Addressing the challenge of climate change and fisheries:

A framework for implementing climate-appropriate fishery management

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What I'll talk about

- Managing fisheries in the face of climate change can seem daunting
- Climate change effects are already here → thus far it's lead to some mixed effects
- Research shows that our response to climate change (or lack thereof) will be a large determinant in how fisheries fare
- How do we approach this critically important, but overwhelming problem?
- EDF has been developing a structured approach to building fishery management systems that are responsive to climate change
  - Concepts
  - Examples

Climate change to cause dramatic drop in Persian Gulf biodiversity and fisheries potential

Climate Change Is Suffocating Large Parts of the Ocean

swaths of the deep ocean,

Climate Change May Shrink the World's Fish

A new study suggests warming sea temperatures could result in smaller fish sizes.

s were by far the
ded

The oceans' circulation hasn't been this sluggish in 1,000 years. That's bad ne

Climate Change Could Destroy Even the Ocean's Most Pristine Parks

"Marine protected areas" have been an environmental success story. But a new study finds that most won't withstand global warming.

Global Fish Catch Could Plummet

This dire ocean scenario is a stark reminder of why the world is trying to stop climate change

Ho

Bull sharks and bottlenose
as the

New study confirms the oceans are warming rapidly

pted ecosystems

Although there's some uncertainty in the distribution among Earth's ocean basins, there's no question that the ocean is heating rapidly

Climate-induced distribution shifts can lead to “Fish Wars”

theguardian

News | US | World | Sports | Comment | Culture | Business | Money

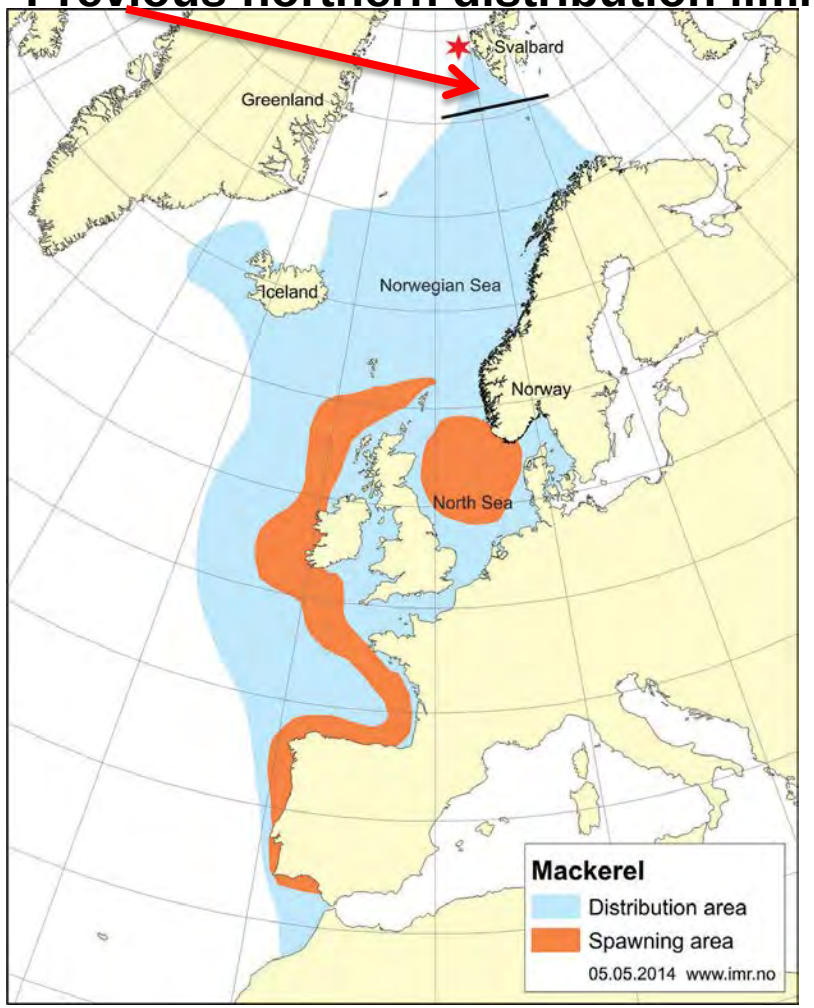
Environment › Fishing

Britain prepares for mackerel war with Iceland and Faroe Islands

Scottish fishermen and politicians call for EU action after two countries raise combined quota from 27,000 to 215,000 tonnes

