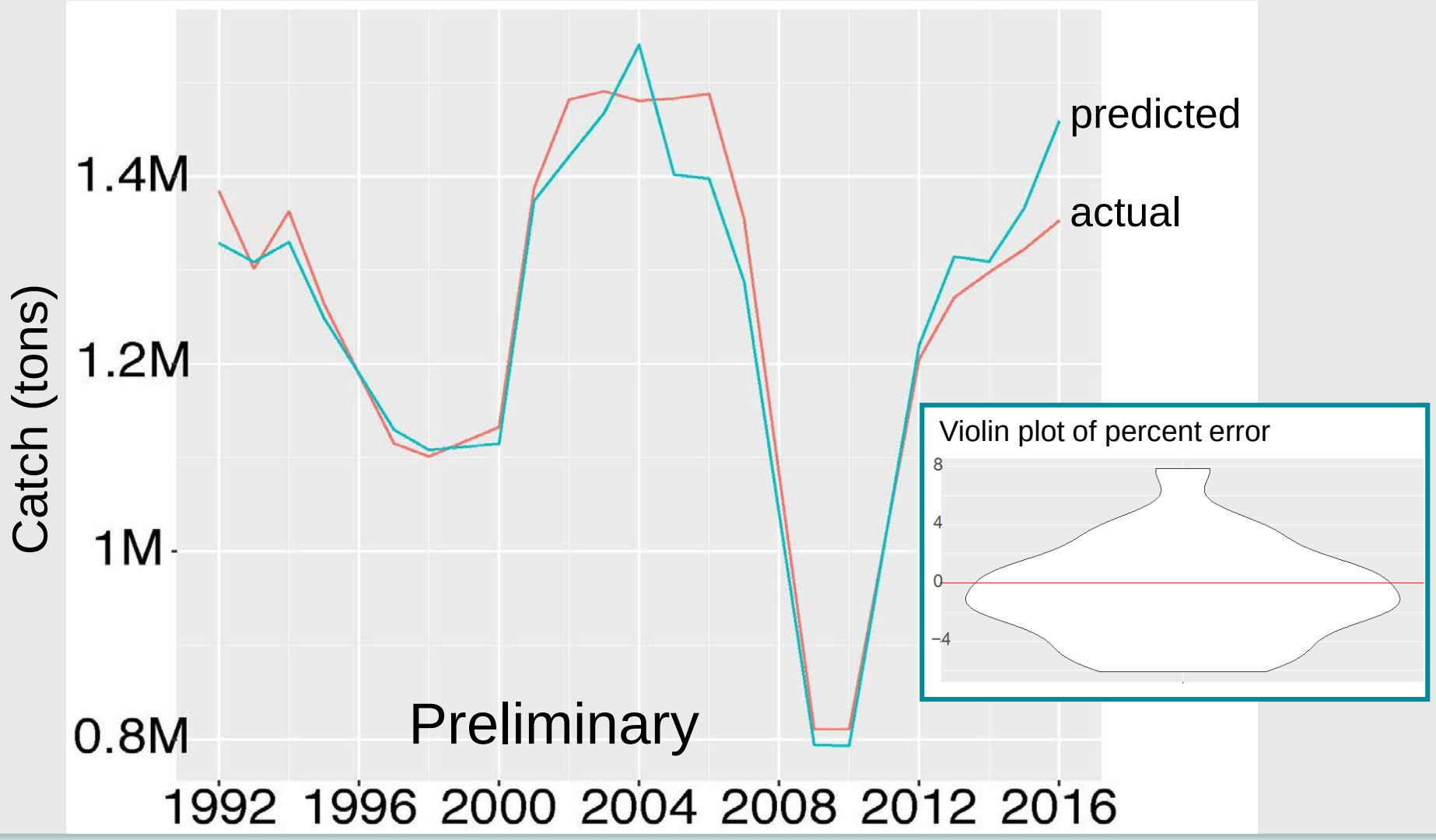
- For each species, TAC <= ABC
- The sum of all TACs <= 2 MMT
- In 2017, Sum(ABCs) = ~ 4 MMT

