Comparing Climate Vulnerability Assessment of Fish and Shellfish Resources across Large Marine Ecosystems

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Some of our workshop goals:

1. Compare and contrast various climate vulnerability assessment (CVA) approaches used for fisheries and aquaculture including their strengths and weaknesses,

2. Discuss opportunities for comparative studies looking at the relative vulnerability of species in different LMEs,

3. Discuss best practices for extending vulnerability assessments of marine fish and invertebrates to the human communities that depend on these resources,

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- Incorporate climate change text into ecosystem overviews (ICES)
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Frameworks…

Adapted from Cinner et al. 2013
Comparisons of 25 CVAs

- Location
- Project name
- Rationale/Purpose
- Targeted users
- Finest scale (unit of analysis)
- Biological component (Y/N)
- Species / habitat focus
- Socio-ecological component (Y/N)
- Socio-economic scale?
- Physical CC scenario(s) (e.g. RCPs) examined
- Capturing uncertainty
- Timeframe covered
- Stage of completion
- Key resources needed
- What would you change if repeated?
- Application: stakeholder engagement, outreach
- Literature citation
- Website info
25 Climate Vulnerability Assessments at WKSICCMCE-CVA

CA West
Alaska OA (soc)
Salmon
Forage fish
California Current

Global
Nereus (23)
OA-Coral (24)
Fisheries (25)

AWA/PREFACE (soc)

NE (soc/biol)
GoM (soc/biol)
CERES (soc/biol)
ClimeFish (soc/biol)
UK ARP

NE (soc)
Coral (soc)

OA 24 states

CA East

(11)
(12)
(3,4)
(5,6)
(8,9)
(22)
(10)
<table>
<thead>
<tr>
<th>Project Description</th>
<th>Region</th>
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<tbody>
<tr>
<td>Southeast Australia Rapid (1)</td>
<td>Australia</td>
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<tr>
<td>Gulf of Carpentaria (2)</td>
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<tr>
<td>Eastern Canada, CVA (3)</td>
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<tr>
<td>E Canada Coastal Infrastructure (4)</td>
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<tr>
<td>Pacific Coastal Waters (5)</td>
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<td>Pacific Canada Infrastructure (6)</td>
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<td>UK ARP (7)</td>
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<tr>
<td>CERES (Fisheries (8))</td>
<td>Europe</td>
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<tr>
<td>CERES (Aquaculture (9))</td>
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<td>ClimeFish (Europe (10))</td>
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<tr>
<td>US East Coast CVA (11)</td>
<td>USA Pacific</td>
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<td>USA 24 Coastal States (12)</td>
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<td>USA NE Shelf (13)</td>
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<tr>
<td>USA, Shellfish OA (14)</td>
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<td>California Current (15)</td>
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<td>NE Pacific Salmon (16)</td>
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<td>Forage Fish automated CCCVA (17)</td>
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<td>Eastern Bering Sea (18)</td>
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<td>Alaska Fisheries OA (19)</td>
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<td>East Africa (20)</td>
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<td>Arabian Gulf (21)</td>
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<td>Caribbean Coral (22)</td>
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<td>Coral Reefs OA (23)</td>
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<td>Fisheries Global (24)</td>
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<td>Nereus Program (25)</td>
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</tbody>
</table>
- **Abundance** – life history traits (fecundity, recruitment pattern, longevity, feeding type, habitat dependence)
- **Distribution** – larval dispersal, adult movement, physiological tolerance, available habitat (range shift capacity)
- **Phenology** – environmental cues, spawning & moulting duration, migration
Combined Regional Assessments → Gear Type → Fisheries

Beth Fulton & Alistair Hobday & Gretta Pecl

Fulton et al. 2017
Ongoing (national-level) Climate Vulnerability Assessments in Europe

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EU H2020

Temperature sensitivity (based on Tmax & range)

Biological sensitivity (based on traits)

Exposure Score (°C)

Sensitivity Score (trait-based)

Mark Payne Marie-Ann Blanchet Michaela Aschon
Tiered approach to CVAs for US large marine ecosystems

See Morrison et al. 2015; Hare et al. 2016; Colburn et al. 2016

Holsman et al. 2017
### West Coast CVA Preliminary Results

<table>
<thead>
<tr>
<th>Biological Sensitivity</th>
<th>Climate Exposure</th>
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<tbody>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
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</tbody>
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#### Green Sturgeon
- Yelloweye Rockfish - Puget Sound

#### Chinook salmon
- Bocaccio Rockfish - Puget Sound

#### Coho salmon
- Sockeye salmon
- Steelhead Salmon
- Black Rockfish
- Bluefin Tuna
- Canary Rockfish
- Chum salmon
- Yelloweye Rockfish
- Pacific ocean perch
- Spiny dogfish
- Yellowtail Rockfish

Haltuch et al. *in prep*

5 out of 6 are anadromous.
Salmon-specific CVA

Crozier et al. in prep
Spread of distinct population segments within each species

Number of DPSs

- Chinook
- Coho
- Sockeye
- Steelhead
- Chum
- Pink

Crozier et al. *in prep*
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Trait-based approach (comparisons across LMEs)

- MAXIMUM LENGTH
- TROPHIC LEVEL
- LIFESPAN
- FECUNDITY
- EGG DEVELOPMENT
- EGG SIZE

- Pelagic
- Benthic
- Guarders
- Bearer

- Opportunistic
- Equilibrium
- Periodic
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- Discuss opportunities for operationalizing CVA methods.
Infrastructure | Institutions | Economic resources | Technology | Information and skills

Equity

Indicators based on:

Adaptive Capacity

Vulnerability (social)

Adaptation

Policy

Climate

Vulnerability (physical)

World development

Global greenhouse gases

Global climate models

Regionalisation

Impacts

Dessai & Hulme 2004

Biological - Top-down approach

Social - Bottom-up approach

Past

Present

Future

Global

Local
Socio-ecological Vulnerability (combine or not to combine?)

Colburn et al. 2016 Mar Pol
Some take-home messages

• The 25 CVAs compared here used similar frameworks but components and methods depended heavily on the purpose and data availability.

• Opportunities exist to normalized results to facilitate inter-regional comparisons which could be useful for global-level prioritization such as UN SDG-14

• Few analyses integrated vulnerability rankings based on both biological resources as well as social and economic indicators of human communities – work is ongoing...

• CVAs of fish & shellfish are often conducted at large (basin-) scales that limit the potential gains in knowledge relevant to human management systems and communities (a barrier to socio-ecological CVAs).

• Importance of how results communicated to stakeholders (policy) was an important discussion at the workshop.

• A paper stemming from this workshop / report is in prep. (the report can be accessed at https://goo.gl/VDDG7g)
Thank you! Questions?

Not pictured: William Cheung, Jörn Schmidt