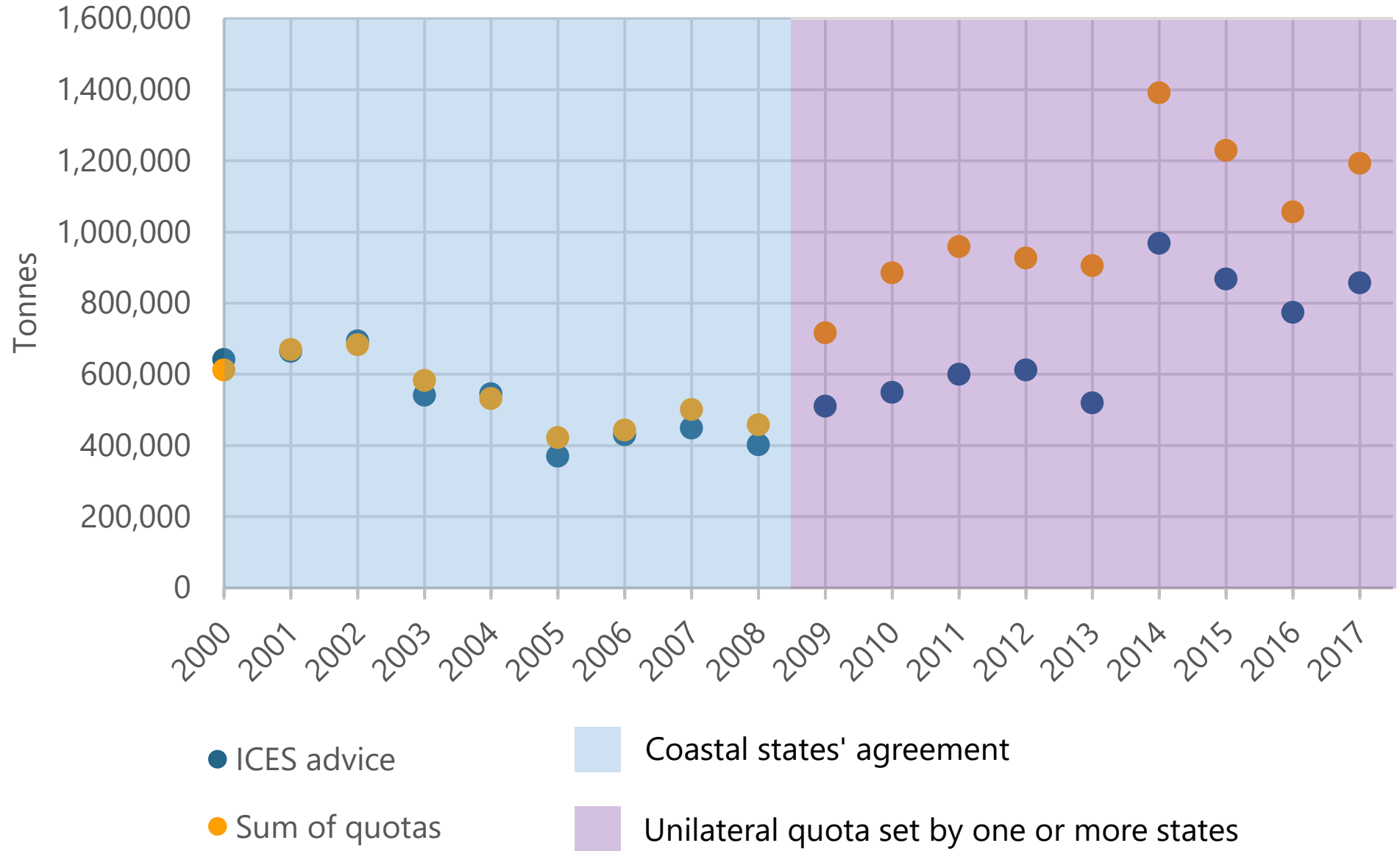
Caroline Davies

The Guardian, Sunday 22 August 2010 11.05 EDT



Berge et al. 2015, *Arctic*

Breakdown in international fishery agreements led to overfishing: Norwegian Spring Spawning Herring



Climate Change & Fisheries

Improved fisheries management could offset many negative effects of climate change

