EwE model for Icelandic waters

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Background

The marine ecosystem in Iceland harbours a wide variety of species, that range from phytoplankton to marine mammals and seabirds. A species of high economic and social value is Atlantic cod (*Gadus morhua*). Due to its importance, cod is deeply studied in the Icelandic ecosystem. However, this is not true for the whole range of species that inhabit Icelandic waters. Thus, an Ecopath with Ecosim (EwE) model for Icelandic waters was developed with the goal of replicating the ecosystem dynamics in the Icelandic exclusive economic zone (EEZ) during a period of 31 years, in order to have a) a better understanding of the ecosystem dynamics and b) gain deeper knowledge on how dynamic flows affect marine populations in regard to stock size and fishable biomass.

Functional groups

- Seabirds - 1 multi-species group.
- Marine mammals
  3 multi-species groups and
  1 single-species group.
- Fish
  11 multi-species groups,
  1 divided in two age groups and
  7 single-species groups,
  5 of which divided in two age groups each.
- Molluscs - 2 multi-species groups.
- Large crustaceans - 2 multi-species groups.
- Zooplankton - 3 multi-species groups.
- Benthos - 1 multi-species group.
- Phytoplankton - 1 multi-species group.
- Detritus - 1 group accounting for all types of detritus.

Area of study

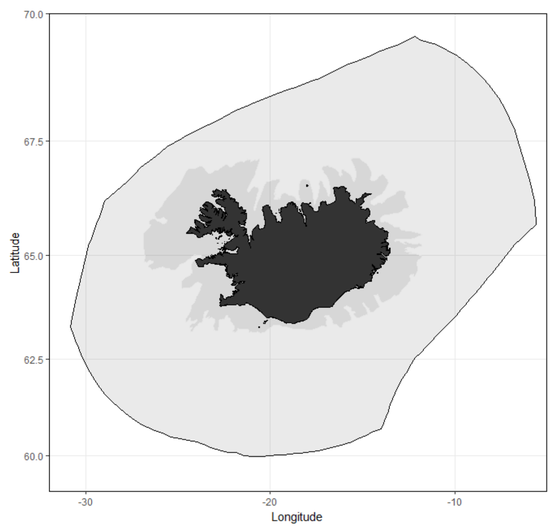

Figure 1. Icelandic EEZ in grey with continental shelf highlighted in dark grey and Iceland in black. The total EEZ area is 758 000 km^2.

Time series

- From 1984-2013.
- Biomass estimates from single species assessments [2].
- Landings data.
- Harvest rate of commercial species.
- Forced biomass for Mackerel (*Scomber scrombus*).
- Ecosim model fitted to the time series.
- The Akaike method [1] was used when choosing between fitting options.

Main results

Food web

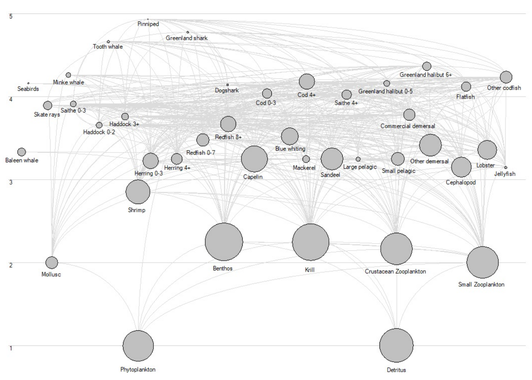

Figure 2. Trophic web diagram organized by trophic level (TL between 1-5).