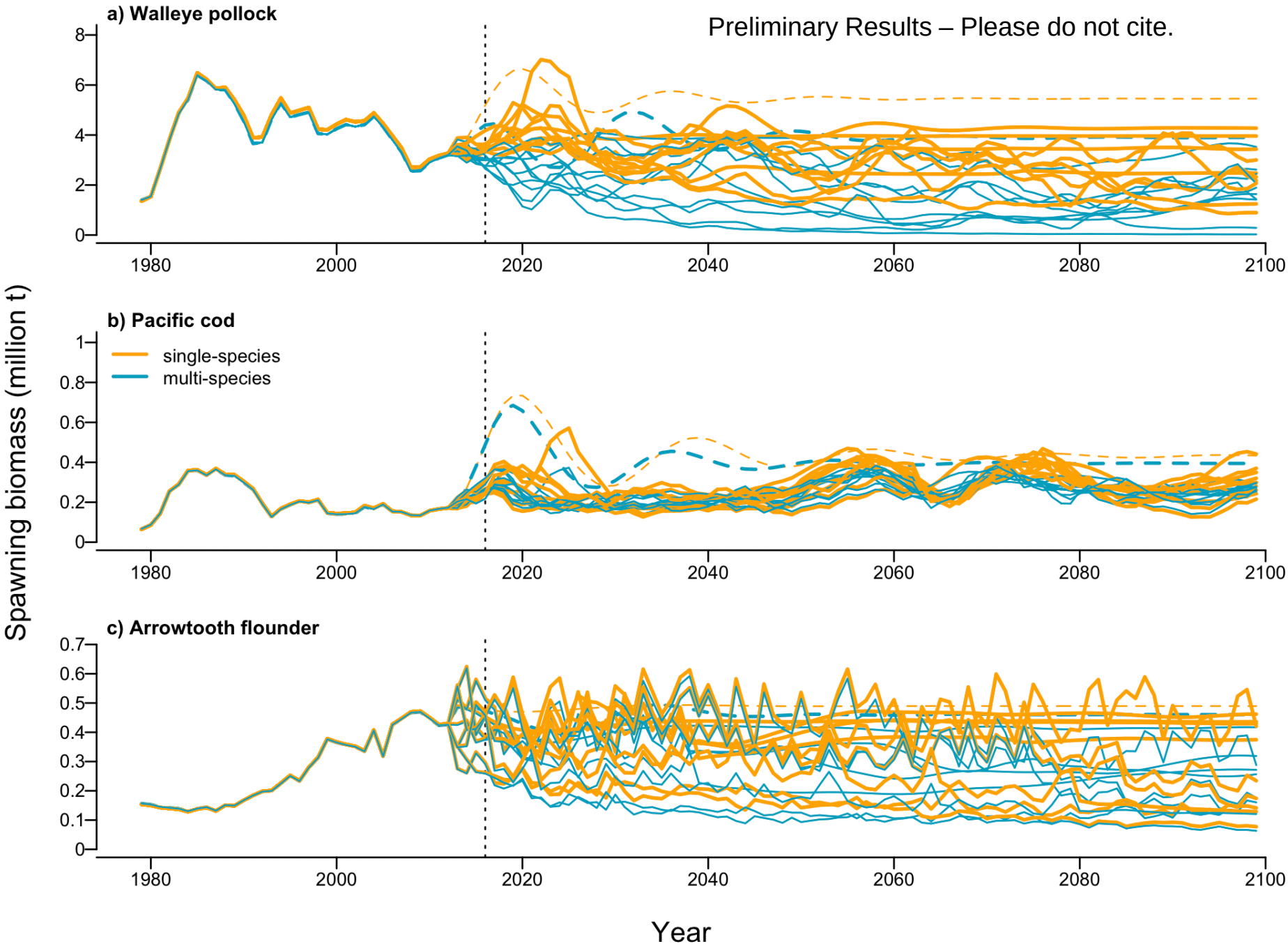
The Council chooses how to reduce the TAC of each species below ABC to make the Total < 2 million MT.

We have to predict TAC & catch in the future.

