

Trophic Analytical Approaches

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3 Approaches

- Trophic transfer and declination
- Trophic-landings based indicators (with ELRPs/EOF delineations)
 - Implied fisheries production potential
- Ecosystem/Food Web models

Ways these measures can be used

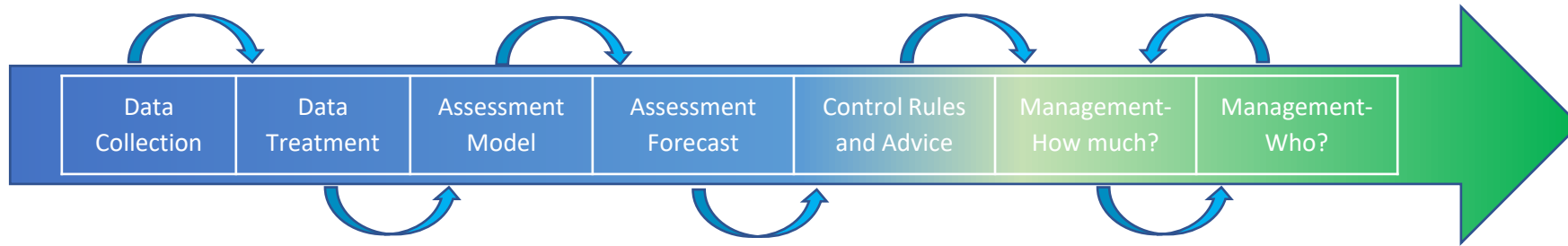
Directly to

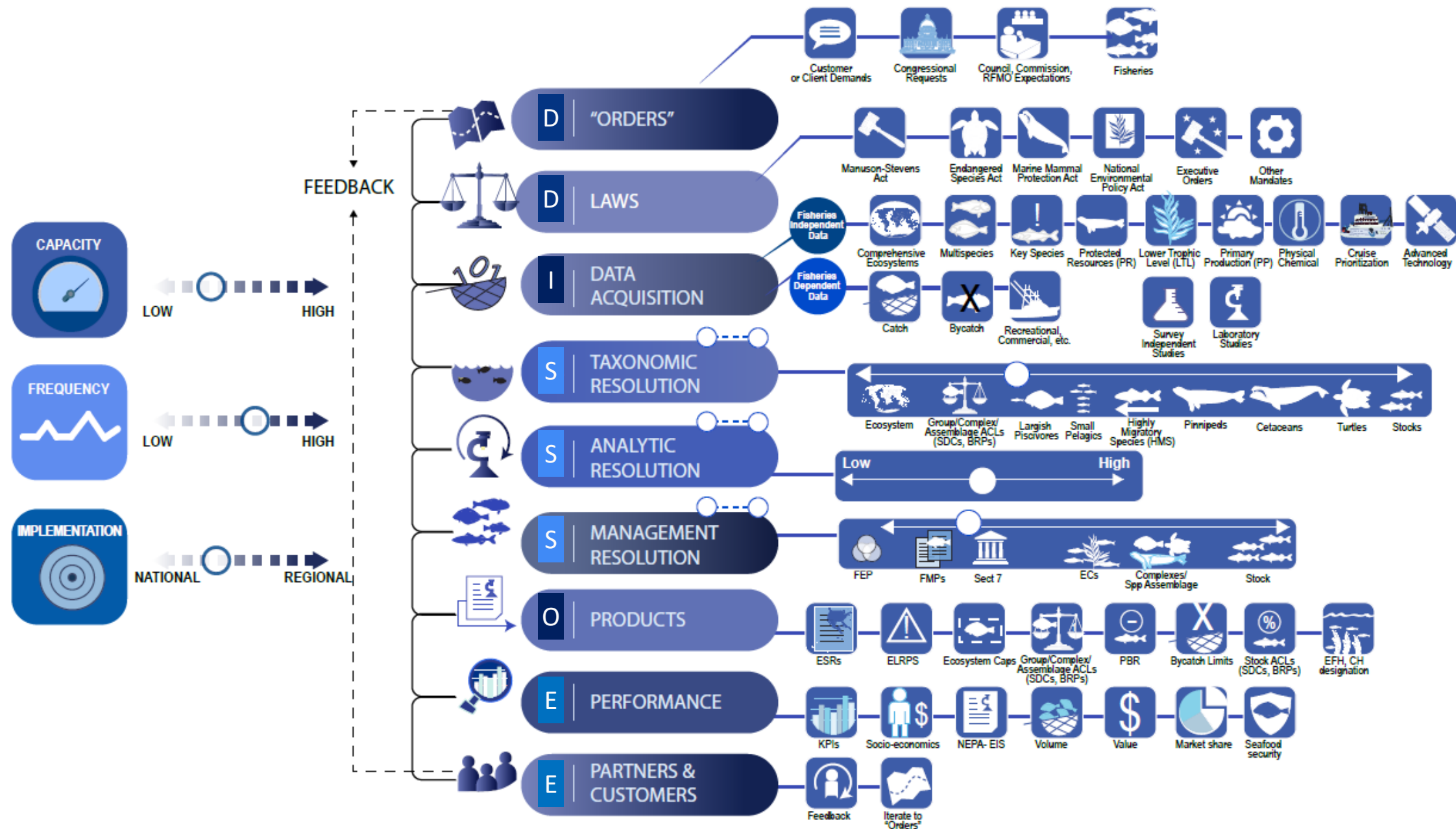
- set OFLs, ACLs, ACTs, SDCs, etc. of the ecosystem, guilds, etc.
- measure EOF
 - serve as comparable “Kobe” plots to delineate EOF when multiple are combined
- inform allocation, effort decisions
- evaluate (overall) fishery performance
- clarify expectations of what Fisheries Removals could be

Indirectly to

- provide context
- provide an ensemble “reality check”
- provide trade space within which systematic degradation is avoided
 - provide backstopping to all fisheries removals
- evaluate the best socio-economic options
- provide insights into system dynamics
- provide early warning signals of system-wide events

Should be viewed as part of a process (or work flow)
which combines a set of (different) analytical methods





Summary Up Front

- Method description: [Trophic Analytical Approaches](#)
- Data inputs (especially critical data and their viability now and in the future): [PP or chl a and Landings data of all/most species; TE and \$TL_c\$ for trophic declination; for Food web models, quite extensive](#)
- Analysis/data output summary: [EOF Indices, Limits on Fisheries Production Potential, Balanced model outputs of landings](#)
- How this method can inform management: [Potential Indicator of EOF, ELRPs](#)
- Caveats for this method: [Various methods in PP ensemble estimation, for trophic declination, assumptions about TL and TE values; inclusion of benthic/coral production](#)
- Previous applications of this method: [multiple, see list](#)
- Any graphs or diagrams to show for this method: [see more info](#)

Basic tenet of renewable natural resource mgt

$$R_{\text{removal}} \leq R_{\text{renewal}}$$

Everybody get the concept?



