

Testing a Framework for Assessing the Vulnerability of Four U.S. West Coast Fisheries to Climate Change

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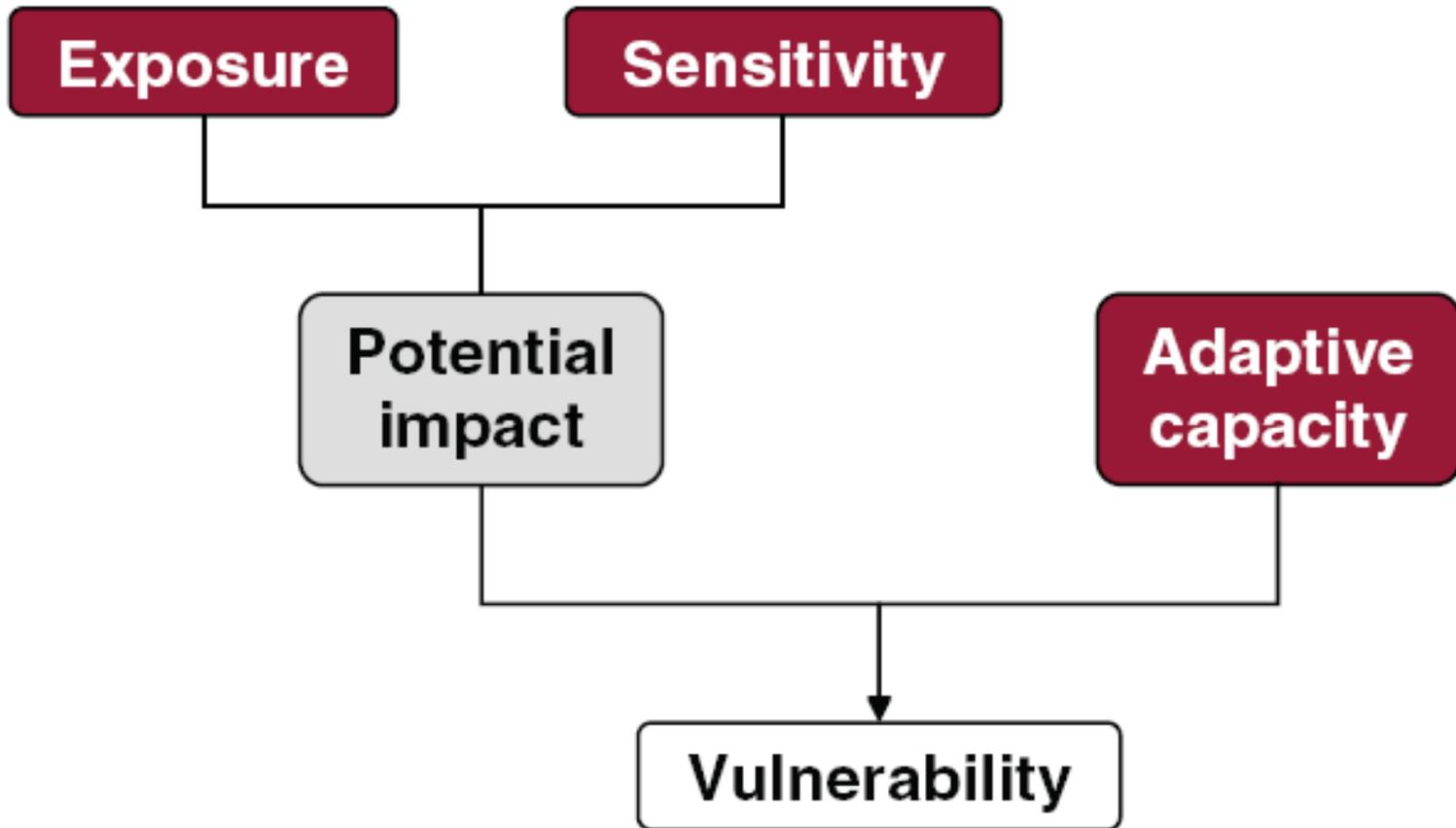
University of Washington
Climate Impacts Group,
College of the Environment

National Adaptation Forum
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*Climate
Science in the
Public Interest*

Components of Vulnerability



Exposure + Sensitivity – Adaptive Capacity = Vulnerability

Why a Rapid Assessment?