(In review with Science Advances)

S.D. Gaines, C. Costello, B. Owashi, T. Mangin, J. Bone, J. García Molinos, M. Burden, H. Dennis, B.S. Halpern, C.V. Kappel, K.M. Kleisner, D. Ovando

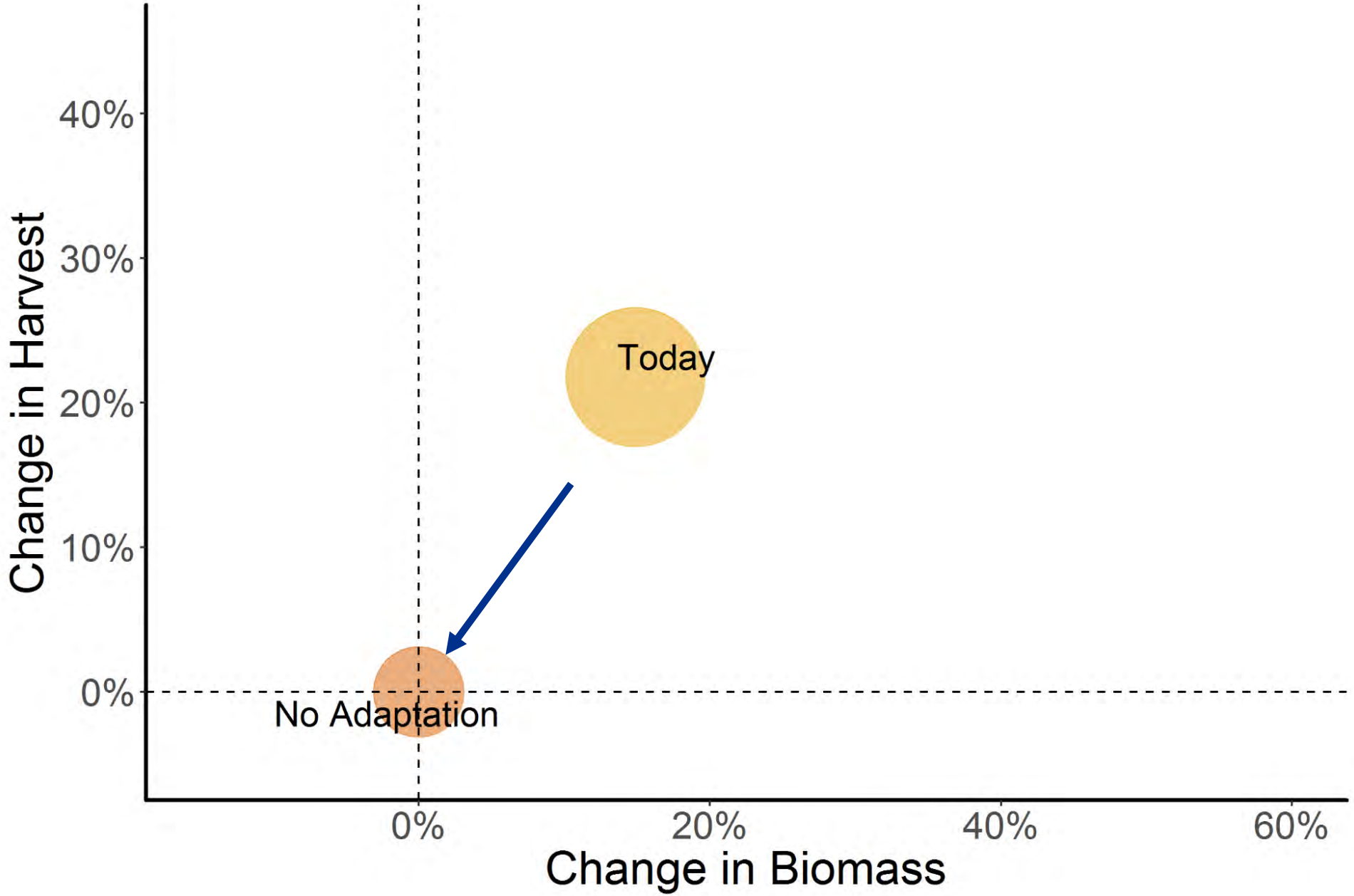
Negative effects of climate change on ocean fisheries could be offset by reforms that fix current problems and limit new climate driven impacts.