Facts of Life



- Total Oceanic Primary Production is on the order of $40\text{-}50 \text{ G ton C yr}^{-1}$ (Longhurst et al. 1995, Antoine et al. 1996, Duarte & Cebrian 1996, Carr et al. 2006; c.f. prior slide)
- Total Marine Capture Fishery Yield is on the order of $0.1 \text{ G ton yr}^{-1}$ (FAO 2016)

Limits to fishery production

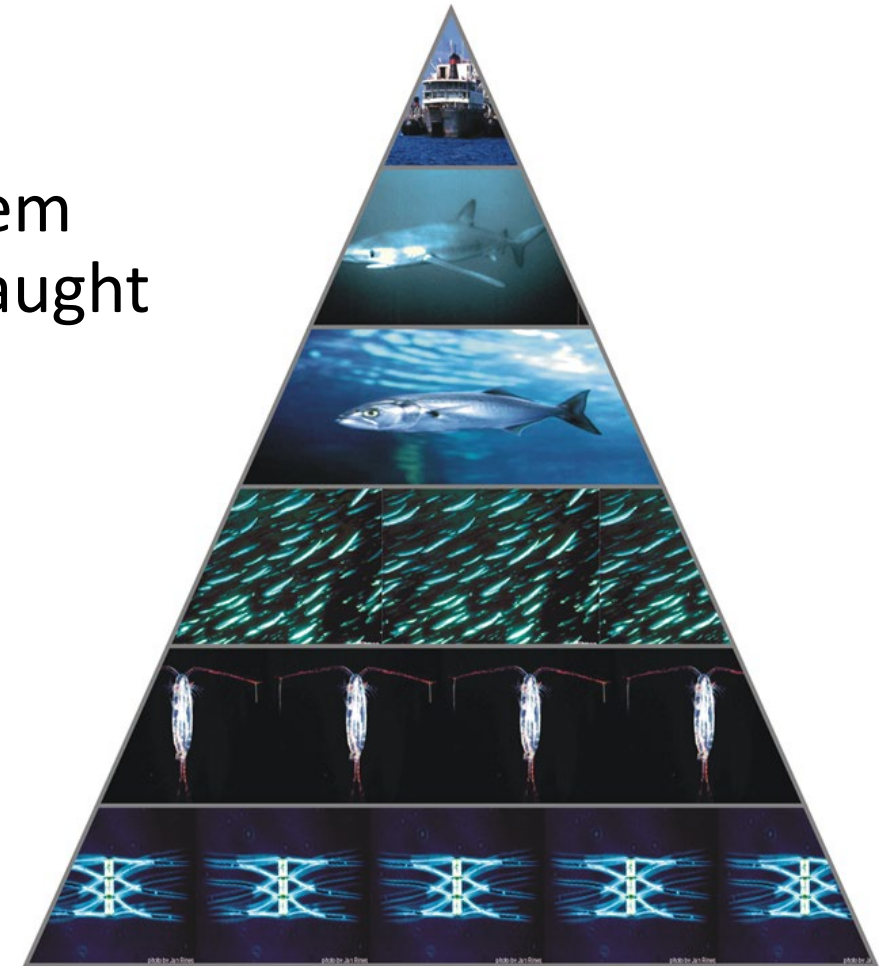


- Pauly & Christnesen 1995- primary production required (for catches, sure seemed off at the time, esp. in some places)
- Chassot et al. 2010- primary production limits fish production (builds upon historical considerations)
- Conti and Scardi 2010- ditto
- Friedland et al. 2012- ditto, pathways important
- Stock et al. 2017- ditto to Friedland
- Watson & Pauly 2014- primary production limits fleet options and dynamics
- Rosenberg et al. 2014- primary production limits fish production, pathways important
- Fogarty et al. 2016- ditto

Limits to fishery production

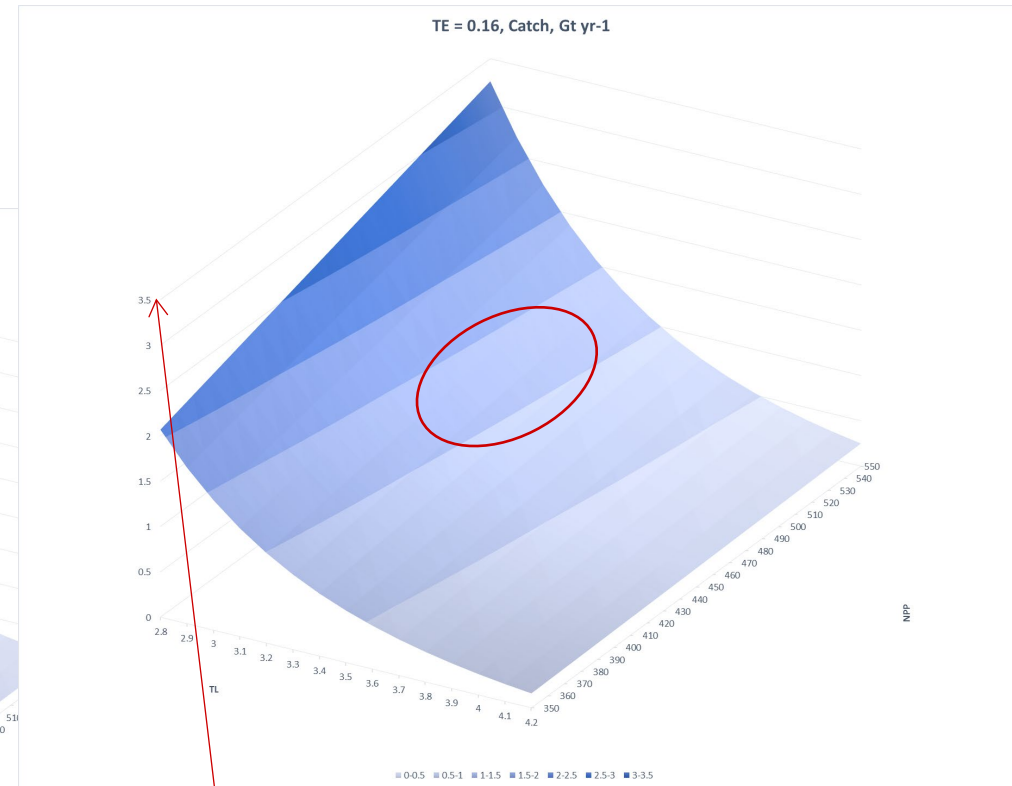
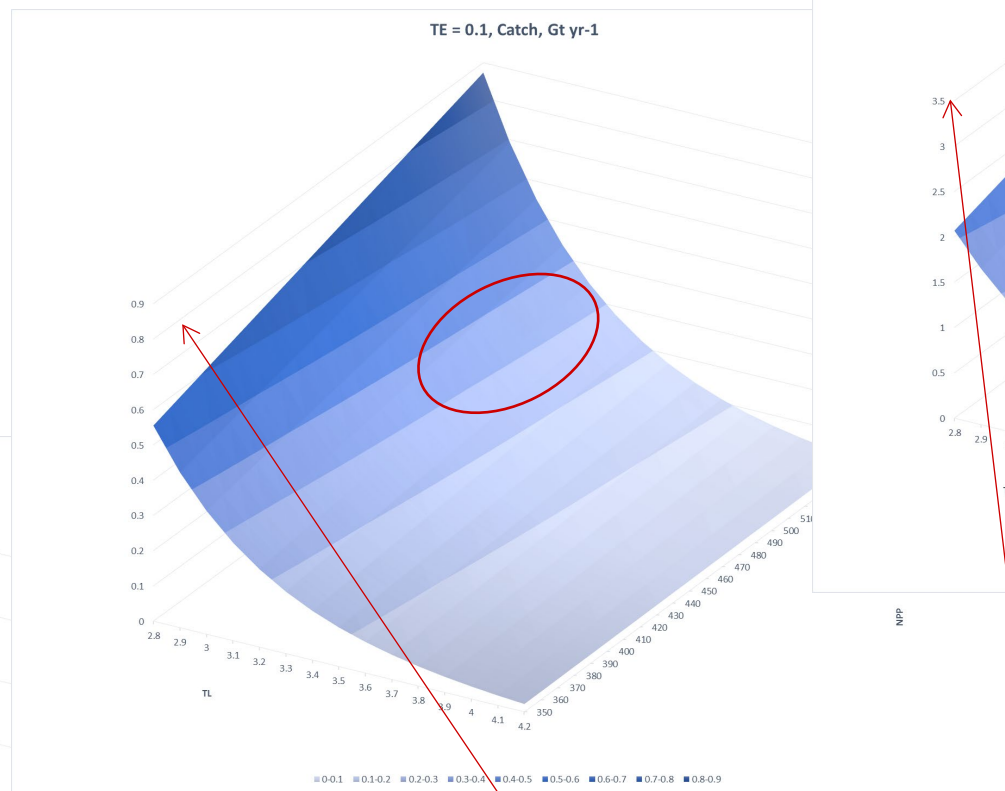
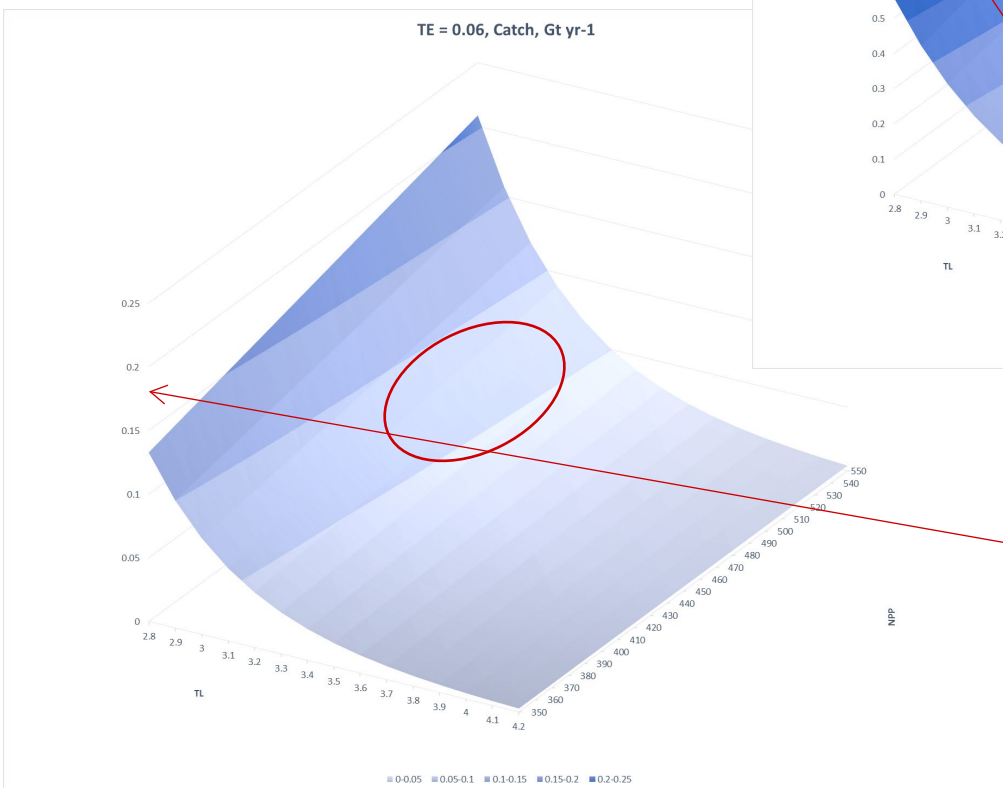
- There are limits to how much fish any ecosystem can produce, and hence can be (potentially) caught
- Transfer efficiency; math; pyramid & stuff...

