Fish on the move: Tools to support EBFM in facing challenges associated with species range shifts

Tessa Francis, Phil Levin, Andre Punt
Ocean Modeling Forum
University of Washington
Pinsky et al. 2013

Distribution shifts 1968-2011
Challenges

- Multiple governance structures
- Multiple harvest rules
- Multiple fleets
- Access & equity (mobile vs non-mobile fleets)

Morley et al. 2018
The Ocean Modeling Forum helps managers, scientists, and the ocean community use models to take on complex ocean issues.
OMF working groups address pressing ocean management topics using diverse modeling methods. Working group members are scholars from a range of natural and social scientific disciplines who work in an integrated and collaborative manner. Scientists work alongside stakeholders and managers to co-develop goals, approaches, and outputs.

Multiple jurisdictions
Mobile and nonmobile fishers

Equity and access
Pacific Sardines
What are the ecosystem impacts of Pacific sardine harvest?

Pacific Herring
How can we better incorporate human dimensions into the management of forage fish and their ecosystem?
Case study 1: Pacific sardine

How can we evaluate ecosystem impacts of fisheries,

under three nations' harvest rules,

for species with international distribution that varies with environmental conditions?
Case study 1: Pacific sardine

Hill, Crone and Zwolinski 2017 stock assessment

Schweigert 2002
## Case study 1: Pacific sardine

### Working group members

<table>
<thead>
<tr>
<th>Fisheries Modelers</th>
<th>Management Agency</th>
<th>Ecologists</th>
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<tr>
<td>André Punt</td>
<td>Kerry Griffin (PFMC)</td>
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<td>Alec MacCall</td>
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<td>Tessa Francis</td>
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| NGO                      |                                          |                           |
|--------------------------|                                          | Steve Marx                |

| Ecosystem Modelers       |                                          |                           |
|--------------------------|                                          | Isaac Kaplan              |
|                         |                                          | Laura Koehn               |
|                         |                                          | Tim Essington             |
|                         |                                          | Kirstin Holsman           |

| Fishing Industry         |                                          |                           |
|--------------------------|                                          | Richard Parrish           |

| Oceanographers           |                                          |                           |
|--------------------------|                                          | Francisco Chavez          |
|                         |                                          | Enrique Curchitser        |
Case study 1: Pacific sardine
MICE: model of intermediate complexity

PREY MODEL
- Sardine
- Anchovy
- Other forage
- Other prey

PERFORMANCE

HARVEST CONTROL RULE
- 3 countries

PREDATOR MODEL
- Pelicans
- Sea lions

Restricted to management questions
Parameterized using data
With process error

Punt et al. 2016
Case study 1: Pacific sardine
MICE: model of intermediate complexity

Spatially- weekly-, and age-structured recruitment driven by SST

movement driven by biomass

October - high

October - low

Punt et al. 2016
Case study 1: Pacific sardine

MICE: three harvest rules

Catch = 5% of the biomass above 150,000mt

Constrained to be <22,000 mt

HG = \text{MAX}(0.87\times\text{FRACTION}\times(B1^+ - \text{CUTOFF}), \text{MAXCATCH})

FRACTION depends on temp

Constant fishing mortality

Set to achieve the average catch from 1981-2009

Punt et al. 2016
Brown pelicans are more sensitive to sardine fluctuations.
Case study 1: Pacific sardine

Conclusions

• Forming a working group with representatives from the jurisdictional areas (Canada, USA, Mexico) led to realistic modeling of multiple unique harvest rules.

• EBFM motivation – understanding influence of fishing on predators with different foraging strategies, given environmental drivers of recruitment, multiple prey species, food web dynamics – required expansion into multiple jurisdictions.

• Development of simple-ish model afforded opportunity to complexify spatial structure, incorporate multiple harvest rules.

• Sea lions fare better than pelicans.
Case study 2: Pacific herring

How can we evaluate tradeoffs between mobile and nonmobile fisheries of fisheries management?
Case study 2: Pacific herring
Local scale matters for non-mobile fishers dependent upon the resource

Courtesy of Dan Okamoto
Case study 2: Pacific herring

Operating Model

Metapopulation:
- Spatial structure
- Migration behavior

Management Scenarios:
- Limit threshold
- Harvest rate
- Spatial closures

Outputs:
- Catch
- Spawning biomass in space/time

Dan Okamoto
Case study 2: Pacific herring

- Haida Cultural Continuity
- Access
- Food Practices
- Well-being
- Governance
- Marine Economy
- Commercial SoK & Roe Harvest
- Other Harvest
- Traditional K’aaw Harvest

Social/cultural benefits for indigenous and non-indigenous users

- Ability to practice harvest
- Access to food
- Community / social relationships
- Opportunity to enjoy herring

Melissa Poe & Russ Jones

OMF
Case study 2: Pacific herring

Ecological benefits
- CL risk avoidance
- Traditional Community
- Traditional Practice

Non-mobile fishery benefits
- Commercial Practice
- Yield
- Years fishery open

Mobile fishery benefits
- Catch stability
- Biomass

Dan Okamoto
Case study 2: Pacific herring

Conclusions

• Forming a working group with representatives from the different fisheries, the managers, traditional knowledge holders, and social scientists allowed for realistic evaluation of tradeoffs

• Traditional knowledge informed modeling

• In this case, the tradeoffs are strongest with spatial management strategies, not harvest thresholds or limits – protecting local areas for non-mobile access may be important.
Thank you

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