Fishery ecosystem reference points for stock dynamics

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Chair, Stock Dynamics QET

Home truths

- Informed decision making requires goals, status determination, and control rules that inform action
  - Indicators provide indication on current status and the trajectory of change
  - Reference points are elements of control rules that trigger action
- EBFM will require multiple indicators and reference points
- A variety of species respond to common environmental, habitat, exploitation and socioeconomic drivers, although their individual responses may differ.
- Indicators and reference point development focused on 5 keystone species
- Improvements in single species management will benefit EBFM, but by themselves will not “evolve” into EBFM

EBFM at the single species level

- Establish total mortality reference points (Z), not just fishing mortality (F) reference points
  - Z is often easier to measure than F
  - Z is what matters for sustainability, therefore setting the framework for EBFM
    - Reflects ecosystem considerations either implicitly or explicitly
  - Assess pattern of variability in Z
- Set F < M for all species
  - Considerable evidence of problems when F > M
  - Consider $F = x \cdot M$ policies

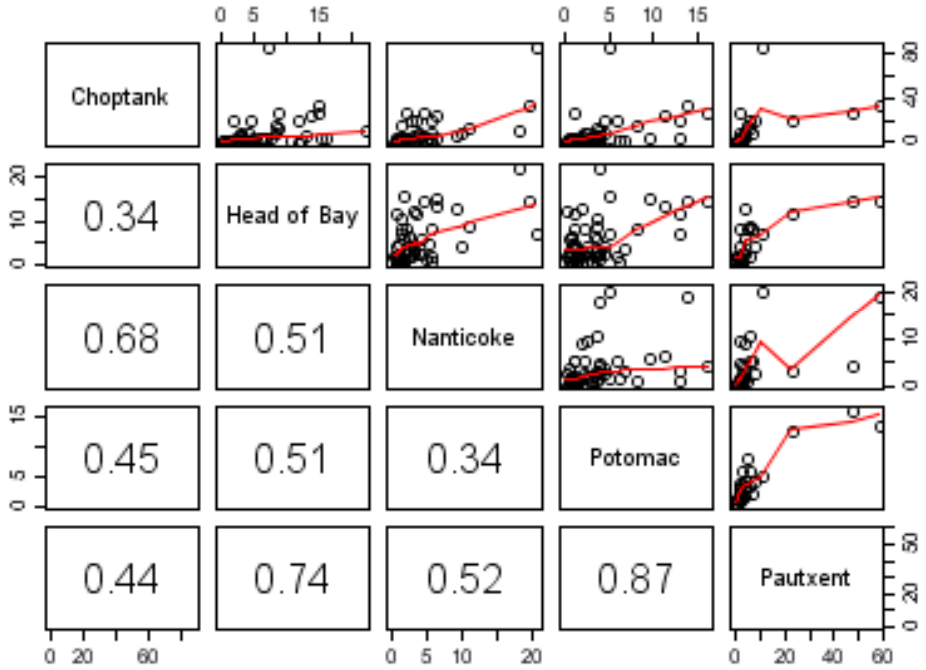
Abundance and structural reference points

- Establish abundance-based reference points for all species
  - Available for some species already, but all should be defensible, non-arbitrary goals
  - Higher N promotes reduced variability in recruitment
  - Higher N confers resilience to environmental stressors
- Consider population structure when establishing N-based reference points
  - Maintain and protect intra-population biodiversity
  - “Portfolio effect”

Population connectivity is common

- Demonstrated in white perch, striped bass. Likely present in menhaden, alosines and oysters
- Multiple sub-stocks provide insurance against failures of single year classes
- Establish sub-population reference points
- Explicit links to habitat fragmentation and habitat QET

