

Use of Landings Data and Production Models (and Global Reef Production Values) as Ecosystem Caps

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3 Approaches

- Landings statistics
 - Environmental tipping points
- Aggregate (surplus) production models
- Global Coral reef production

Ways these measures can be used

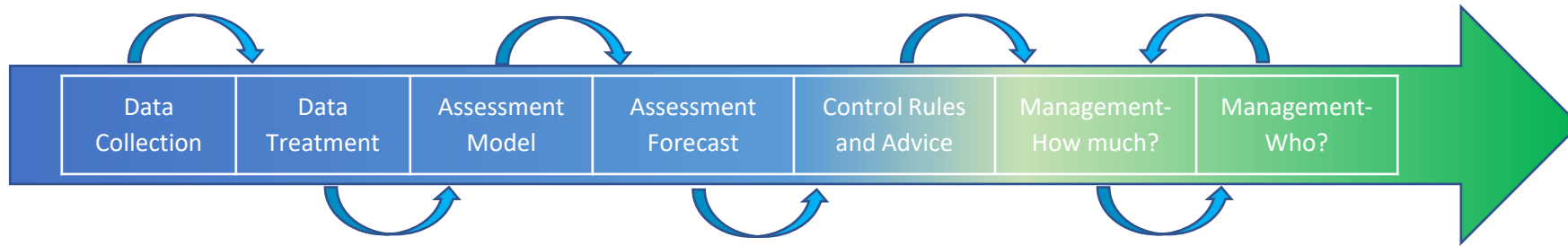
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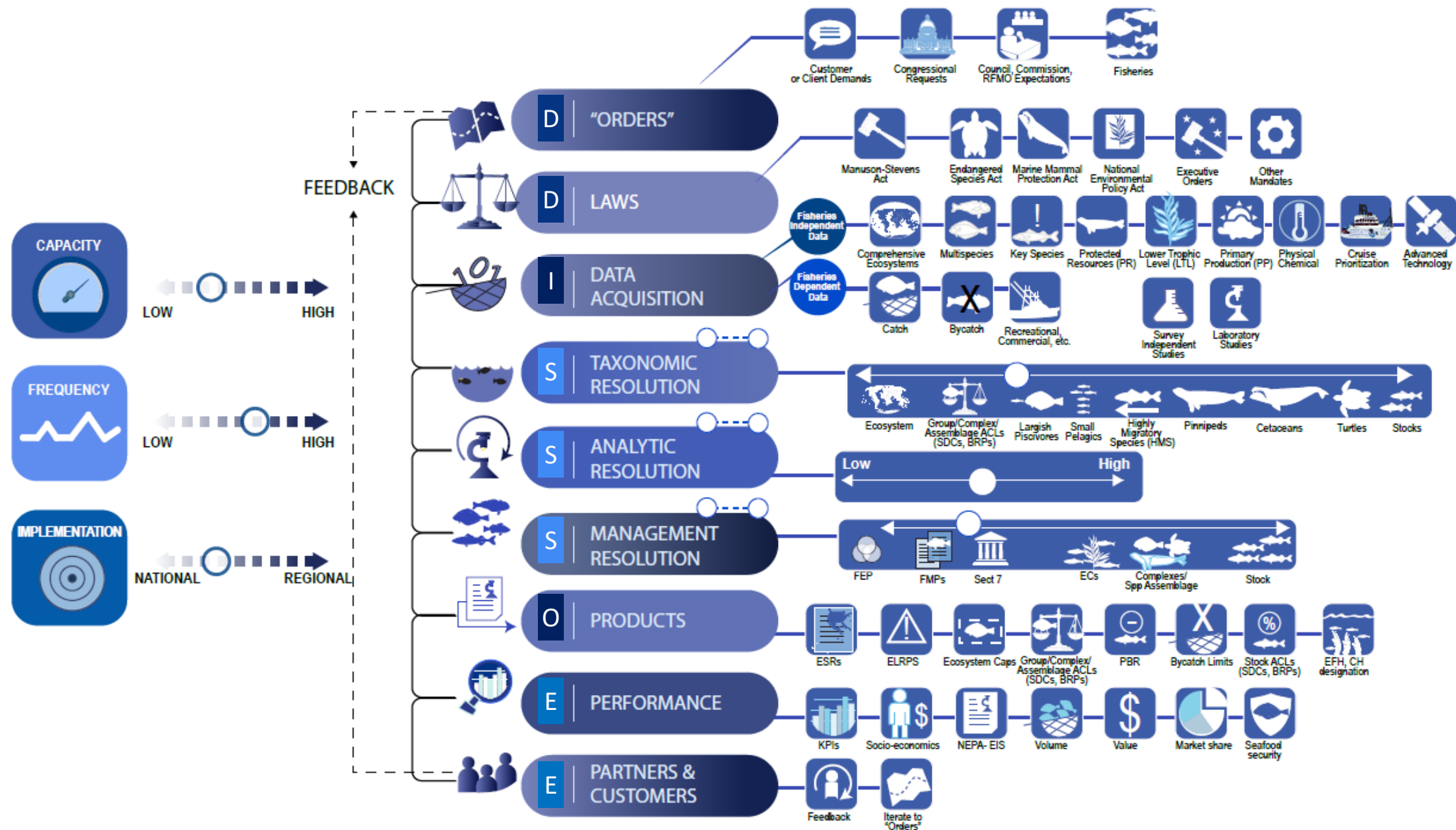
- set OFLs, ACLs, ACTs, SDCs, etc. of the ecosystem, guilds, etc.
- measure EOF
 - serve as comparable “Kobe” plots to delineate EOF when multiple are combined
- inform allocation, effort decisions
- evaluate (overall) fishery performance
- clarify expectations of what Fisheries Removals could be