$$C_{tot} = \alpha \sum_{i=1}^{TL} PP \cdot TE_i^{TL-1}$$



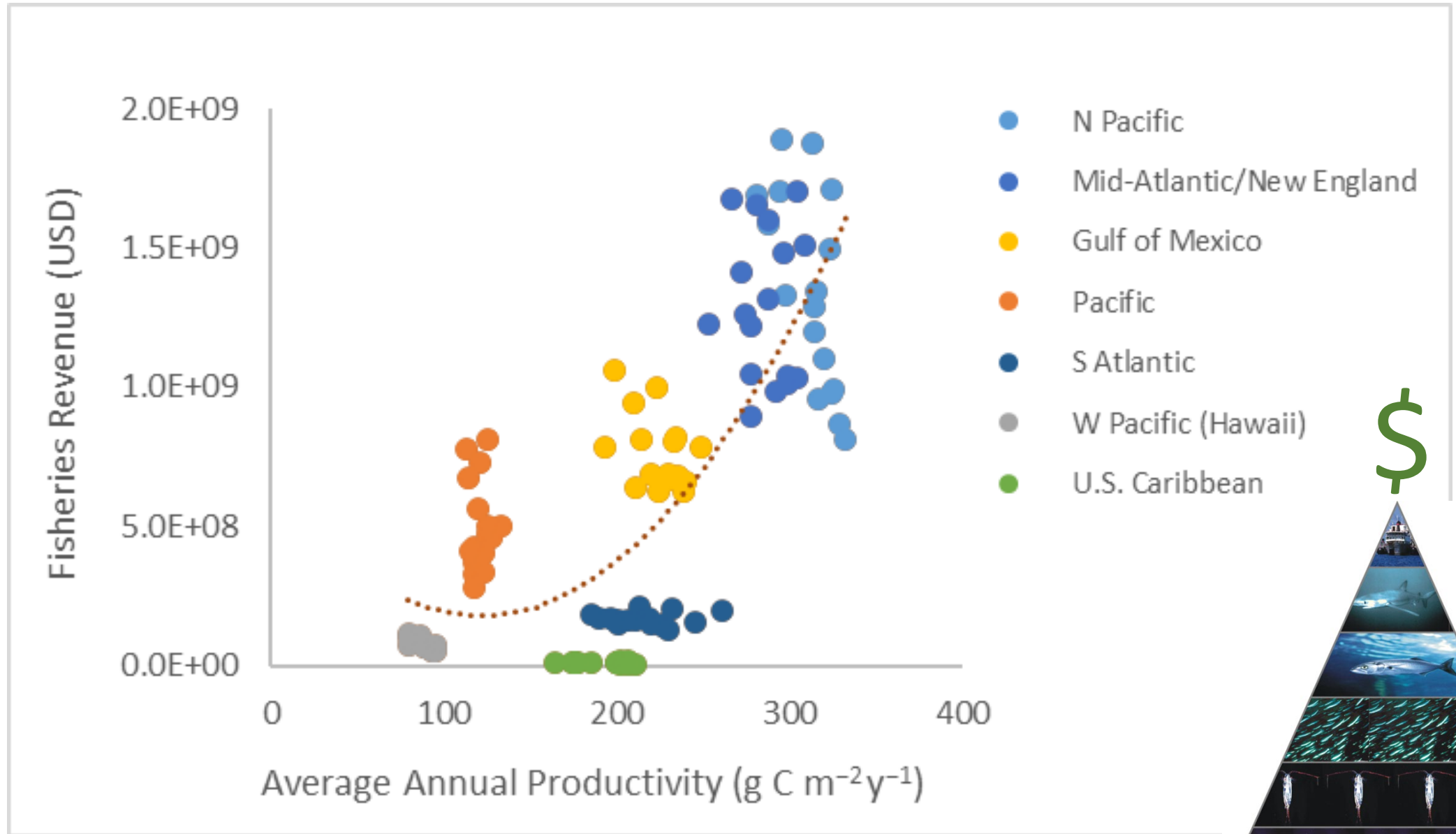
Everybody get the concept
of transfer efficiency across
Trophic Level?