- Traditional modeling for an individual species (much less multiple species) can require substantial data, resources, and time.
- The rapid assessment methodology combines expert knowledge [*scientists, managers, fishermen*] with published literature to assess vulnerability.
- As such, the rapid assessment approach:
 - Can be applied in data-poor situations
 - Can be done quickly and inexpensively for many species



Sablefish



Pacific Whiting



Dungeness Crab



Canary Rockfish

A photograph of a sablefish, a large, silver fish with a dark stripe along its side, swimming in clear water.

Representative of
important commercial
fisheries in
Washington, Oregon,
and California

Sablefish

A photograph of a Pacific whiting, a silver fish with a prominent dorsal fin, swimming in clear water.

Varying life histories
with different
sensitivities to climate*

* Important for methodology

Pacific Whiting

A photograph of a Dungeness crab, a large, brown and orange crab, resting on a dark, rocky surface.

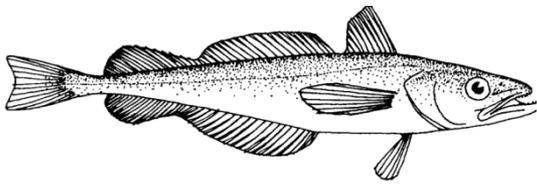
Some published
literature related to
climate impacts
available*

Dungeness Crab

A photograph of a canary rockfish, a small, colorful fish with a yellow and orange body, swimming in clear water.

Species of interest for
NOAA California Current
Integrated Ecosystem
Assessment, Pacific
Fishery Mngmt Council;
state/tribal managers

Canary Rockfish



Approach Taken

Prior to the Workshop

- **White Papers developed**
 - Used to “jump start” the process; sent in advance
 - Overview of species life history and fishery
 - Preliminary evaluation and qualitative rating of *exposure* and *sensitivity* of the species and the human side of the fisheries to climate change (based on literature)

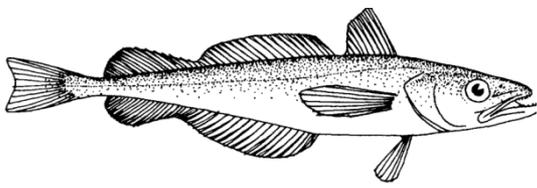
Qualitative Ratings Approach

Qualitative ratings for exposure, sensitivity, adaptive capacity, and vulnerability scored as follows:

		<i>Equivalent Score</i>	
		For Exposure, Sensitivity, Vuln.	For Adaptive Capacity*
<i>Rating</i>	High	3	1
	Medium-High	2.5	1.5
	Medium	2	2
	Medium-Low	1.5	2.5
	Low	1	3

In general, the closer you are to 3, the worse off things are

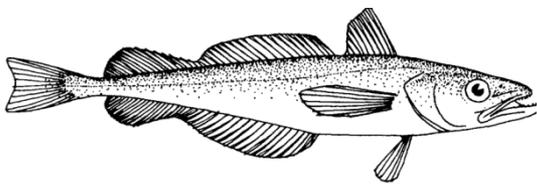
* Reversed because of use of averaging



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- **Interviews conducted**
 - To assess thoughts and opinions on climate change and the target fisheries



Approach Taken Cont'd

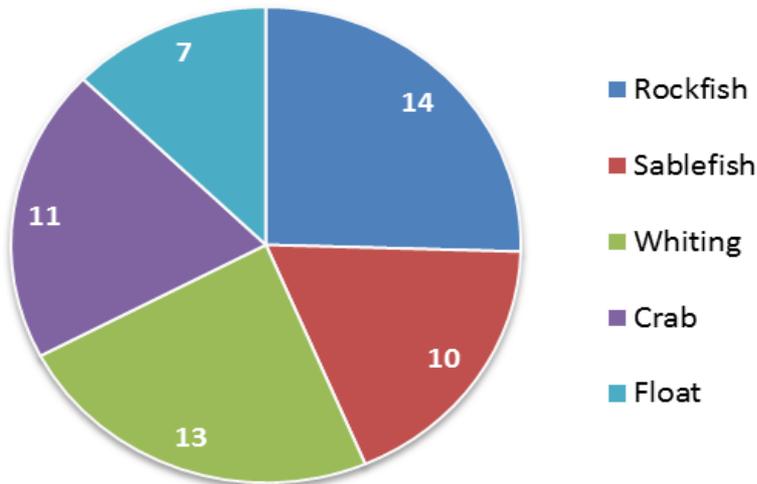
During the Workshop

- **Extensive use of breakout groups**
 - Review, discuss, and modify *sensitivity* and *exposure* ratings provided in paper
 - Identify and rate *adaptive capacity* attributes and vulnerability
- **Final compilation** of exposure, sensitivity, and adaptive capacity scores for overall vulnerability rating