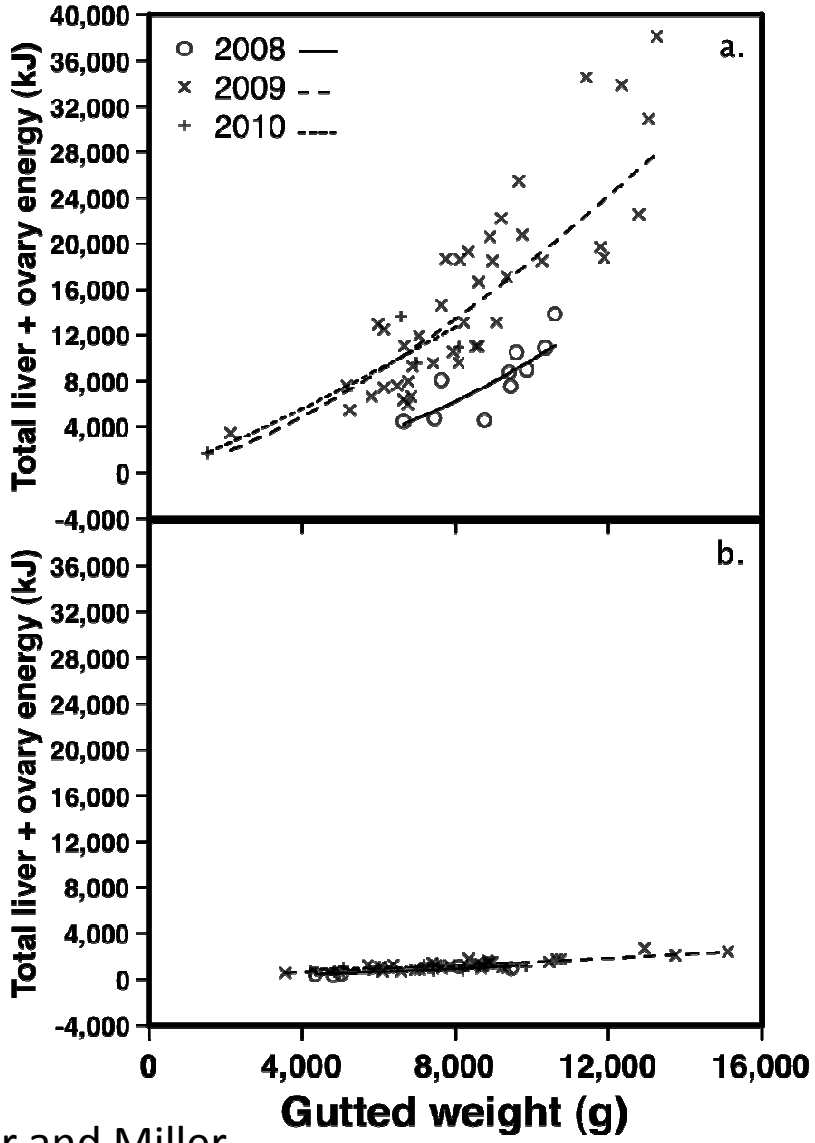
Striped bass seine survey correlations



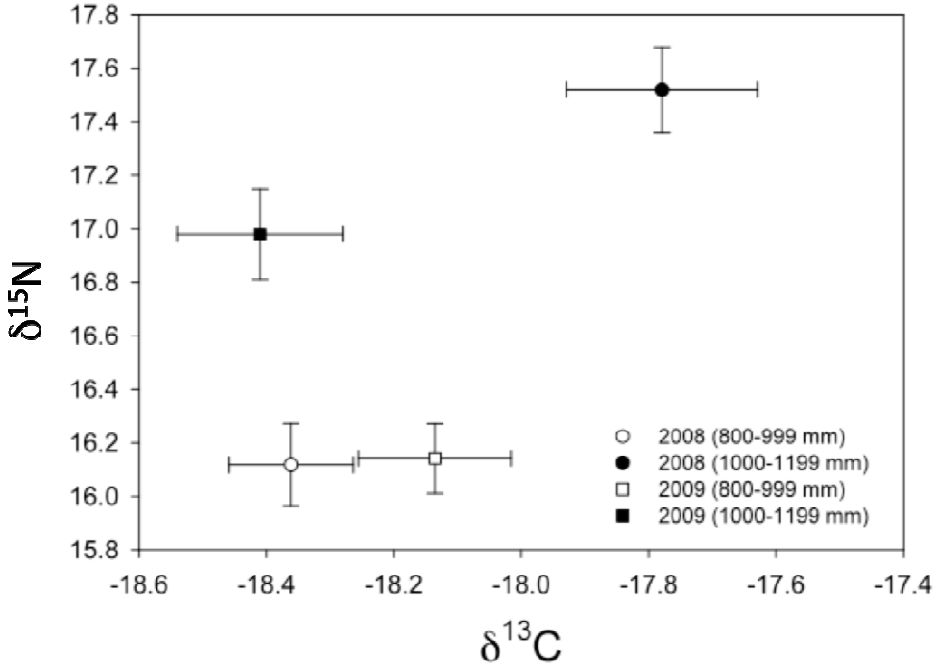
Age- and size-diversity indicators

- Maintain age diversity
  - Insurance against temporal variability
  - N-based or diversity based reference points possible
- Consider maternal effects
  - Some mothers are more “successful” than others
    - Clearly demonstrated in cod, & pacific rockfishes etc
    - Strong evidence in lab for striped bass
    - Growing evidence for striped bass in the field both inter- and intra-annually

Maternal effects in striped bass



Peer and Miller



- Inter-annual differences in energetic investment in spawning
- Linked to inter-annual differences in previous feeding history
  - Large females in 2009 had a lower trophic position and more marine-based diets
  - Suggesting role of menhaden?