$\downarrow \text{Catch} \begin{cases} \uparrow TL \\ \downarrow TE \\ \downarrow NPP \end{cases}$

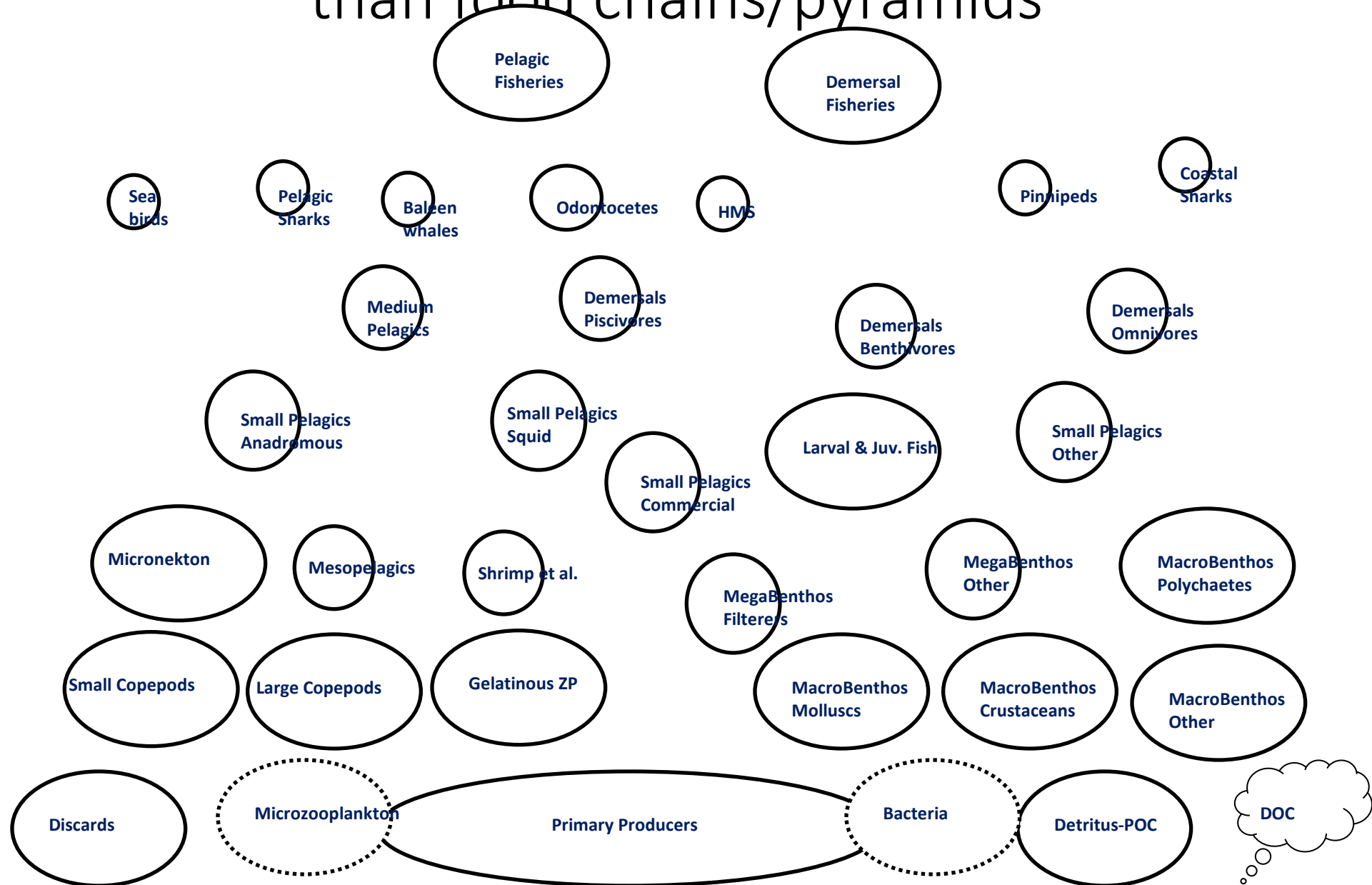


$$C_{tot} = \alpha \sum_{i=1}^{TL} PP \cdot TE_i^{TL-1}$$

Same general surface, but note ~an OOM change in values with TE



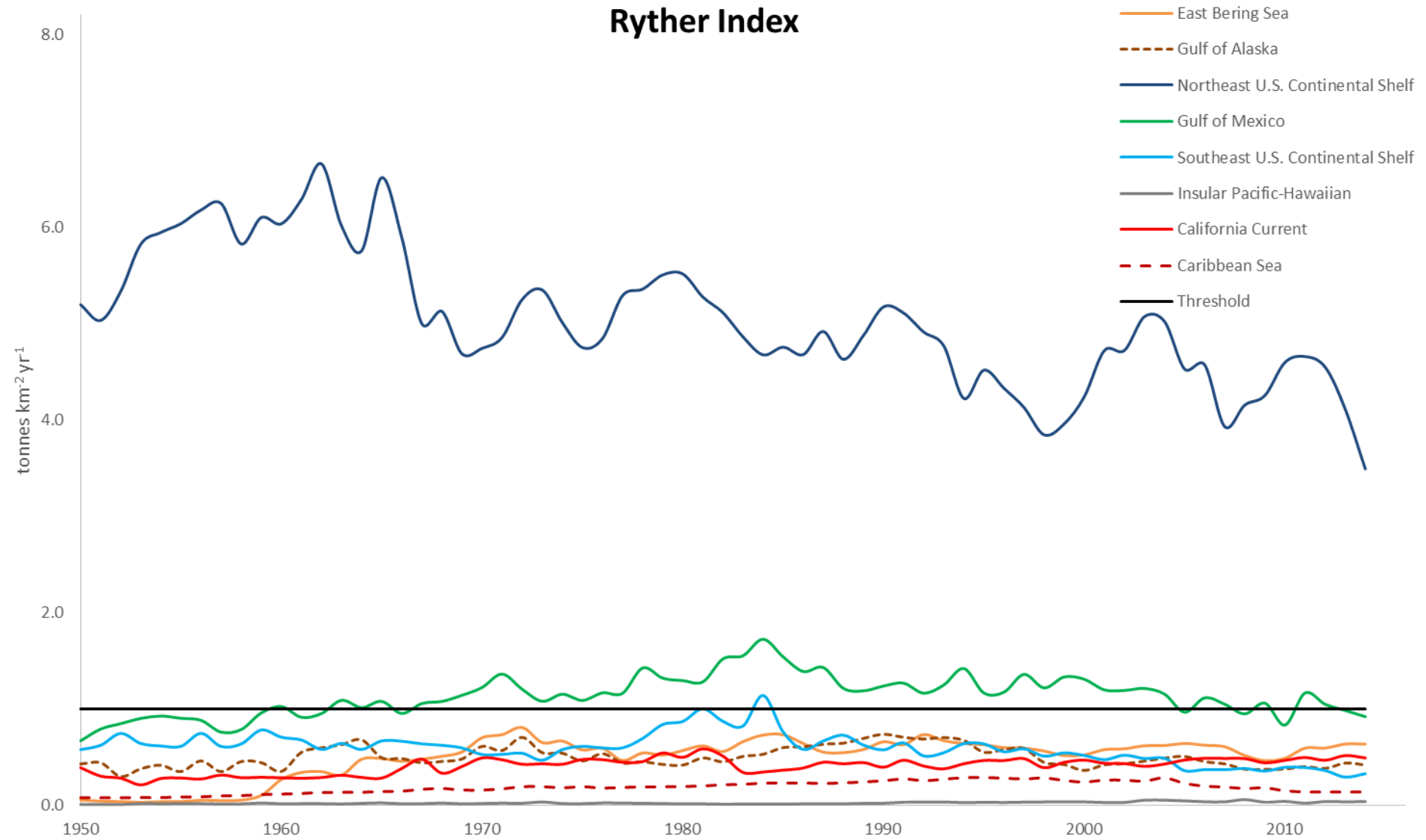
than food chains/pyramids