Biomass estimates

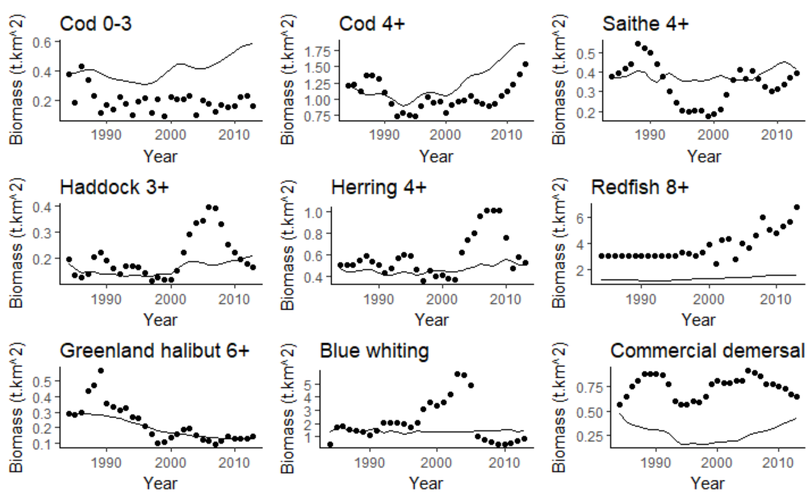

Figure 3. Biomass estimates (represented by a line) in comparisson to reference biomass (represented by dots).

Catch estimates

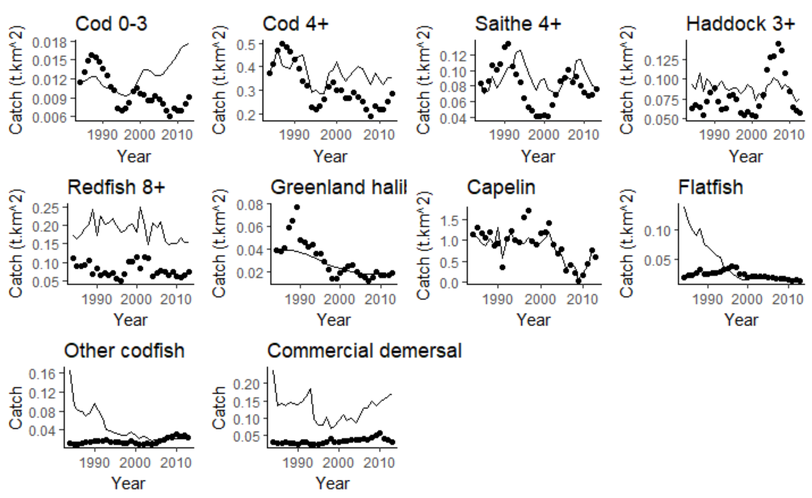

Figure 4. Catch estimates (represented by a line) in comparisson to reference catches (represented by dots).

Ecopath

The results suggest an ecosystem controlled by bottom-up trophic control, having four TL. Mammals and seabirds had $TL > 4$, as expected from top predators. Top predatory fish ($TL > 4$) included dogsharks, Greenland halibut (*Reinhardtius hippoglossoides*), cod, saithe (*Pollachius virens*; only 4+ age group), flatfish and other codfish. Biomass for capelin (*Mallotus villosus*) in 1984 was estimated to be 2.36 higher than previous estimates by the Marine and Freshwater Research Institute of Iceland (MFRI) [2]. These results are in concordance with results in a previous study [3], in which the authors hypothesized that the amount of capelin in Icelandic waters would have to be approximately doubled from MFRI estimates, in order to satisfy consumption by predators.

Ecosim

Previous biomass and catch trends by the MFRI [2] were replicated by Ecosim, although this did not apply to all groups (functional groups cod 0-3, redfish 8+ and commercial demersal fish are good examples). The vulnerabilities after fitting the model to the time-series strongly support the hypothesis that the Icelandic marine environment is defined by bottom-up trophic control. EwE is not recommended for biomass estimates and fisheries quota setting. However, it can provide valuable information on trophic interactions through-out food-webs. As such, the EwE model for Icelandic waters can be used for better understanding of the whole ecosystem and thus provide key insight for ecosystem based fisheries management.

References

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[2] Marine Freshwater Research Institute. *State of Marine Stocks in Icelandic Waters 2013/2014 - Prospects for the Quota year 2014/2015*. Marine Research in Iceland 176. Marine og Freshwater Research Institute of Iceland, 2014.

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MareFrame
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