Variation in life history traits, and signs of recovery in a collapsed marine forage fish species

Brooke Cistarelli, Gail Davoren
Department of Biological Sciences, Faculty of Science, University of Manitoba

Introduction

- In marine ecosystems, forage fish transfer energy from primary producers and convert it into food for top predators. Therefore, even modest declines in forage fish populations can have ecosystem-level impacts.
- Forage fish are small-medium sized fish with a short life span that reach maturity early and have high fecundity. These life history traits result in high population growth rates.
- After a population collapse, individuals are released from competition and, thus, are predicted to have more available energy to allocate toward reproduction, thereby allowing the population to grow quickly.
- Higher inter-annual variability in life history traits also are predicted after a collapse, as there are fewer individuals in the population to buffer the impacts of environmental factors.
- As a population continues to recover, pre-collapse trends in life history traits, typically start to reappear.

Study Species

- Capelin (Mallotus villosus) is the key forage fish species on the Newfoundland and Labrador Shelf.
- Capelin in this region are commercially fished for their eggs (rogs) prior to spawning during the summer in coastal regions.
- This capelin population collapsed in the early 1990s, which was associated with an anomalous cold-water event.
- Immediately after this collapse, capelin had smaller body size, earlier age at maturity, and delayed spawning (~3 weeks).
- Since collapse, the inshore rog fishery continues and the population continues to be monitored for signs of recovery.

Methods

- Multiple samples of capelin (sample = 200 fish) were collected at spawning sites (Fig. 3) through July – August 2009-2020.
- Spawning sites were monitored every 1-3 days to determine the number of spawning forage fish used and the first date of spawning in the study area.
- A hydroacoustic survey (Fig. 3) was conducted weekly throughout July-August in each year to quantify capelin biomass in the study area.

Conclusion

- Still showing life history traits (body size, age at maturity, timing of spawning) that are similar to immediately post-collapse.
- Increased variability in body size and timing of spawning further suggests a lack of recovery.
- The trend of increasing number of spawning sites used with increasing abundance suggests that the population is not near the carry capacity of the environment. This is further supported with increasing length and abundance.

Results

- Body size: was low post-collapse, showed signs of recovery (2013-2014), but then decreased after 2015.
- Age at maturity: earlier age at maturity post-collapse (2-3 years old) relative to pre-collapse (3-4 years old).

Other indications

- We predicted that a collapsed population would occupy fewer spawning sites because they should select the most favourable spawning sites to ensure high reproductive success. A recovering population would increase the number of sites used as abundance increases.
- Although forage fish populations infrequently reside near the carry capacity of their environment, increasing body size with increasing abundance indicates that the capelin population is not experiencing density-dependent growth that is more typical at pre-collapse population sizes.

Objective

Investigate the status of the Newfoundland capelin population after collapse (post-1991) to determine if the population is showing signs of recovery.

Predictions

Life history trait Pre-collapse Post-collapse Recovering
Body size Moderate Small Increasing
Age of maturity Later Earlier Delaying
Spawning time Earlier Later Advancing
Area occupied High Low Increasing
Life history trait variability Low High Decreasing

Table 1. Predictions of life history traits in forage fish before a population collapse and during recovery.

Citations