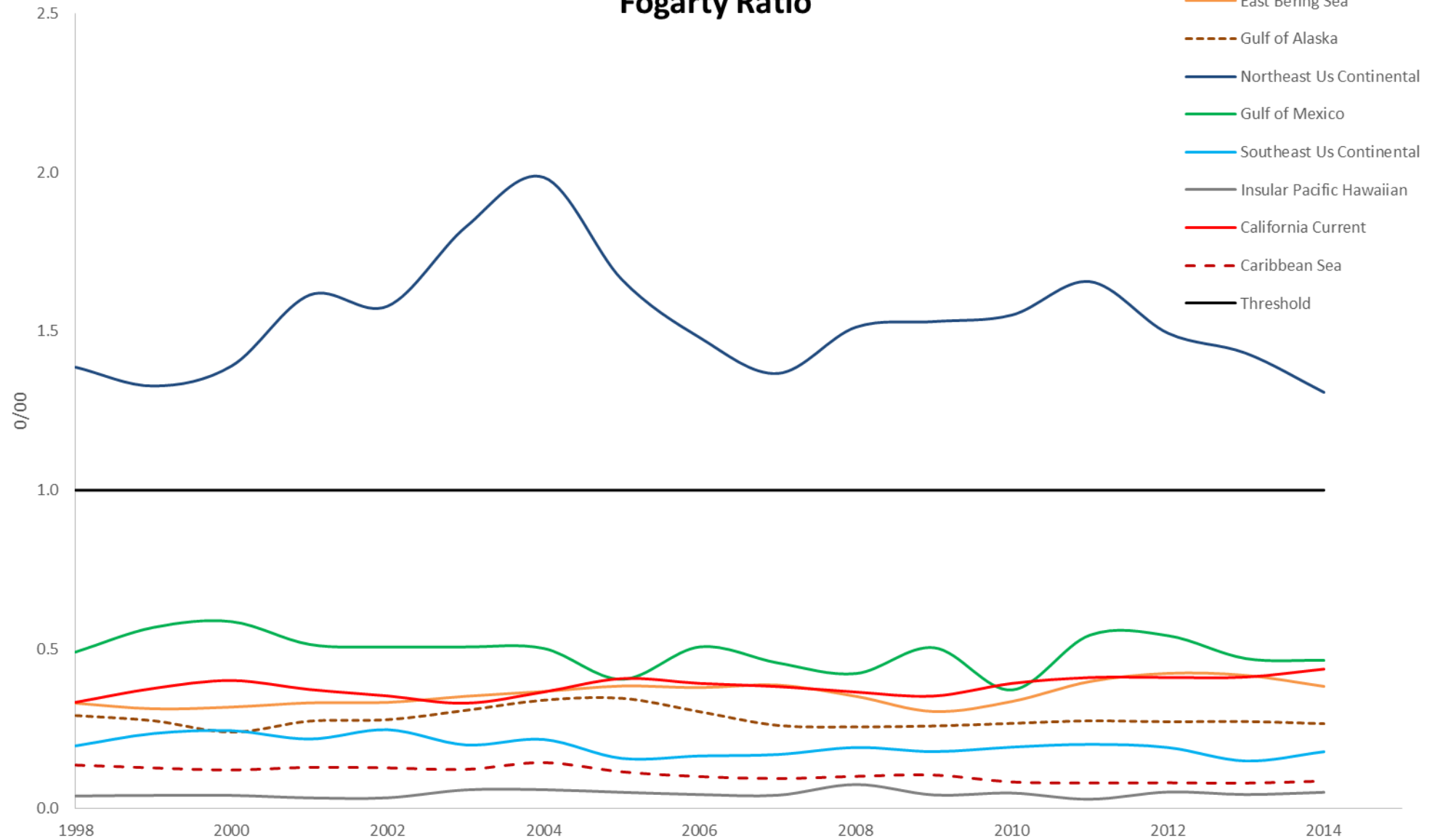
EOF Indicators

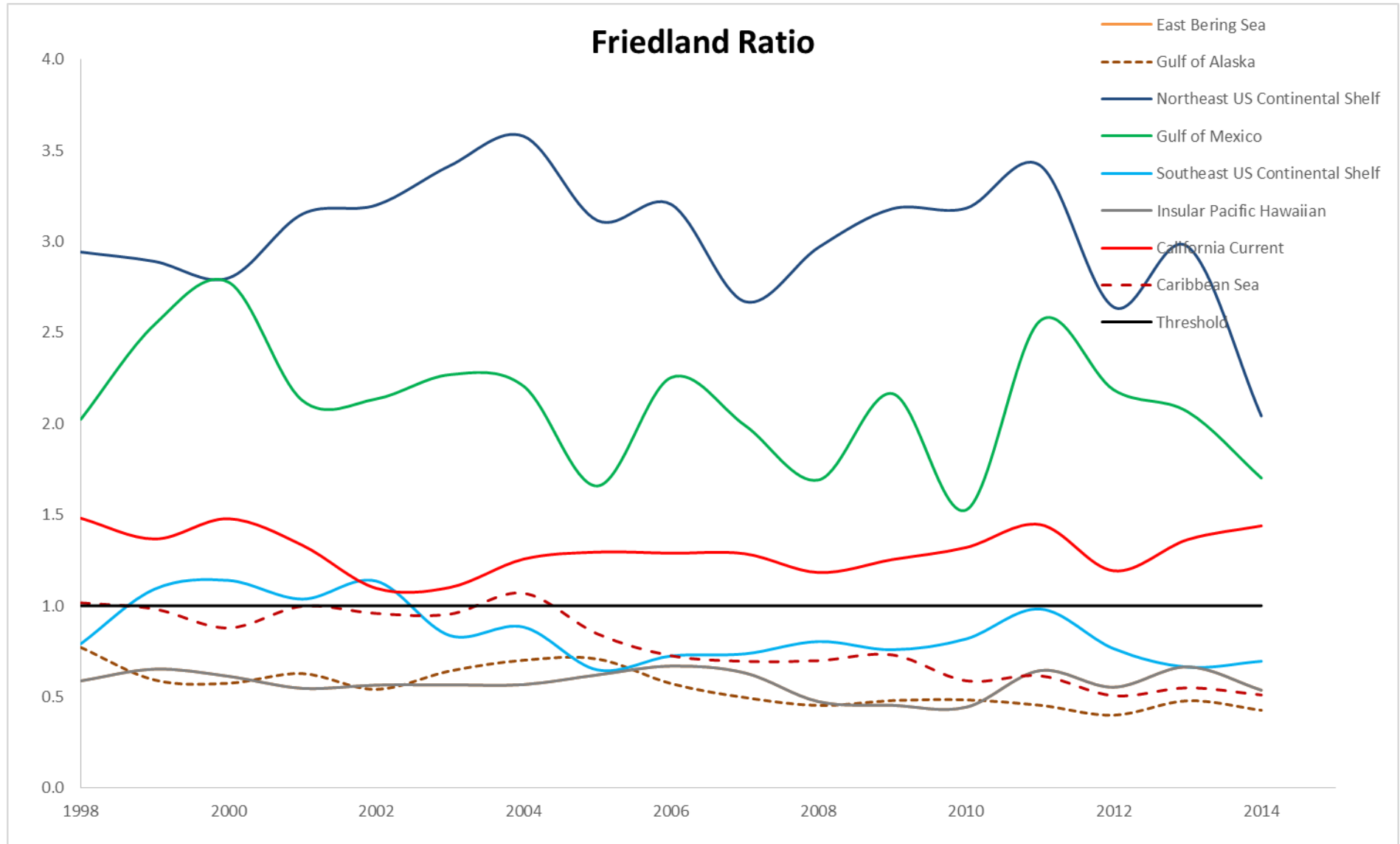
- Essentially use Landings data coupled with
 - Area- Ryther
 - PP- Fogarty
 - Chl a- Friedland
- These have global thresholds to delineate EOF
- Can back out expected yields and compare to trophic declination work (for more examples, [see these in Landings lightning talk](#))