What is the effect of climate change on fisheries and our response to it?

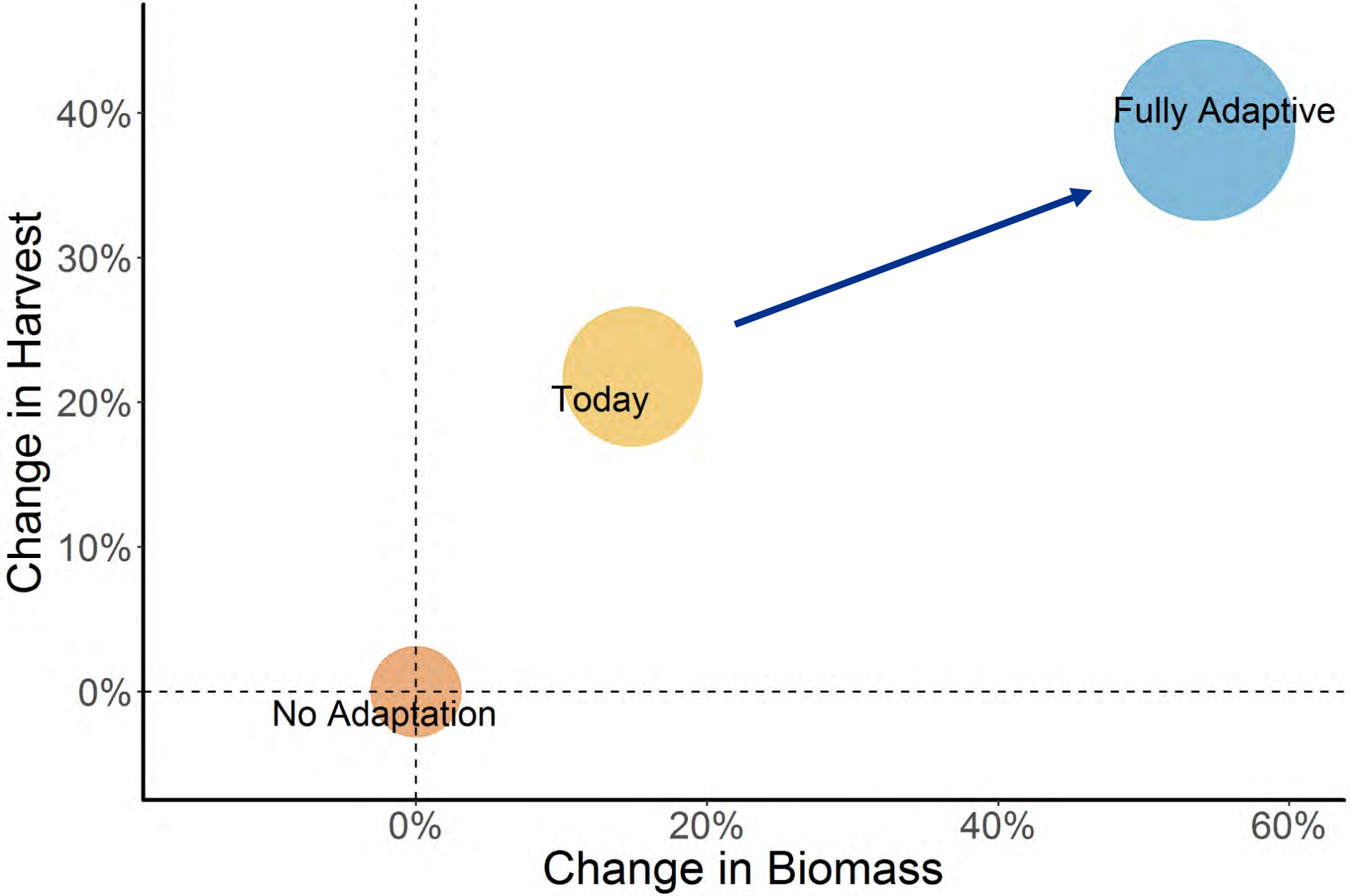
- We asked how will the productivity and distribution of fisheries around the world be affected in the face of climate change?

