

Demonstration of ecosystem-based catch advice: simple interactive web application example

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<https://gavinfay.shinyapps.io/ebfm-ne-teaching-eg/>

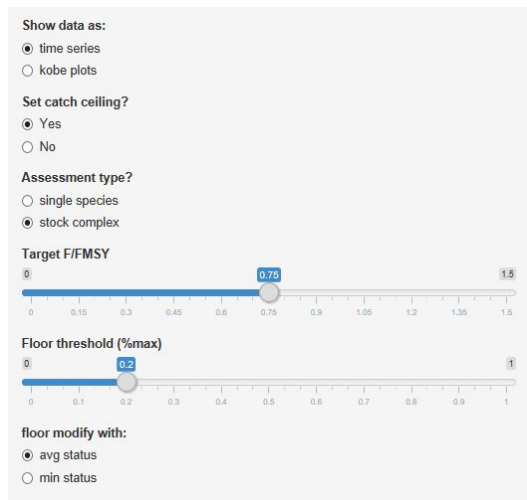
Overview

This demonstration tool outlines the basic steps used to develop catch advice for the example Fisheries Ecosystem Plan (eFEP) for a Georges Bank Ecosystem Production Unit (EPU). It is a simplified example using simulated species and information to walk through the steps. It is not intended to replicate any specific species or location, and uses a four species model ecosystem to provide an example work through of the steps to specify catch advice under different scenarios with both single-species and ecosystem-based fisheries management.

[A video, with live demo walk through of the app can be found here.](#) (The audio track is not yet available).

The catch advice app is available [online here](#), for interaction within a web browser. The user may adjust several decision points to examine their effect on catch advice, outlined below. Catch advice is generated for a single year given available information over a historical 50-year time period.

The user may adjust the following inputs, either as single species catch advice for four stocks or as stock complex catch advice (2 species in each of 2 stock complexes). Additionally, the user can specify whether a catch ceiling is placed on total ecosystem removals, and if biomass floors are applied to reduce fishing mortality if individual stocks are assessed to be at biomass levels below the specified floors. More details are given in the “Catch advice procedure” below.



Show data as:
 time series
 kobe plots
 Set catch ceiling?
 Yes
 No
 Assessment type?
 single species
 stock complex
 Target F/FMSY
 0 0.15 0.3 0.45 0.6 0.75 0.9 1.05 1.2 1.35 1.5
 Floor threshold (%max)
 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
 floor modify with:
 avg status
 min status

Figure 1: Interactive decision points for the catch advice procedure

App layout

The “Read Me” tab provides a text walk through. The sidebar to the left provides options for the various decision points of the management procedure. The “Outcomes” tab shows the results of applying the chosen procedure to data generated from the modeled four species ecosystem, including results of assessment models and harvest control rules, to derive catch advice for the next year. The (forthcoming) “model options” tab will allow the user to change some of the parameters of the underlying ecosystem operating model (e.g. growth rates, species interactions, time series of fishing effort and relative catchability of each species).

Modeled Ecosystem

The demonstration tool models a simplified ecosystem that contains four generalized fish species and simulates their life histories (births, deaths, and growth) as well as fishery harvest over a fifty year historical time span. The level of fishing in the model (fishing mortality) increases over time with a reduction in the most recent years. The four species have different life histories (e.g. different birth rates, growth rates) and are caught at different rates by the fishing gear (different vulnerability or catchability). The four species are split into two stock complexes, each containing two species. Within the modeled ecosystem, survey data and catch data are collected, replicating what happens in the real world and used to fit stock assessments and generate catch advice within the catch advice procedure.

Catch advice procedure

The “Outcomes” tab allows the user to specify the decision points to develop catch advice for the next year. The catch advice will be updated whenever the user (you) chooses a different option on the left or moves one of the sliders to a different parameter value.

- The user can decide whether assessments and catch advice will be produced at the single-species level (status quo management), or at the stock complex level (as in the eFEP for EBFM).
- The user can decide whether or not to impose a ceiling on total catch from the system. If this is chosen, then an additional stock assessment is produced at the system level to obtain a value for this ceiling (here, the estimate of multispecies maximum sustainable yield is used). In the demo example, the value for the ceiling is estimated to be 474 mt.
- For each assessment chosen (single species vs stock complex and possibly a catch ceiling), the procedure fits a biomass dynamics stock assessment model to the survey and catch data to obtain estimates of Maximum Sustainable Yield (MSY) reference points and the final year’s biomass.

- These results and further calculations are produced in a table below the time series plots.

Assessment results & catch advice

Complex	FMSY	BMSY	B_final	F/FMSY	B/BMSY	Catch at FMSY	Floor F multiplier	F	Catch at F	Ceiling	Advice
1	0.15	1,786	1,523	0.68	0.85	226	1	0.11	170	474	170
2	0.14	1,122	1,100	0.48	0.98	149	1	0.10	111	474	111

Assessment results & catch advice

Species	FMSY	BMSY	B_final	F/FMSY	B/BMSY	Catch at FMSY	F	Catch at F	Ceiling	Advice
1	0.15	983	913	0.73	0.93	141	0.12	106	474	106
2	0.12	727	510	0.72	0.70	62	0.09	46	474	46
3	0.16	406	520	0.31	1.28	85	0.12	64	474	64
4	0.10	991	669	0.70	0.67	69	0.08	52	474	52

Figure 2: Table of catch advice output produced by the app.

- The user specifies what proportion of the fishing level reference point should be used to generate the catch advice (e.g. 0.75 FMSY), which would be applied to the final year estimates of biomass to obtain the initial catch advice (either for each species or for each stock complex)
- Similar to current management, in addition to the development of the initial stock complex catch advice, the stock status of the different species are considered to determine if there should be a reduction in the fishing level if the species is assessed to be below a certain threshold (in single-species management this might be 0.5 BMSY). The threshold level is called the biomass floor. Here, the user specifies the threshold to determine the biomass floor, as a percentage of the maximum observed biomass for each species over the time series (e.g. if this is set to 0.4, then the floor is set at 40% of the highest data point).
- Because there is more than one species in each complex, the user can choose how the biomass floor status for each complex is determined. This can be set either using the average of biomass floor status for each species within the complex, or using the species with the poorest status in the complex.
- Once the stock complex biomass floor status is determined, the target fishing mortality is reduced if the complex status is below the threshold, to create a fishing mortality (labeled F_use) that will determine the catch advice.
- The F_use estimates are then applied to the final year estimates of biomass to obtain the catch advice (either for each species or for each stock complex) for the year following the simulation.
- If an ecosystem catch ceiling is being applied by the user, the sum of the catch advice over species or complexes is compared to the ceiling value. If the catch advice is more than the ceiling then the catch advice is reduced (here, scaled equally across species/complexes) so that the total catch advice does not exceed the ecosystem catch ceiling.

Any challenges or feedback, please let [Gavin Fay](#) know.