Ryther Index



Fogarty Ratio



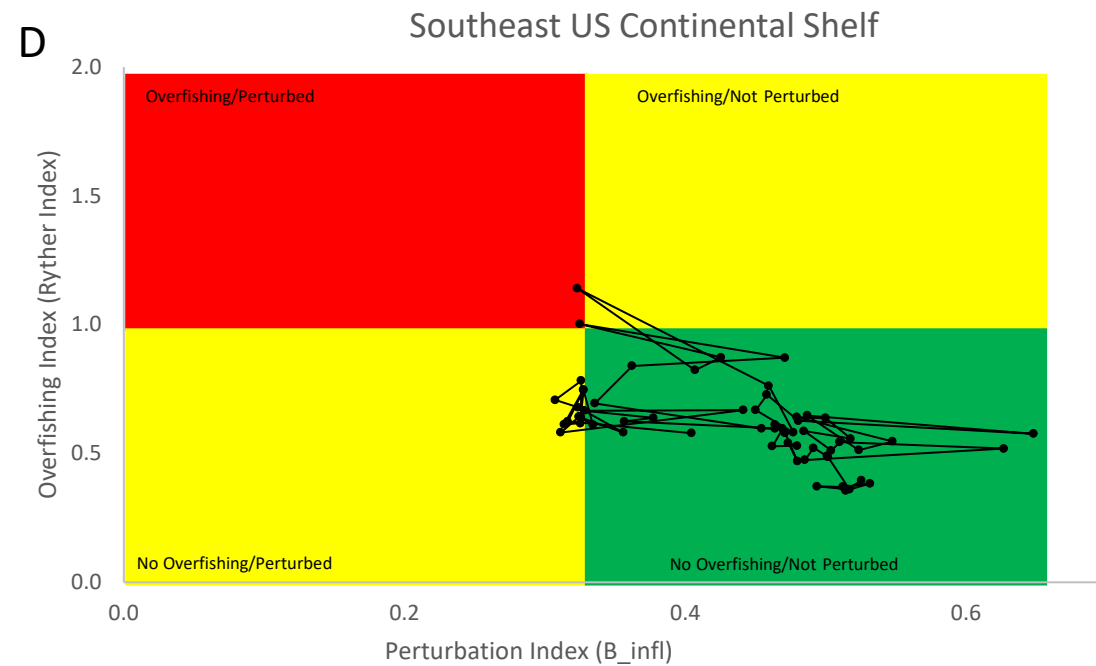
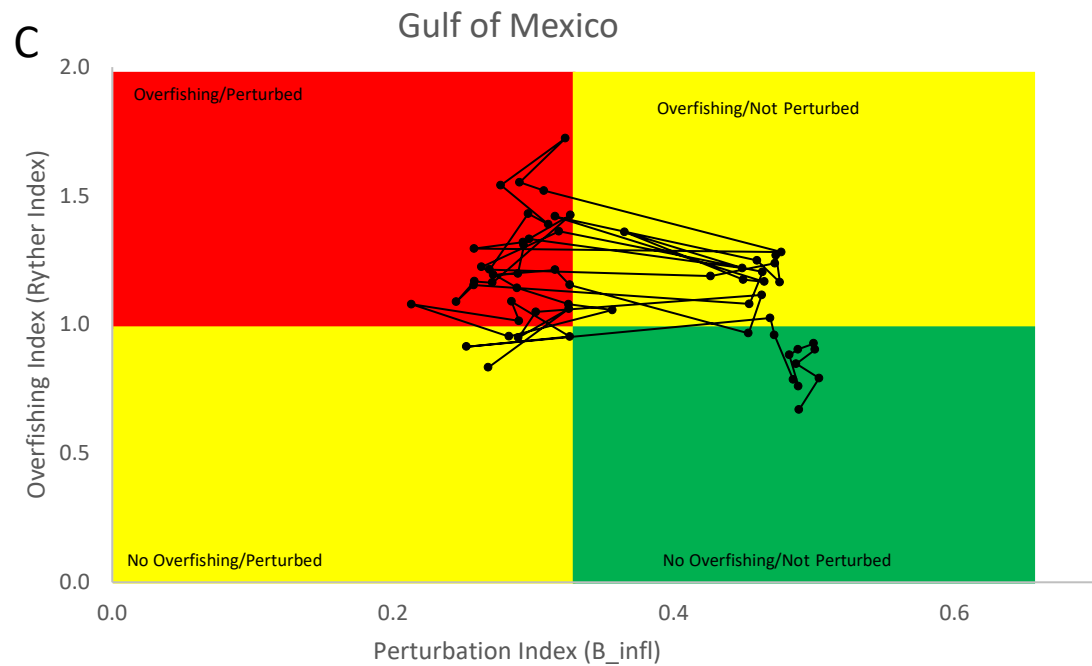
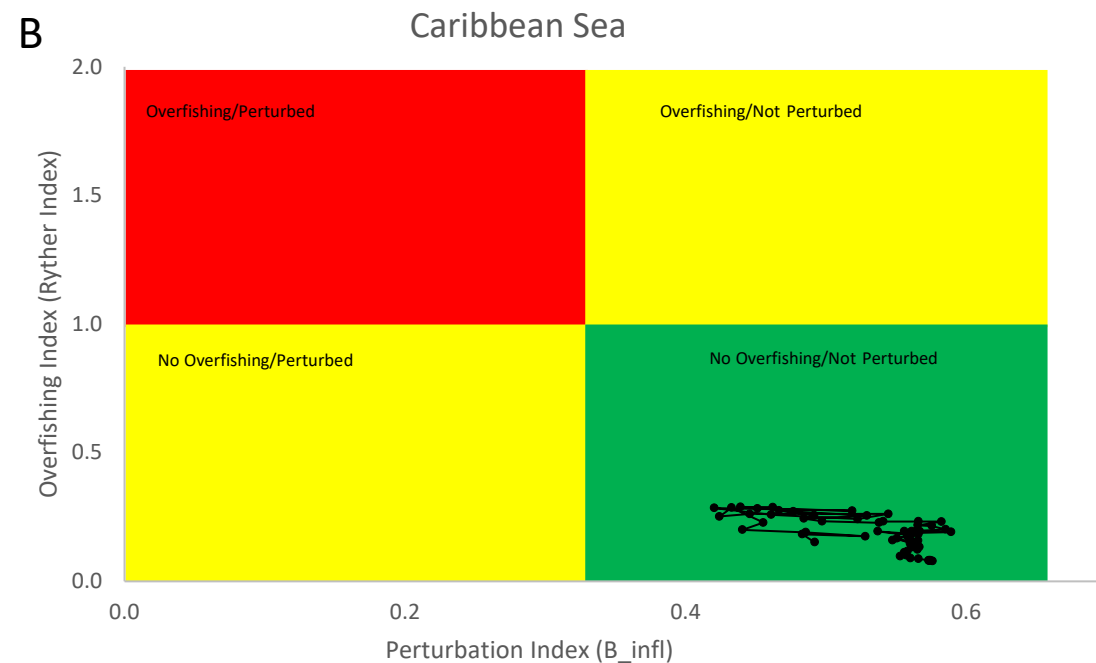
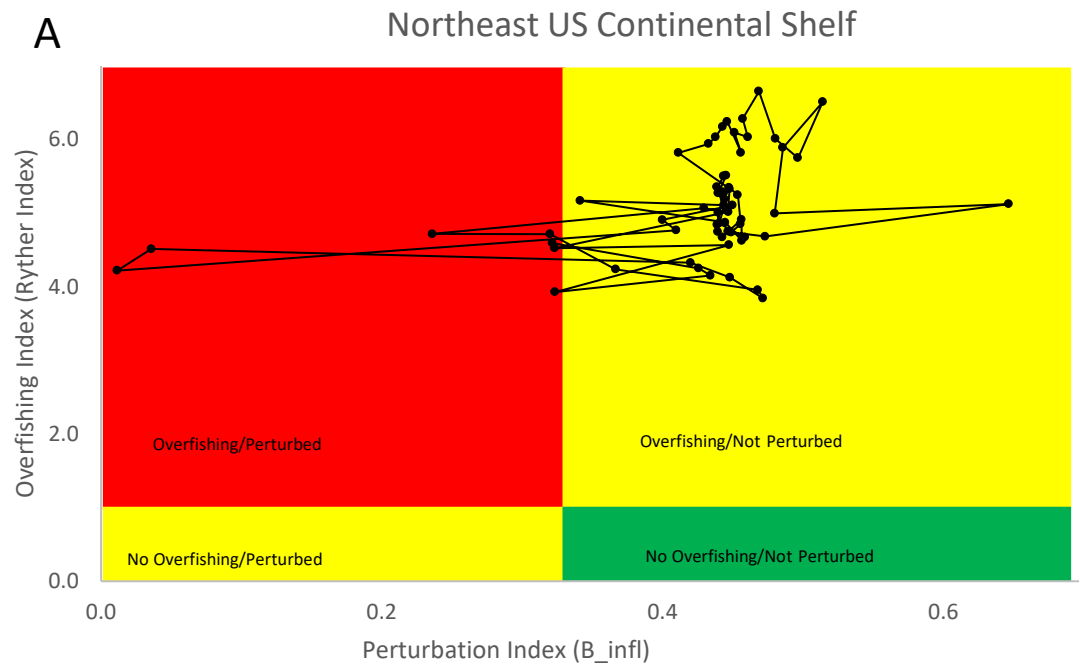