- Used a climate velocity model to explore these changes

- Used a bioeconomic model to understand the tradeoffs between harvest, profit, and biomass under management that accounts for climate change vs. management that doesn't



Source: Gaines et al. In review. *Improved fisheries management could offset many negative effects of climate change.* In review



If we adapt our fisheries management approaches to account for changing productivities and species movement, we can do better than today, even in the face of climate change (RCP 6.0)

Source: Gaines et al. In review. *Improved fisheries management could offset many negative effects of climate change.* In review

Developing climate appropriate fishery management can have a significant impact

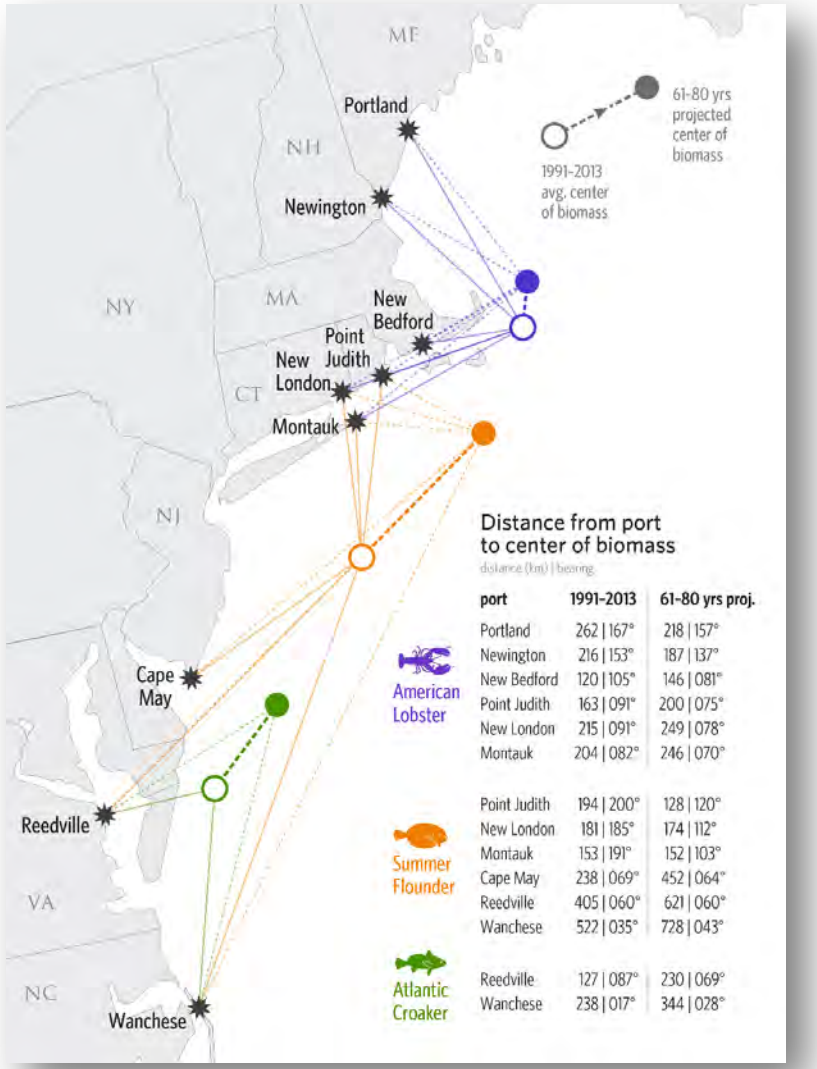
We are starting to figure out how potential changes may unfold, but our management systems are not yet ready to deal with these changes

Can we develop and apply structure to this issue to make it more manageable?

"*There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know*"