Ecosystem-based indicators and reference points

- Consider indicators and reference points at different levels
  - Species groups – reflective of alternative "uses" involving specific interactions known to occur
    - E.g., menhaden – striped basses
  - Ecosystem level – reflective of emergent properties that arise only at this level
    - E.g., total system yield lower and less variable than the sum of the yields of individual species

“Allocation” reference points

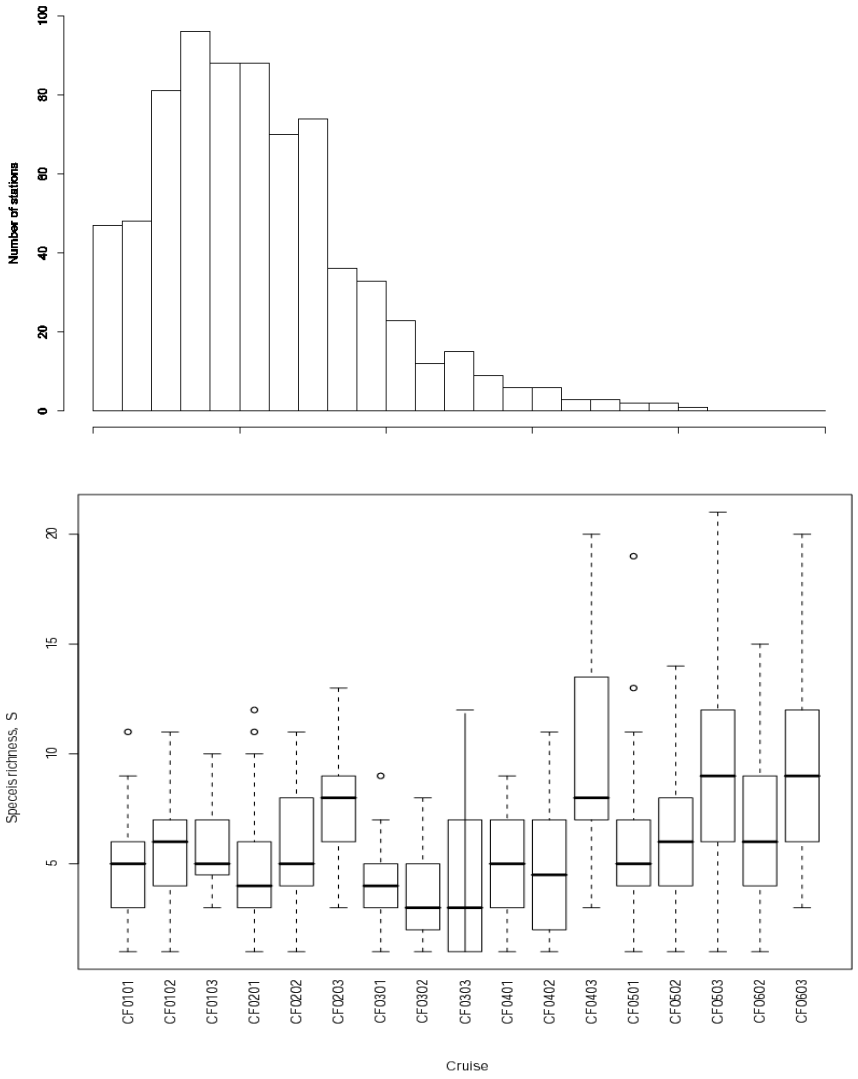
- Single species approach assumes all surplus production can be allocated to catch
- Ecosystem-based approach recognizes surplus production is required to support ecosystem services
  - Surplus production of prey should be allocated to support predators
  - Expressed as either a specification allocation (biomass) or an exploitation rate (M2)