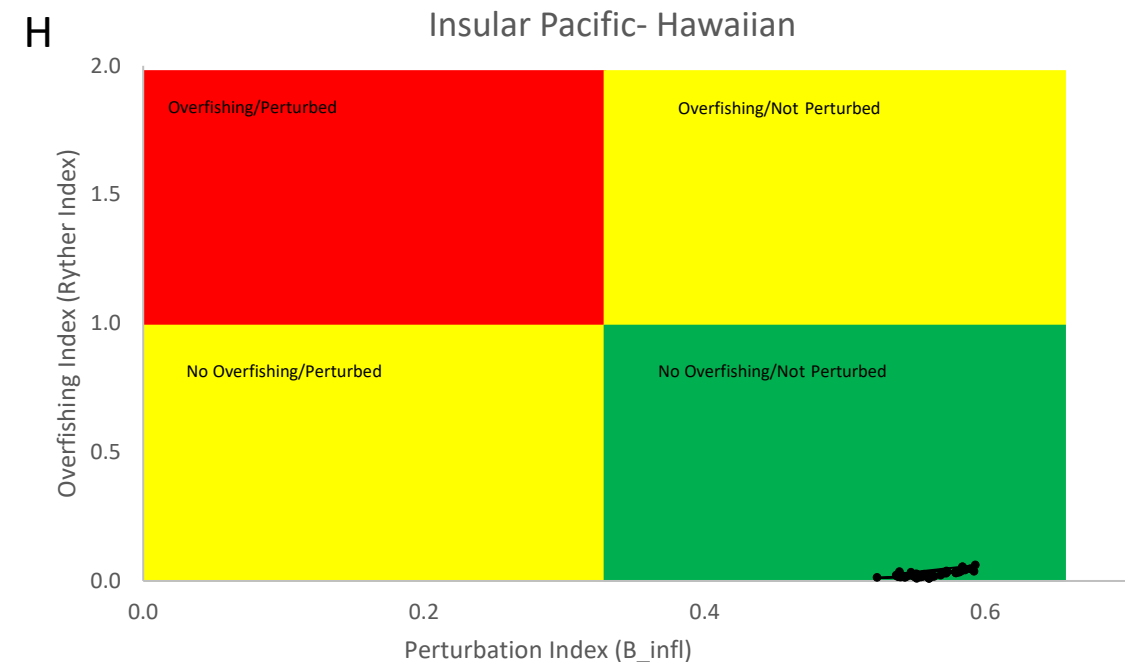
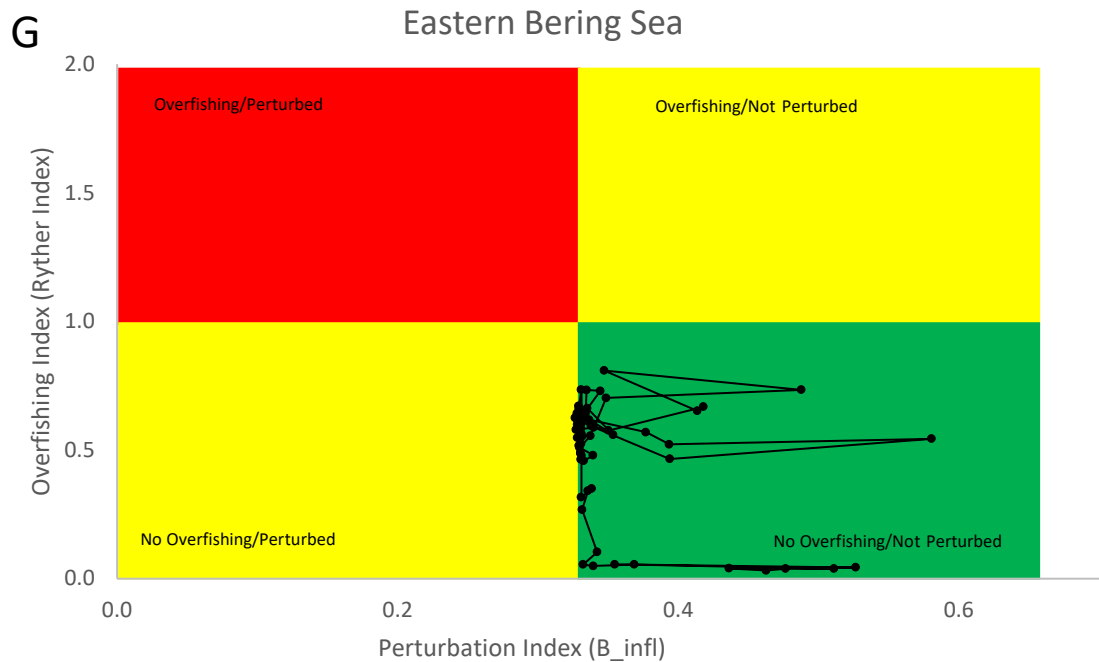
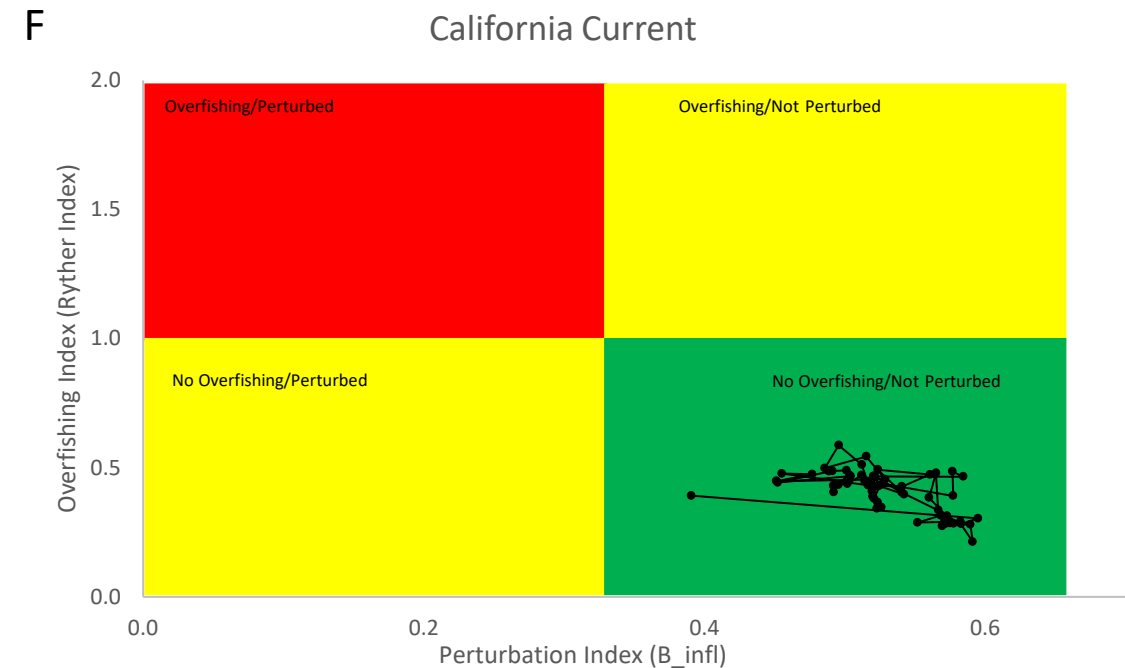
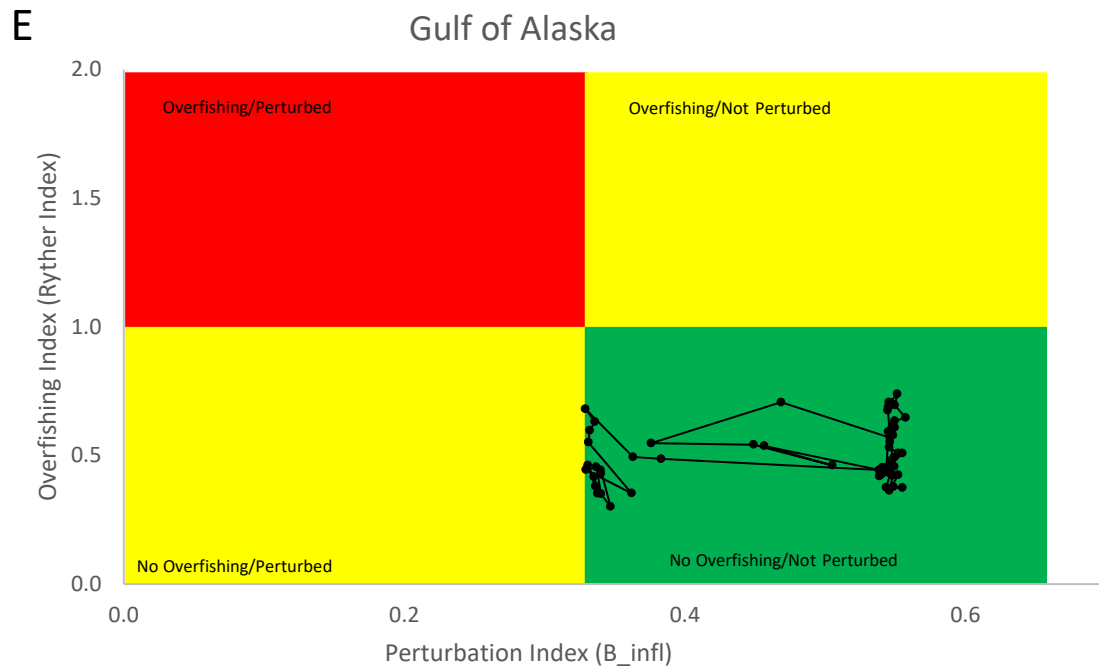
When combined with other measures