- Donald Rumsfeld

We know fish will shift their range: new locations, new range size



Kleisner et al. (2017) *Progr. Oceanography*

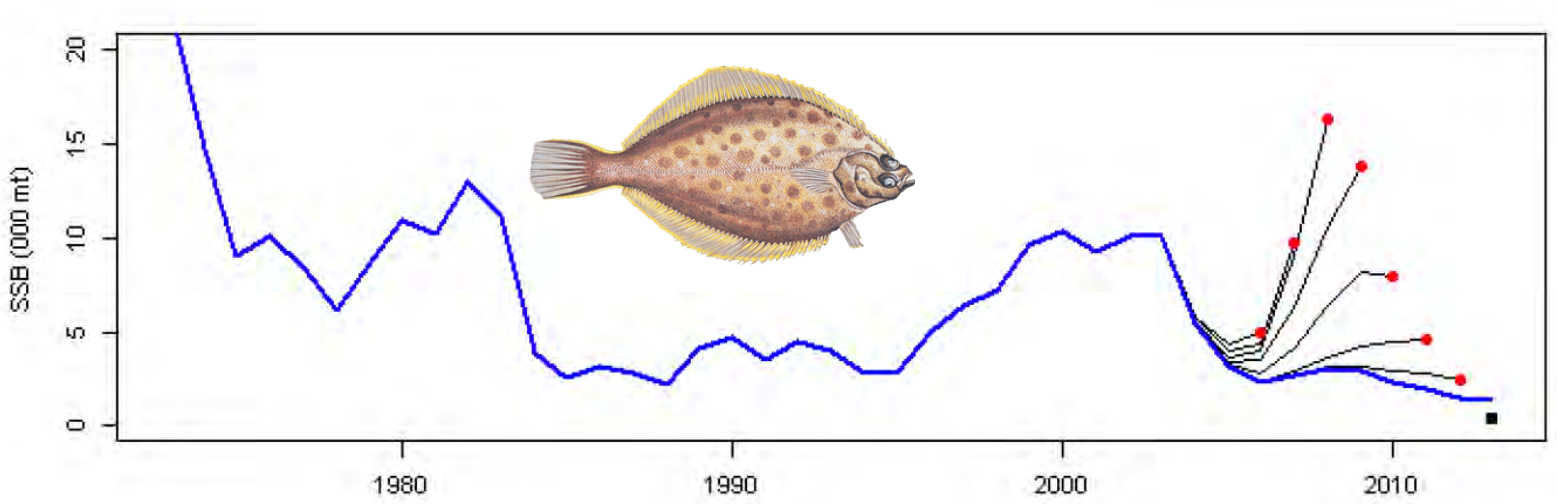
<u>Some challenges created:</u>

- Cross EEZ challenges create potential for competition and race for fish
- Expanded range means more parties to coordinate management with
- Entry into new zones creates mismatch between fishing regulations and opportunities on the ground

<u>Some solutions and tools to address these challenges:</u>

- Bioeconoimc/game theoretics to identify points of mutual benefit
- Mutually beneficial international agreements
- Provisions that allow fluid transferability of quota across regions

We know productivities will change

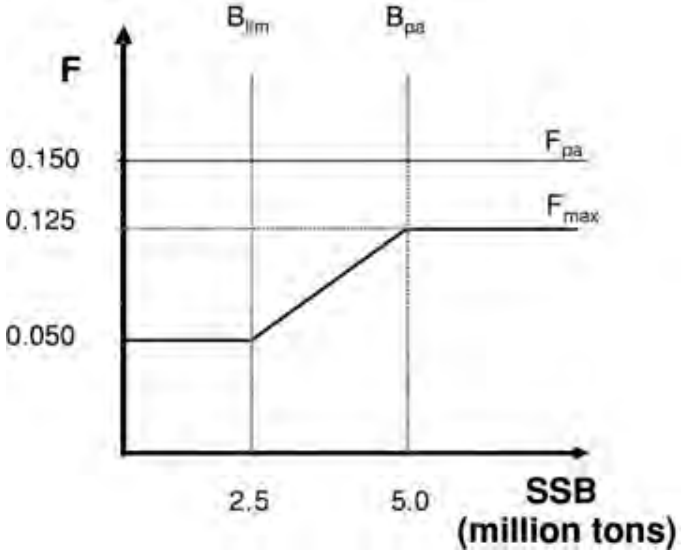


Some challenges created:

- Potential to unknowingly engage in overfishing
- Potential to unknowingly forego harvest opportunity

Harvest Control Rule (HCR)

A mathematical relationship between the estimated biomass of the stock and the fishing mortality rate used to determine catch limits