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: Use of Landings Data and Production Models (and global reef production values)
- Data inputs (especially critical data and their viability now and in the future): Landings data and (for Prod Models) biomass data
- Analysis/data output summary: Historical statistics (time series, central tendency, stability, variance, etc.) of Landings, estimates of Yield from Production models
- How this method can inform management: can directly set MMSY, Agg MSY
- Caveats for this method: veracity/robustness of landings data; does not need copious information as might be implied; depends on simply production model fits, but those are downplayed in SSSA due lack of age/size structure; depends on veracity/robustness of biomass (or fisheries independent survey data); MS prod model needs some info by spp; agg prod model does not need spp data/info
- Previous applications of this method: multiple, used in Alaska for Ecosystem Caps; Nat'l work estimating caps ongoing in parallel
- Any graphs or diagrams to show for this method: see more info

What is the value/rationale of Ecosystem Caps/Limits/EOF?

Legal & Mandate considerations

- Is legal, allowable, and advisable to do now
- Affords opportunity for potential deregulation of copious single stock oriented SDCs or BRPs
- Provides SDC coverage and a backstopping for all spp, many of which we may never assess individually or as part of a complex, as an “uber” complex, including EC spp

Utility of Limits

- Gives an overall sense of the capacity, and hence limits, of an ecosystem, as tied to regional (primary) productivity
- Sets expectations for regional fisheries economics– potential
- Provides a “trade-space” for regional fisheries priorities

Benefits

- When implemented, has categorically results in improved regional fisheries economics
- Affords opportunities for some fisheries flexibilities, thereby reducing discarding
- Facilitates development and monitoring of key fisheries performance measures



Ecosystem Caps— methods

Please note and appreciate that
there are lots of caveats to all these;

Here highlighted in blue, some in other talks

- Landings-based
 - Long-term avgs
 - Moving avgs
 - Break point analysis
- Primary Production-based
 - Trophic declination- simple TL
 - Trophic declination- complex, TE and TL
- EOF indicator-based- diagnostics
 - Ryther
 - Fogarty
 - Friedland
- Landing-driver based
 - Tipping point analysis relative to key factors (e.g. Temp, PP)
- Aggregate Surplus production model-based
- Summation from prior Ecosystem Models
 - Atlantis
 - EwE, etc.