- Can serve as comparable “Kobe” plots to delineate EOF
- Can provide insights into system dynamics
- Can provide backstopping to all fisheries removals

OR

- Expectations of what Fisheries Removals could be
- Also provide early warning signals of system-wide events





Management implications

- Potential Indicator of EOF, ELRPs
- Can provide theoretical limits of the amount of total fish that should be caught in an Island ecosystem/region
- Can provide thresholds for how much fishing, in total, is too much
- Can provide estimates of how much fish could *potentially* be caught

Management Applications

- Has been used to test and inform policy on good environmental status in the EU under their MSFD auspices (ICES 2014, Tam et al. 2017).
- Backstopping and testing for EOF, especially with ecosystem-level Kobe plots, in the US (Link 2021).
- Identified EOF for African LMEs and used to inform sustainable development decisions (Link et al. 2020).
- Reported on in various national and regional Ecosystem Status Reports

Responses specific to SEDAR 103 and CFMC

- Are the required data currently available for some number of Caribbean species based on the data reviews provided in the Data Webinars? **Yes**
- What species or species groups can the method currently be performed on? **All**
- Does the time step (e.g., day, week, year) required for the method align with currently available data? **Typically annual, but can be flexible**
- Can the method inform management now? **Yes**

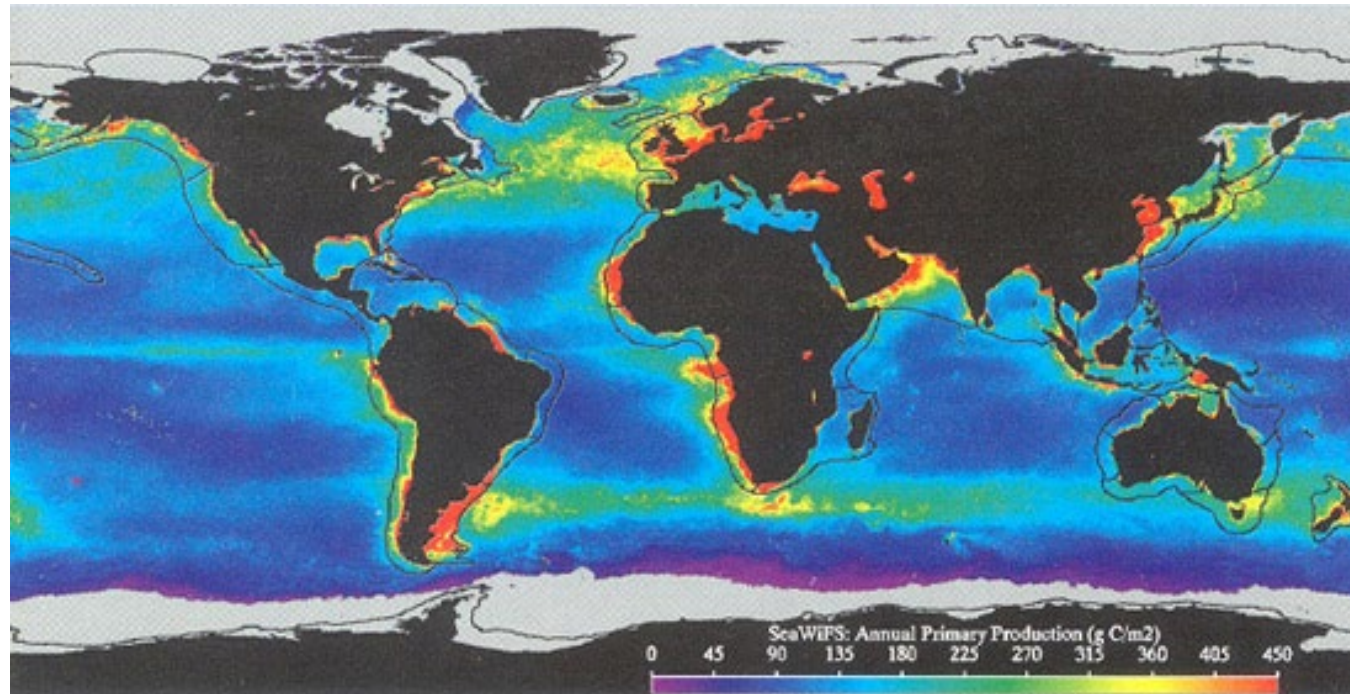
Recommended Approach to use all this information and address major considerations

1. Evaluate Ecosystem Caps for each Island
 - Use 1-2 main methods, complement with an ensemble for reality check
2. Estimate ACLs for guilds/aggregate groups
 - Use 1-2 main methods of modeling
3. Estimate ACLS/etc. for top 3-4 individual taxa
 - Use appropriate data ltd Stock Assessment methods
 - Use appropriate prioritization protocols
4. Evaluate economic performance
 - Some form of efficiency frontier
5. Translate to clear mgt decisions
 - Likely to focus on effort (input) controls

Extra Slides

Observations

- Primary Production is projected to shift location, vary timing, and change in spp composition, but not change in overall magnitude
- Will be subject to more frequent intermittent events that change with altered hydrodynamics, thermal content and chemistry



Primary Production