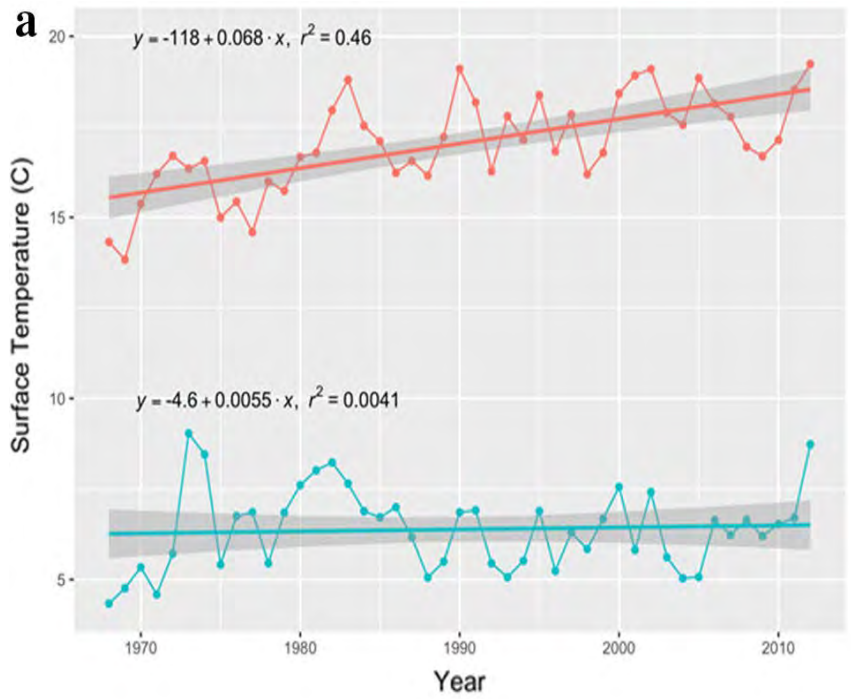


Some solutions and tools to address challenges:

- Ramped harvest control rules that change F in response to change in B
- Protection of age structure

Myrseth et al. 2011; Transboundary Resources Assessment Committee 2014

We don’t know when much of this change will occur



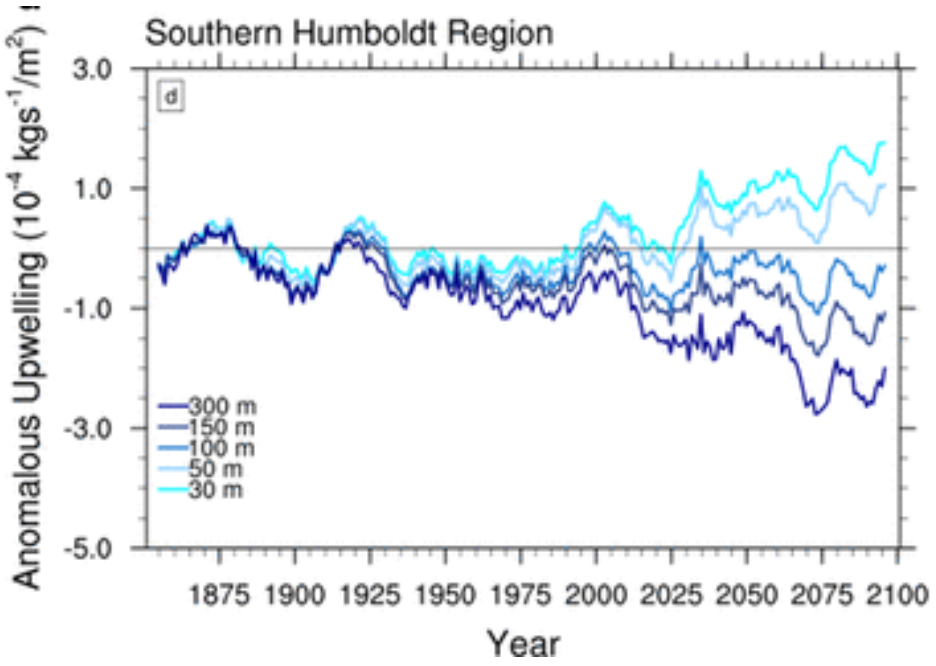
Some challenges created:

- Risk of chasing false signals
- Risk of not acting when we should
- Risk that management institutions may not adapt quickly enough when change does happen

Some solutions and approaches for these challenges:

- HCRs tied to biomass
- Adaptive management
- Co-management

We know variability in many regions will change, but we have a lot of uncertainty regarding how



Oyarzún, D. & Brierley, C.M. Clim Dyn (2018). https://doi.org/10.1007/s00382-018-4158-7