Bering Sea Pollock: Out Of Sample

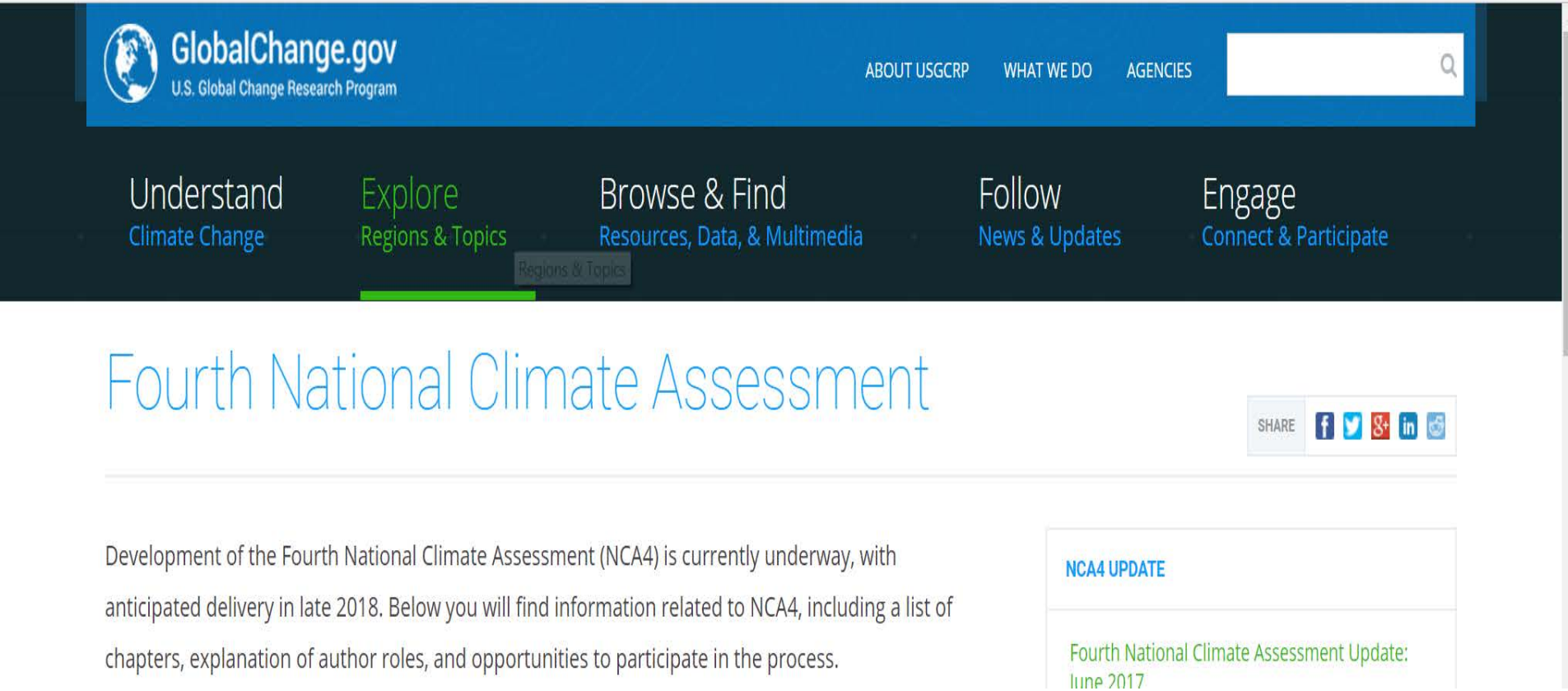
BS Pollock catch, predicted from ABC




Preliminary Results – Please do not cite.
a) Walleye pollock
b) Pacific cod
c) Arrowtooth flounder
single-species
multi-species
Spawning biomass (million t)
Year
0
2
4
6
8
0.2
0.4
0.6
0.8
1
0.1
0.3
0.5
0.7
1980
2000
2020
2040
2060
2080
2100

4. Management Tool Evaluation

- New technology
- Catch shares
- Dynamic area closures
- Bycatch reduction incentives
- Revised harvest control rules
- Others to be invented



Alan Haynie is a co-author on NCA4 Oceans Chapter

Detailed AFSC socioeconomic research vital to filling information gaps. Sometimes global models are all that exist (e.g., Cheung et al *Science* 2016).

Some take home lessons

- Ignoring economic and social impacts in climate modeling is likely to give you the wrong answers
- Long-term interdisciplinary teams and projects have valuable spillovers
- Integration is hard & takes work
- Regional analysis is essential.

Thank you!

Thanks to NOAA Fisheries S&T for funding ACLIM:

- Fisheries and the Environment (FATE),
- Stock Assessment Analytical Methods (SAAM),
- Climate Regimes and Ecosystem Productivity (CREP)
- Economics and Human Dimensions Program

Thanks to NPRB for funding BSIERP, and to all collaborators, especially

L. Pfeiffer, A. Hollowed , K. Holsman, A. Faig, J. Watson, H. Huntington, S. Kasperski, M. Dalton, M. Sigler, F. Mueter, K. Aydin, J. Ianelli, & the rest of the ACLIM Team.

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