Striped bass / Menhaden

- Estimate the trophic demand of striped bass population as a function of their abundance
  - Using EwE evaluate the potential of the ratio of striped bass to menhaden as an indicator of status
    - What is the inherent variability in the ratio?
    - What levels of removals lead to “preferred” ratio?
    - How responsive is the ratio to changes in harvest of either striped bass or menhaden?
- Multispecies surplus production models offer one pathway to explore this interaction to develop reference points

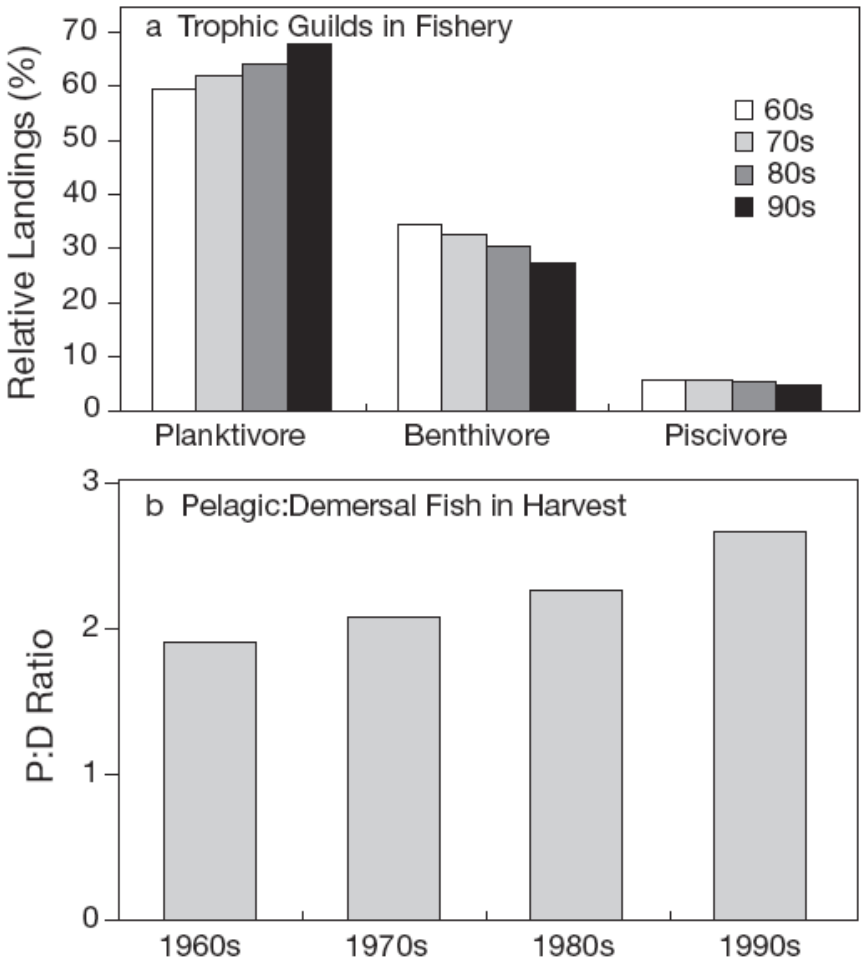
System indicators

- Indicators of system status
  - Monitor diversity and evenness metrics of surveys and catch
    - History of analysis
  - Track multivariate Index of system status
- Indicators provide information on the direction of change