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Ecosystem Caps– data needs

- Spatial area
- Landings data
 - Commercial
 - Recreational
 - Commercial w/ discards (or estimates thereof)
- 2nd order, survey biomass of all taxa
- Primary production- Satellite imagery
 - Chl a
 - NPP algorithm
 - VGPM (chl a)
 - VGPM-Eppley (chl a)
 - CbPM (carbon)
 - CAFÉ (absorption)
- 2nd order, temperature for from satellites– but not req'd, yet east to obtain
- 2nd order, benthic productivity (cover x rate) in shallow water reefs – but not req'd initially



Production models

- Can be at a species, multispecies, aggregate, or very aggregate (system) level
- Need catch/landings, and biomass inputs
- Simple but robust
- Long history of use in fisheries science, but less widely used in US for SS applications
- Being concurrently considered in Nat'l Ecosystem Caps approach

$$ASP_t = B_t - B_{t-1} + C_t$$

where B is biomass, C is catch, and t is year for Annual Surplus Production (ASP; see Mueter and Megrey 2006)

Numerous (too many to list) publications of MS and Agg applications

Are being used as operating models in an MSE context, some being used to set quotas/OFLs/ACLs/etc. directly (usually outside of US)

Global Reef Fish Estimates

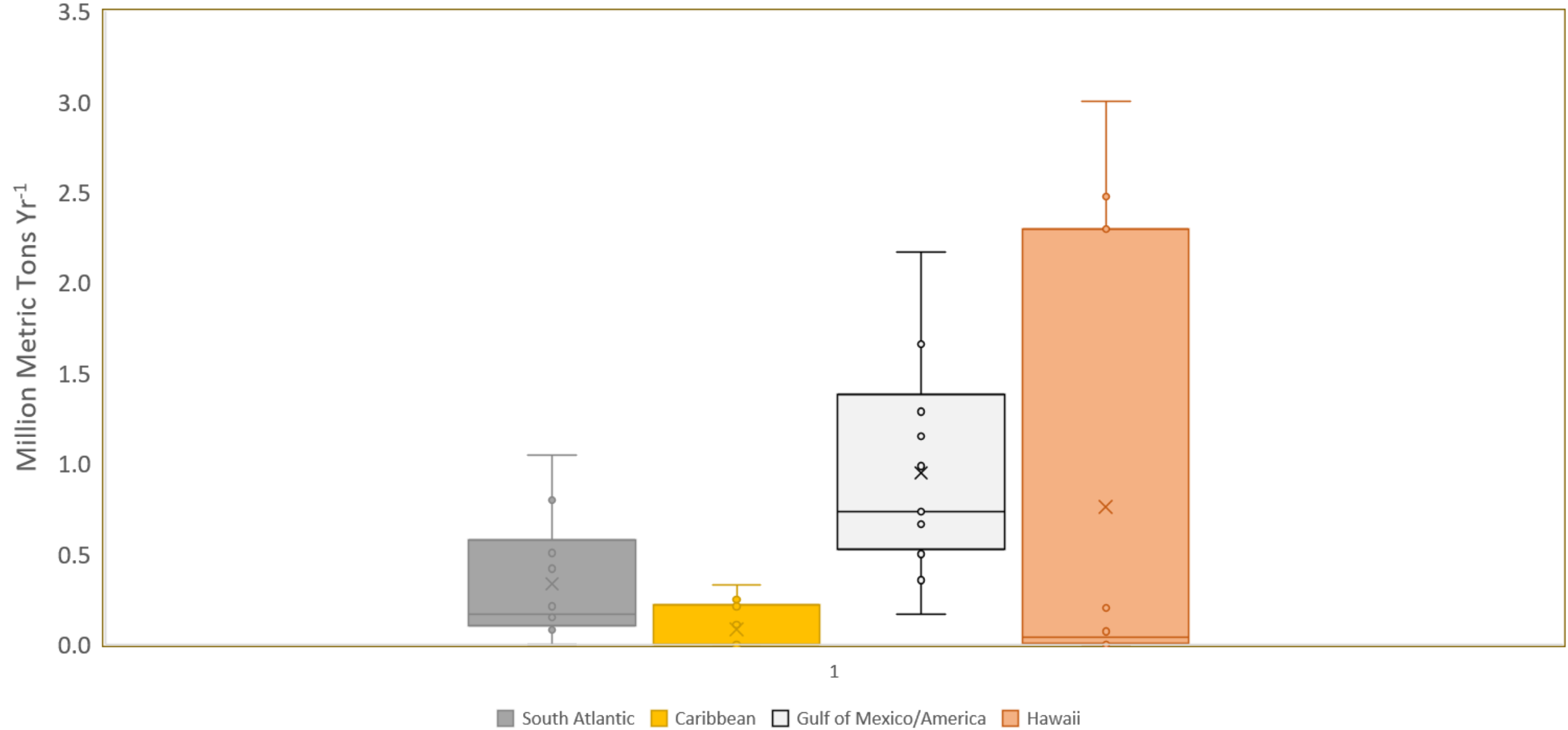
- Most fisheries tend to support landings of $\sim 1\text{-}5 \text{ t km}^{-2} \text{ yr}^{-1}$ (Bundy et al. 2012, etc.)
- Reef fisheries have a smaller area, but on a per unit area basis have supported fisheries something closer to $\sim 15\text{-}20 \text{ t km}^{-2} \text{ yr}^{-1}$ (Zamborain-Mason et al. 2025, etc.)
- A lot of these methods use simple Aggregate or MS production models
- One approach would be to glean from the literature (there is a reasonable set of information on this topic) and set a limit/cap based on an amalgamated global standard