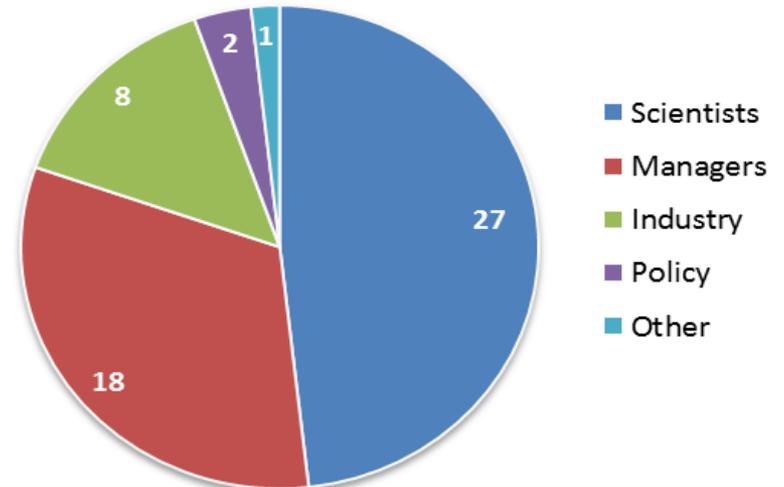
Who Participated?

55 scientists, managers, fishermen, processors from Washington, Oregon, and California

Final Participant Breakdown by Fishery Breakout Group

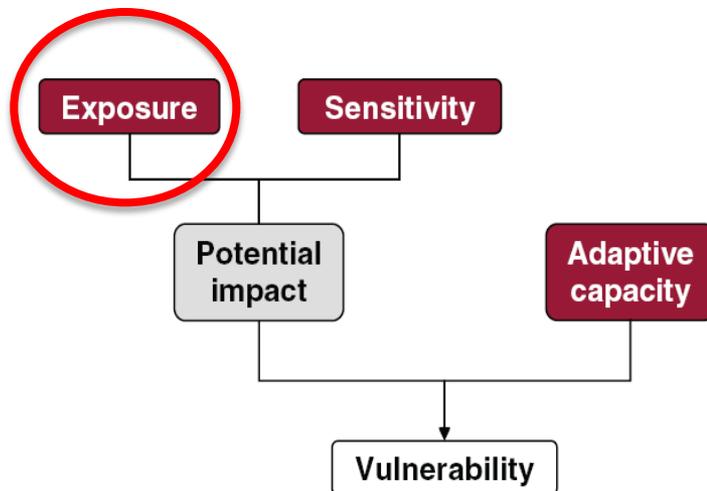


Final Participant Breakdown by Professional Category



Exposure Attributes & Results

Exposure - the degree to which a stock or fishery *experiences* changing climatic conditions



Exposure Attributes

- Sea Surface Temperature
- Ocean acidification
- Ocean current changes
- Changes in upwelling
- Interannual and interdecadal cycles
- Sea level rise and wave height
- Changes in storm intensity

Rockfish Exposure

No changes

Exposure Attributes	Attribute Rating	Score	Overall Exposure Rating
Sea Surface Temperature	Medium	2	Medium High 2.4
Ocean Acidification	High	3	
Ocean Current Changes	High	3	
Changes in Upwelling	High	3	
Interannual and interdecadal cycles	Medium	2	
Sea Level Rise and Wave Height	Medium	2	
Changes in Storm Intensity	Medium	2	