Miller et al 2007

Other possible system indicators

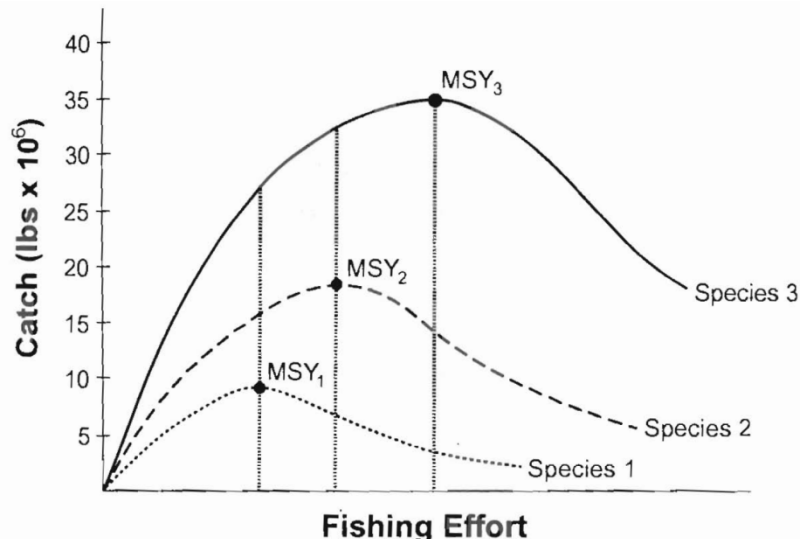


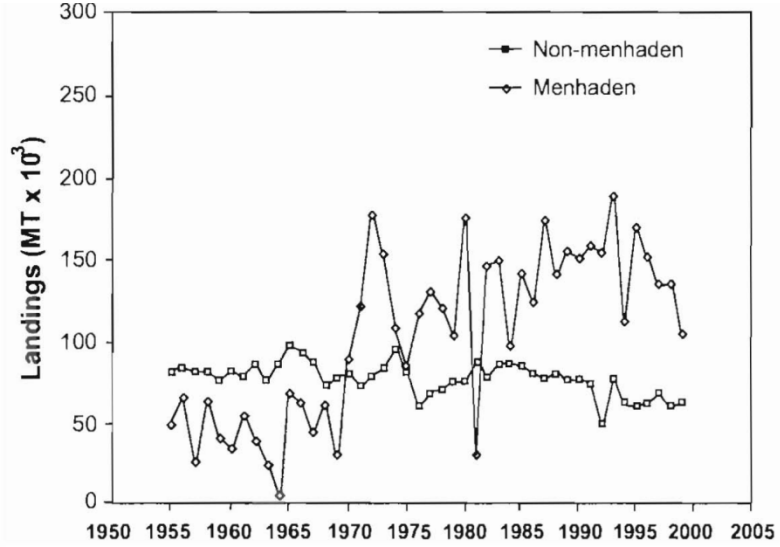
Kemp et al. 2005

- Ratio of benthic: pelagic biomass as in indicator of eutrophication
- Size-spectra
  - The distribution of biomass by size class shows a predictable relationship
    - Deviations from the prediction may indicate distburbance