MMSY Supported by Coral Reef Ecosystems

	<i>Gompertz-Fox</i>	<i>Graham-Schaefer</i>	<i>P-T 3</i>	<i>P-T 4</i>
MMSY for average environmental conditions and non-atolls (t/km ² /y)	5.8	5.5	5.7	5.5
Range of site-specific MMSY (t/km ² /y)	[2.5 – 20.6]	[2.4 - 19.8]	[2.4 – 21.8]	[2.3 - 26.1]
B _{MMSY} for average environmental conditions and non-atolls (t/km ²)	42.5	56.9	65.4	70.9
Range of site-specific B _{MMSY} (t/km ²)	[18.0 – 151.0]	[23.8 – 200.8]	[27.3 – 234.6]	[28.2 – 294.8]

Zamborain-Mason et al. 2023

Ecosystem Caps



Caribbean Ecosystem Caps



Management implications

- Ecosystem caps can be developed from these methods
- These ecosystem caps or limits can set limits for MMSY and aggregate MSY
- These can serve as an ecosystem level reference point (Morrison et al. 2024).

Management Applications

- Landings data are used as data inputs globally in nearly every stock and MS assessment
- Landings data have been used to set BRPs in data limited situations around the world and the US. Even in FMCouncils with copious data, when there are challenging model diagnostics it is not uncommon for ACLs to have been set to the past 5 years of landings if they are stable
- Ecosystem caps are already used in Alaskan regions
- Ecosystem caps are used internationally to establish total fishing limits in countries in SE Asia
- National working group estimating caps is ongoing in parallel
- Landings and production model approaches are well known, well-vetted, and largely depend upon confidence of the input data.