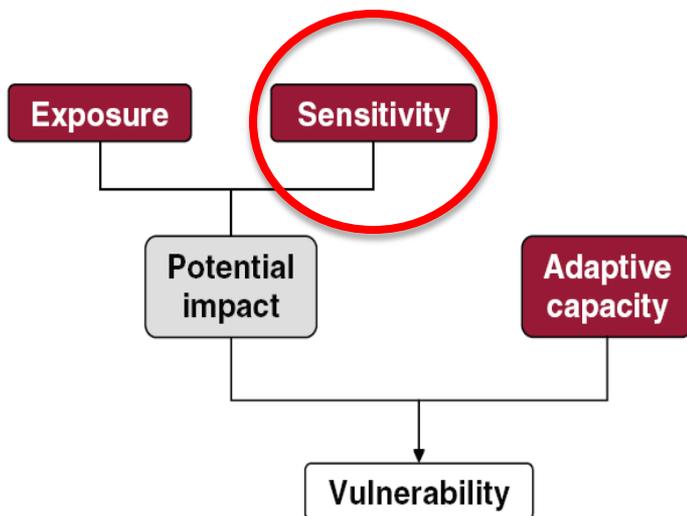
Reminder about numbering for exposure and sensitivity: The closer you are to **3**, the **worse** things are

More than just scores... Example of qualitative information gathered in discussion

Attribute	Rating (High, Med, Low)	Reasons for Rating
Stock Status	Low	<p>Since it's pretty depressed, having been overfished most places for a long time, with impacts on age structure, reproductive success, fecundity... that impairs its adaptive capacity.</p> <p>How to define what low means? Because the stock is depressed or because its depressed status impairs its capacity. It's life history is truncated from what it was <u>historically</u>... additional stressors on the health of the stock. Uncertainty about that but it's not as good as it used to be.</p> <p>It's an overfished status, not endangered or threatened. It's not 2% or 1%, it's 20 to 30% each.</p> <p>There have been changes in the age structure. The average age of maturity has gotten younger. Smaller average age at reproduction would lead to variability in recruitment would be greater. Lower rebound capacity of the population than when the age structure was more normal with large fat females dominating the reproductive part of the population.</p> <p>The adaptive capacity of canary rock fish due to its existing stock status is low.</p>
		<p>Low because canary rockfish is managed under a rebuilding program and while it is rebuilding, there is a distribution of adult ages toward the low end of the age/size spectrum.</p> <p>Stock status is not depleted. It's rebuilding. But is it to its <u>prefishing</u> age and size structure? That's arguable. Interaction with impacts from climate change- does that make it more resilient? Life history features- <u>is</u> the stock more at risk?</p>

Sensitivity

Sensitivity - the degree to which a stock or fishery *changes in response to* changing climatic conditions



Sensitivity Attributes

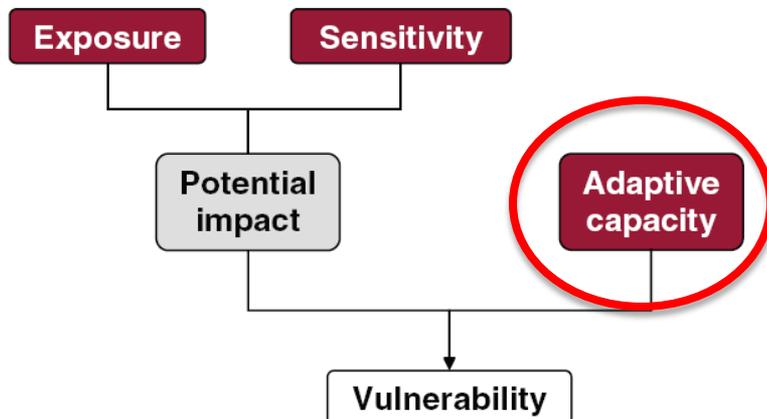
- Changes in plankton productivity
- Changes in larval and adult growth, development, survival
- Changes in adult reproduction
- Changes in species ranges and distribution
- Changes in fishing risks and practices
- Changes in fishery infrastructure
- Economic dependence on fishing

