... As Forage in the Ecosystem:
The Demand for Ecosystem Valuation

IIFET 2018, Seattle WA

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In 2015 Fisheries Managers in New England wanted:

- A Harvest Control Rule (HCR) that accounts for the role of Atlantic herring in the ecosystem, including its role as forage
- A HCR that stabilizes the fishery at a level that achieves optimum yield
The Complex Food Web in the Northeast US

H. economicus

Whales

Large Pelagics

Tasty Groundfish

Herring

(Link, 2002)
My Takeaway from the Herring Experience

**Problem:**
Difficult to do ESV in complex multispecies systems on the timeline expected by fishery managers.

**Solutions:**
- More, different human resources?
- Better expectations-setting and communication with partners?
- Settle for “good enough”?
- Others?
Herring

- Mostly used for bait in the lobster fishery
- Some catch of juvenile haddock and river herring
- Two gears (Trawl offshore and Purse Seine inshore)
- The herring industry is small in numbers and has few allies
New England Fishery Management Council Goals

• “...conserve and manage the living marine resources of the United States of America by carrying out the business of the Council for the greatest overall benefit of the Nation.”

• “being careful to balance competing private or regional interests.”
“... the whale watching industry has been significantly impacted by the departure of whales ... due to the commercial removals of entire herring schools.” (2000)

“The herring fishery is eliminating forage that other species rely on... including cod, haddock and bluefin tuna, are likely being negatively impacted.” (2005)

a healthy inshore herring stock is critically important to lobster fisherman who use herring for bait (2007)

“...enough herring in the ocean will improve the chances of recovery for cod, tuna, whales, and seabirds.” (2015)
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The Dream

The herring harvest that produces the “greatest overall benefit” is the solution to this dynamic optimization problem:

$$\max_{h_t} \sum_{t=1}^{N} \delta^t \left( CS(h_t) + PS(h_t, X_t) + ESV_t(h_t, X_t) \right)$$

$$h_t, X_t = \text{harvest and biomass of herring}$$

$$ESV_t(h_t, X_t) = \text{annual flow of value from herring as forage in the ecosystem}$$

and some constraints, including a state-transition equation

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1Ragozin and Brown Jr (1985); Crocker and Tschirhart (1992); Finnoff and Tschirhart (2003); Brown, Berger, and Ikiara (2005)
So Many Ecosystem Services Need to be Valued!

How do changes in herring biomass work though the ecosystem to affect humans activities, including:

- Eco-tourism
- Non-consumptive or Passive Use
- Recreational Predator Fisheries
- Commercial Predator Fisheries

You have 1 year to figure out CS, PS, and ESV. What do you do?
The Dream vs The Reality

The Dream:

\[
\max_{h_t} \sum_{t=1}^{N} \delta^t \left( CS(h_t) + PS(h_t, X_t) + ESV_t(h_t, X_t) \right)
\]

The Reality:

\[
\max_{h_t} \sum_{t=1}^{N} \delta^t \left( CS(h_t) + PS(h_t, X_t) + ??? \right)
\]
Why?

1. Complex ecosystem
2. Timelines
3. NMFS is a little stovepiped
4. Me (instead of Dan or Kristy)
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(Link, 2002)
An Example: Recreational Fishing?

- Which predator fishery?
- What’s the relevant metric?
- Wait until the ecosystem model is done? Or take your best guess?

- Benefit Transfer (quick)
- Travel Cost Method to ongoing MRIP data collection? (quick)
- Develop and deploy a valuation survey (slow)
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Deroba, J.J. *et al.* “The dream and the reality: meeting decision-making time frames while incorporating ecosystem and economic models into management strategy evaluation” *Canadian Journal of Fisheries and Aquatic Sciences*. In Press.

Thanks to: MSE participants

The findings and conclusions of this article are those of the authors and do not necessarily reflect the views or opinion of NOAA Fisheries, NEFMC, or USGS.

