Beach seine methods

All samples were collected using a 45.7 m long, 2.4 m tall seine built by Memphis Net and Twine of 4.8 mm knotless delta-style nylon mesh with a central 2.4m by 2.4m by 2.4m bag. The bottom line was weighted with lead sinkers and the top line was fitted with buoyant Spongex floats. The seine was connected to a bridle and 2m of spare line on both ends. Seines were deployed with the help of a skiff. For each sampling event, one end of the seine was held on the beach while the net was flaked out from the bow of the skiff as it backed off the beach. The skiff was moved to extend the seine to the near edge of the bag, then pivoted to return to shore. The remaining length of the seine was flaked out until the skiff landed back on the beach. This resulted in a generally U-shaped deployment of the seine with approximately 20 m between the ends on the beach. Tidal stage was not a criterion for sampling, but tidal information was recorded and seines were set so that the deepest point sampled was between 0.5 and 2.2 m. Once both ends of the seine were on the beach, one person on each end hand hauled the net in. The bag was left partially in the water to limit specimen mortality. The contents of the bag were sorted by species and enumerated. The first 25 individuals of each species were measured to the nearest mm and species with easily identifiable sexually dimorphic features (i.e., crabs) were sexed. All organisms were released immediately after they were counted and/or measured. After completion of seine operations, surface temperature and salinity were measured using a YSI multiparameter sonde, and general weather conditions were recorded.

Identifying age-0 fish by length

Growth rate fluctuates with age, so it is necessary to separate fish captured in summer beach seine operations into discrete year classes. When direct measurements of age are not available, statistical length-frequency models can be used to estimate age. This process is effective for temperate fishes with short, distinct spawning seasons (Macdonald & Pitcher 1979). The relationship of length to age becomes more difficult to detect as fish age and growth slows or ceases (Maunder et al. 2018). However, both focal species (herring and silverside) can likely be aged using this approach. Both species have seasonal growth patterns. The short lifespan and simple age structure of silverside should facilitate the detection of distinct ages by size. Though older and larger herring may no longer have distinct distributions of size at age, all herring individuals caught in our seine sampling efforts were 14-139 mm long. When comparing to the expected size and age of herring at maturation (275 mm at ages 3-4; Boyar 1968) it is clear that these are all younger individuals which should have detectable relationships of length to age.

Next, we identified and selected probable age-0 individuals of both species for the calculation of weekly growth rates. This begins with an assumption that the lengths of sampled conspecifics in the same year class at the same time come from an identifiable distribution. Commonly, a normal distribution is assumed (Macdonald & Pitcher 1979, Zhou et al. 2022). It is therefore possible to identify age groups by their unique modal lengths along a cumulative length distribution (Macdonald & Pitcher 1979). To confirm the presence of age-0 fish, the weekly length distributions of silversides and herring were visualized (Fig. S1) and compared to published values of length at age. Juvenile herring grow to lengths of 90-125 mm by the end of their first year (Anthony 1972). The size range of herring caught in our beach seines indicates they were mostly age-0 fish spawned the previous fall (mean 64 mm, SD 13 mm). Silverside spawn in the spring, with juveniles reaching 90-100 mm before growth ceases in the late fall (Conover & Ross 1982). Silverside weekly average lengths were consistently around 100 mm in the first third of the sampling season but rapidly decreased to a low of 67 mm in week 31. This indicates that mostly age-1+ silversides were caught early in the season, but recently-spawned silversides recruit to the seine and dominate catch by late July. This is consistent with phenological patterns and growth rates reported in the literature (Conover & Ross 1982, Conover & Present 1990, Gao & Munch 2013).

A graph of different sizes and lengths

AI-generated content may be incorrect.

Figure S1: Weekly length distributions (in mm) for herring (top panel) and silverside (bottom panel) aggregated across all sampled years. Blue lines indicate locally estimated scatterplot smoothing (LOESS) regressions to illustrate changes in average weekly lengths.

Literature Cited

Anthony VC (1972) Population dynamics of the Atlantic herring in the Gulf of Maine. Ph.D. dissertation, University of Washington, Seattle, WA

Boyar HC (1968) Age, Length, and Gonadal Stages of Herring from Georges Bank and the Gulf of Maine. International Commission for the Northwest Atlantic Fisheries (ICNAF) Research Bulletin 5:49–61.

Conover DO, Present TMC (1990) Countergradient variation in growth rate: compensation for length of the growing season among Atlantic silversides from different latitudes. Oecologia 83:316–324.

Conover DO, Ross MR (1982) Patterns in Seasonal Abundance, Growth and Biomass of the Atlantic Silverside, *Menidia menidia*, in a New England Estuary. Estuaries 5:275.

Gao J, Munch S (2013) Genetic and maternal variation in early growth in the Atlantic silverside *Menidia menidia*. Mar Ecol Prog Ser 485:211–222.

Macdonald PDM, Pitcher TJ (1979) Age-Groups from Size-Frequency Data: A Versatile and Efficient Method of Analyzing Distribution Mixtures. J Fish Res Bd Can 36:987–1001.

Maunder MN, Deriso RB, Schaefer KM, Fuller DW, Aires-da-Silva AM, Minte-Vera CV, Campana SE (2018) The growth cessation model: a growth model for species showing a near cessation in growth with application to bigeye tuna (Thunnus obesus). Mar Biol 165:76.

Zhou S, Hutton T, Lei Y, Miller M, van Der Velde T, Deng RA (2022) Estimating growth from length frequency distribution: comparison of ELEFAN and Bayesian approaches for red endeavour prawns ( *Metapenaeus ensis* ). ICES Journal of Marine Science 79:1942–1953.