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? **Mostly/maybe**
- 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**

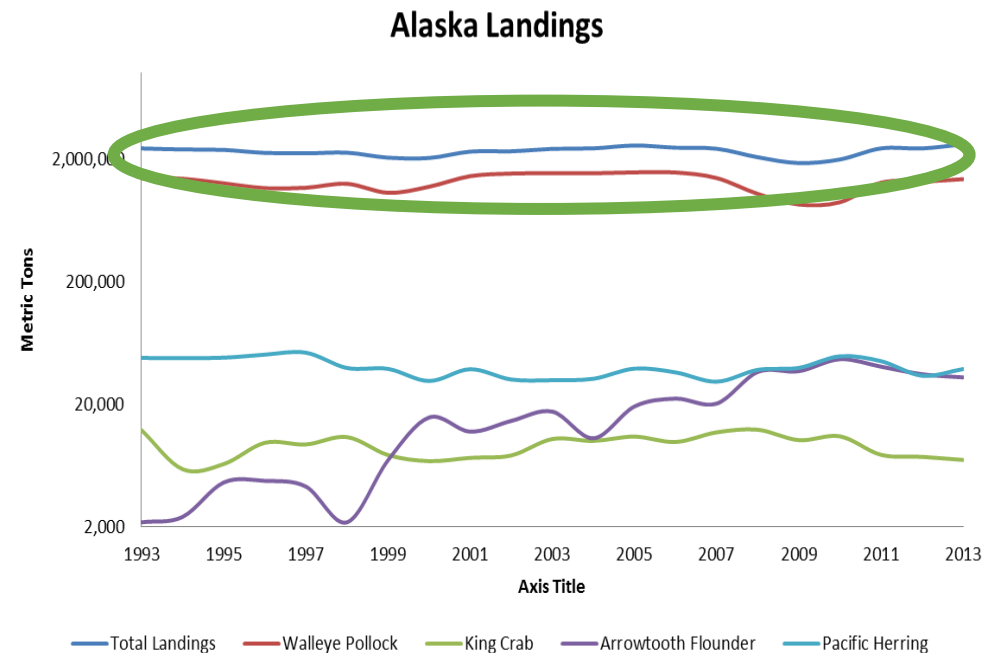
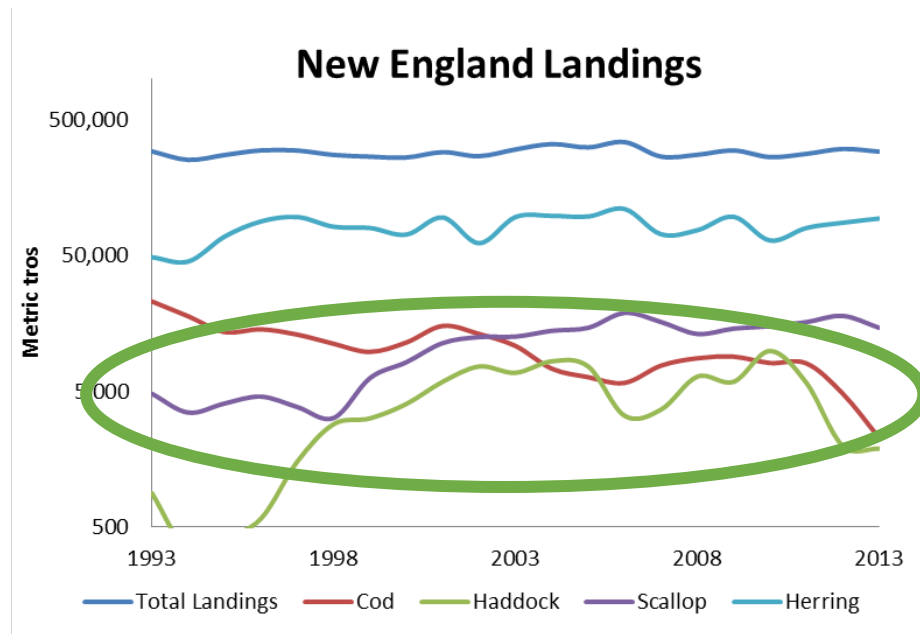
Recommended Approach to use all this information and address major considerations

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

Bringing it Back to Management

- Connecting, Distributing
- Challenges and Opportunities
- Foundational, Future, Functional



Ecosystem Caps