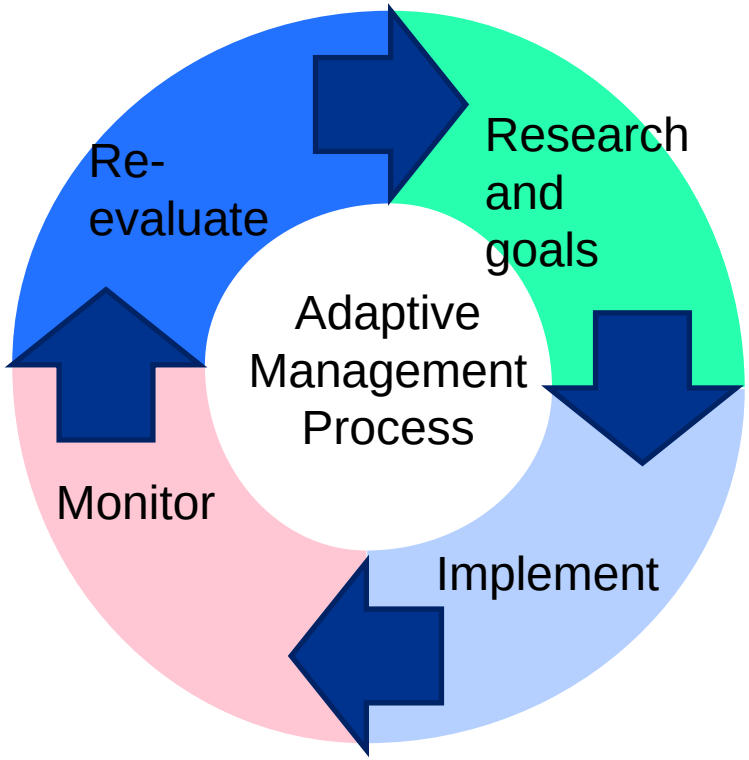
<u>Some challenges created:</u>

- Greater magnitude can cause socioeconomic duress and impacts across the food web
- Greater frequency could affect overall yields
- Not knowing whether these are/will occur makes it difficult to identify appropriate management

<u>Some approaches to addressing these challenges:</u>

- Identifying these questions allows us to focus our limited scientific resources
- Scenario-based planning, bioeconomics, and MSE can provide insights into the effects of different management approaches

Much will happen that we cannot foresee



Approaches that foster adaptability and nimbleness will be necessary

- Implement robust adaptive management processes: set appropriate goals, enact approaches to meet them, monitor performance against those goals, re-evaluate
- Foster and facilitate co-management: acknowledge that management institutions may move too slowly. Devolve some decisions down to cooperatives, associations, communities

A few concrete examples of what we can do

- International agreements: bioeconomics and game theoretics are being used to inform coalitions in Europe, the South Pacific, and elsewhere
- Adaptive management: institutions like the US Council system can be quite adaptive if the will exists. Further implementation of EBFM can further advance these capabilities
- Co-management: fishery cooperatives, fishing trusts, community-based management, risk pools, NW treaty tribes, and other arrangements are routinely used examples
- Responsive, dynamic management: fishery cooperatives in the US and elsewhere use real time data, various analytical techniques, and deploy rolling hotspot closures to manage bycatch in near real time
- More strategic use of scientific information: Ramped harvest control rules can be deployed in ways that are naturally climate adaptive. Also, Ecosystem Status Report information, ecosystem indicators, and climate vulnerability indicators
- Better identifying climate-related challenges: research is underway in the Humboldt current region and elsewhere to better understand how upwelling and other types of ecosystem drivers will be altered as climate change takes hold

Different approaches will need to be tailored to people and place

- Diagnose: What is the nature of the challenge and the impact?
  - How will climate change affect fish stocks?
  - How do these changes converge with management practices, and what challenges exist as a result?
  - What are the major points of risk and uncertainty?
- Design: What types of fishery management design elements can be implemented to deal with the identified challenges?
  - What are the laws, values, customs, and norms of the local society, and what management approaches are realistic given these?
  - Is the major problem one of mortality controls, stock sharing arrangements, etc
  - Can approaches be implemented that are robust to risks and uncertainties?
  - Are there ways to plug the knowledge and uncertainty gaps?

Bringing it together

- Building climate-appropriate fishery management can seem daunting and overwhelming
- Failure to tackle this challenge will create immense human and conservation problems
- We can provide structure to the climate and fishery challenge that allows us to begin moving forward
- When we do this, it becomes clear that we know enough to begin taking action now

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