Ecosystem-based reference points

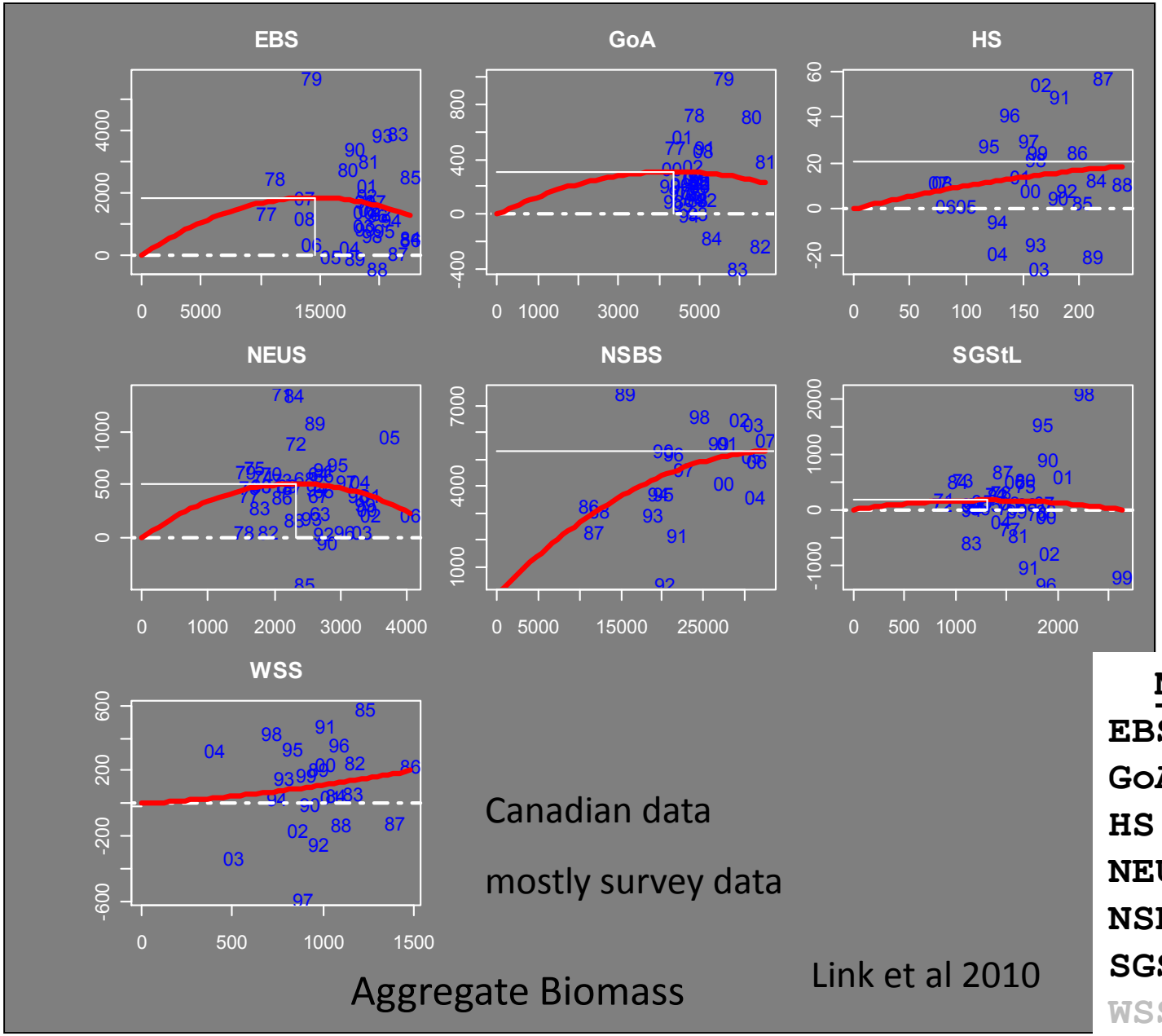
- EBFM involves trade-offs
- Ecosystem properties may not be the sum of its parts
  - Emergent properties
  - Aggregate catch is less variable than individual catch time series





FFEPTAP 2006

Aggregate ASP vs. aggregate biomass



	MSY (1000t)
EBS	1851
GoA	310
HS	21
NEUS	510
NSBS	5327
SGStL	166
WSS	-22

Ecosystem-level reference points

- Promote application of aggregate surplus production modeling to generate ecosystem-level reference points
- As an interim establish an empirical system-level catch limit ~ 300,000 mt (CFEPTAP 2006).
  - Promotes explicit recognition of trade-offs
  - Recognizes system level limits to production

How to move forward

- Many of the proposed steps require improvements to fishery-dependent and fishery-independent data
  - Invest in data infrastructure
    - QA/QC on catch records
    - Improvement, standardization and rationalization of scientific surveys
    - Application of new technologies

- Many of these proposed steps involve enhancements to the regions ability to conduct stock assessments
  - Invest in capacity building
    - Student training
    - Staff development
    - Regional consortia


BUT MOST IMPORTANTLY
SET GOALS