Rockfish Sensitivity

Sensitivity Attributes	Attribute Rating	Score	Overall Sensitivity Rating
<i>Stock Attributes: Rockfish</i>			
Changes in plankton productivity	High	3	Medium-High: 2.6 <i>(was 2.7)</i>
Changes in larval growth, development and survival	High	3	
Changes in adult growth and development	Medium	2	
Changes in adult reproduction	High	3	
Changes in species ranges and distribution	Medium	2	
<i>Human Dimensions Attributes : Rockfish</i>			
Changes in time and space of groundfish distribution	Medium	2	Medium-High: 2.4
Changes in the availability of groundfish	High	3	
Changes in fishing risks and practices	Medium	2	
Changes in fishery infrastructure	High	3	
Economic dependence on fishing	Medium	2	
Total Sensitivity Rating			Medium-High - 2.5 <i>(was 2.6)</i>

Adaptive Capacity

Adaptive Capacity - the degree to which a stock or fishery *can adjust to* changing climatic conditions



Adaptive Capacity Attributes

- Stock Status
- Reproductive potential
- Fishing pressure and practice
- Species mobility
- Species range (adults)
- Species range (Juvenile)
- Pollution
- Ability to fish other stocks
- Management flexibility
- Cultural dependence

Rockfish Adaptive Capacity: Stock

Adaptive Capacity Attributes	Attribute Rating	Score	Overall AC Rating
Stock Status	Low	3	Medium-high 1.4
Reproductive potential	High	1	
Fishing pressure and practice	High	1	
Species Mobility	High	1	
Species Range (adults)	High	1	
Species Range (Juvenile)	Medium	2	
Pollution	High	1	

Reminder about numbering for adaptive capacity: The closer you are to **1**, the **better** things are (reversed because of approach's use of averaging)

Rockfish Adaptive Capacity: Human Dimensions

Adaptive Capacity Attributes	Attribute Rating	Score	Overall AC Rating
Dependence of West Coast shelf fisheries on canary rockfish during rebuilding	Low	3	Medium 2.2
Ability to fish other stocks	Medium	2	
Management Flexibility	Medium	2	
Cultural dependence (rural)	Low	3	
Cultural dependence (urban)	High	1	

Reminder about numbering for adaptive capacity: The closer you are to **1**, the **better** things are (reversed because of approach's use of averaging)

Final Vulnerability Ratings

	Exposure	Species Sensitivity	Human D. Sensitivity	Species Ad. Cap.	Human D. Ad. Cap.	Average	Rating
Rockfish	2.4	2.6	2.4	1.4	2.2	2.2	<i>Med</i>
Sablefish	1.9	2	2	1.3	1.5	1.7	<i>Med-Low</i>
Whiting	2.4	2.3	1.3	1.6	1.3	1.8	<i>Med-Low</i>
Crab	2.5	2.6	2.3	1.8	2	2.2	<i>Med</i>

Lessons Learned: Applying the Methodology



In one sense, successful:

- Deconstructed climate change vulnerability and better defined what influences vulnerability (e.g., via attribute identification)
- Identified the relative significance of the individual attributes (e.g., changes in upwelling vs SST)
- Identified which components (e.g., exposure vs adaptive capacity) of vulnerability drive overall vulnerability within and between fisheries
- Proved to be an effective and constructive method of stakeholder engagement

On the other hand, a lot of work is needed....

- Starting point of assessing vulnerability (e.g., rather than resilience) may bias process against identifying benefits (through choice of attributes, etc.)
- Required separation of attributes within and across categories seemed artificial
 - Systems are complex and interrelated. Hard to isolate attributes; some attributes affected others (e.g. larval survival and reproduction)
 - Wanted to evaluate life stages separately; attributes ratings differ with larvae vs adult stages

- **Challenge of scale – many winners and losers in the same category.**
 - geographic scale, fleet vs community vs individual
- **Attributes characterized as “Changes in...” made it hard to evaluate**
 - Some positive, some negative (lack of specificity about attributes)
- **Qualitative rating difficult**
 - Need better definition of high/med/low
 - Need way of weighting for confidence, significance of the attribute as a change agent, or other criteria

Other Observations...

- Difficult to fully integrate the human dimension (scale and data were an issue)
- Groups had different approaches for adjusting for uncertainty (e.g., a reflection of risk tolerance and sensitivity)
- Downgrading of human dimensions sensitivity by most groups
- Should results be compared against one another? How would that affect the approach?

Parting Thoughts

“Well it’s funny, you’re causing me to think by some of your questions.... some of the things that you are asking are things that we really haven’t considered, to be honest with you.”

– Subject 9, during interview



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For more information:

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