The University of Rhode Island
Graduate School of Oceanography

2024 ANNUAL FISH TRAWL SURVEY REPORT

The Graduate School of Oceanography (GSO) Fish trawl survey began weekly sampling of two stations in Narragansett Bay, Rhode Island, USA in 1959. One station is mid-bay, near Fox Island, at about 7m depth; the other station is in the lower bay, near Whale Rock, at about 23 meters depth (Collie et al. 2008, Fig. 1).

Occasionally, due to poor weather conditions or boat repair, weekly sampling did not take place. However, of the 792 months sampled between the start of the survey in 1959 and 2024, all but twelve contained two or more weekly surveys, and 96% had three or more surveys. In the most recent year, 2024, 50 weekly tows were made at the mid-bay station and 51 tows at the lower-bay station. Over the last six decades, the GSO trawl survey has recorded numerous changes in the bay including changes in water temperature and species composition. The following report contains a summary of the data, including updates to the most recent survey publication, Collie et al. (2008).

Sea surface temperatures

Surface and bottom water temperatures were recorded at the beginning of each trawl. A Niskin bottle and bucket thermometer was used until 2006; since then, a conductivity, temperature, and depth (CTD) probe have been used up to the present. Water temperatures at both stations warmed by about approximately 2°C between 1959 and 2024 (Fig. 1).

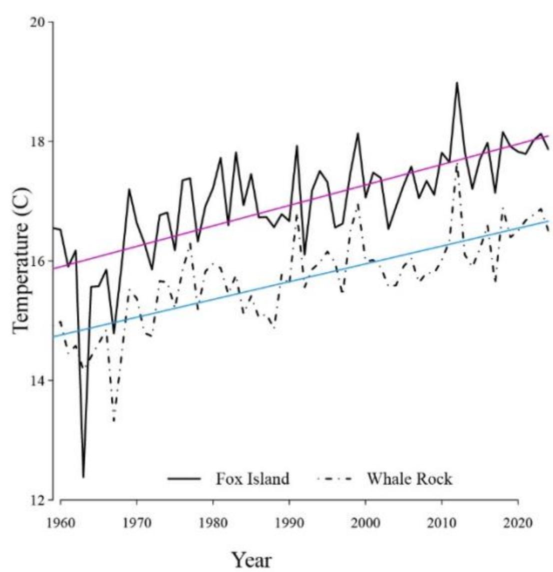


Figure 1. Average spring-summer sea surface temperature and corresponding linear regression lines (mid-bay station, solid line, violet regression; lower bay station, broken line, blue regression) (based on Fig. 7a, Collie et al. 2008).

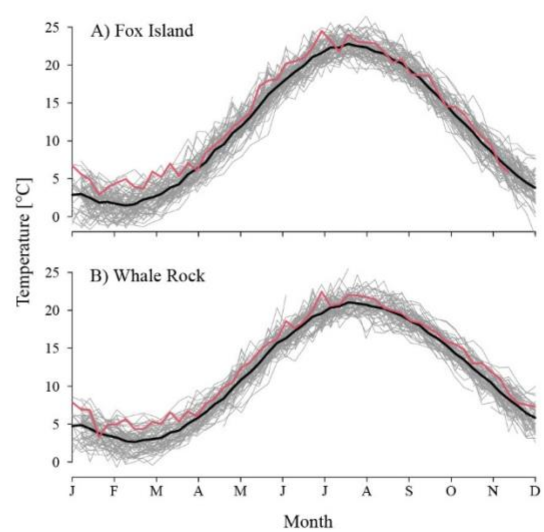


Figure 2. Weekly sea surface temperature at the mid-bay (a) and lower bay (b) stations. Time series mean weekly temperature (black), individual year weekly temperatures (gray), most recent year 2024 (red).

2024 ANNUAL FISH TRAWL SURVEY REPORT

Weekly sea surface temperatures ranged from about 3°C in winter to about 25°C in summer (Fig. 2). The most recent year, 2024, was 1-2°C warmer than the historical average for most of the year (Fig. 2).

Species composition (based on Collie et al. 2008)

Species composition in Narragansett Bay changed several times over the last six decades (Collie et al. 2008). Here, the most numerous 25 species caught between 1959 and 2005 (as determined in Collie et al. 2008) are used to summarize changes in the bay.

Catch composition shifted from mostly demersal fish species in the first twenty years of the survey to more pelagic fish and squid species from the 1980s through present (Fig. 3). The proportion of pelagic species declined slightly in the past fifteen years, possibly indicating a shift back towards a system dominated by demersal fish species. Furthermore, comparisons of annual species compositions at both stations indicate two clusters of 60% similar years, corresponding to the demersal and pelagic species regimes (Fig. 4). The similarity comparison also indicates that the present annual trajectory may be leading to a third species composition regime in the future (Fig. 4).

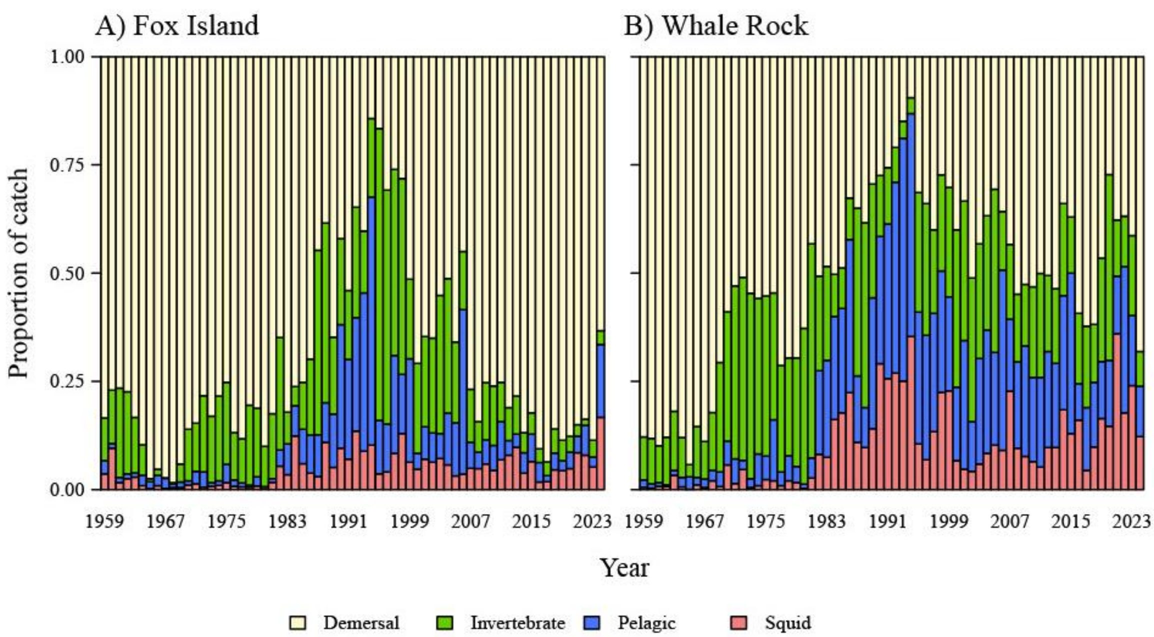
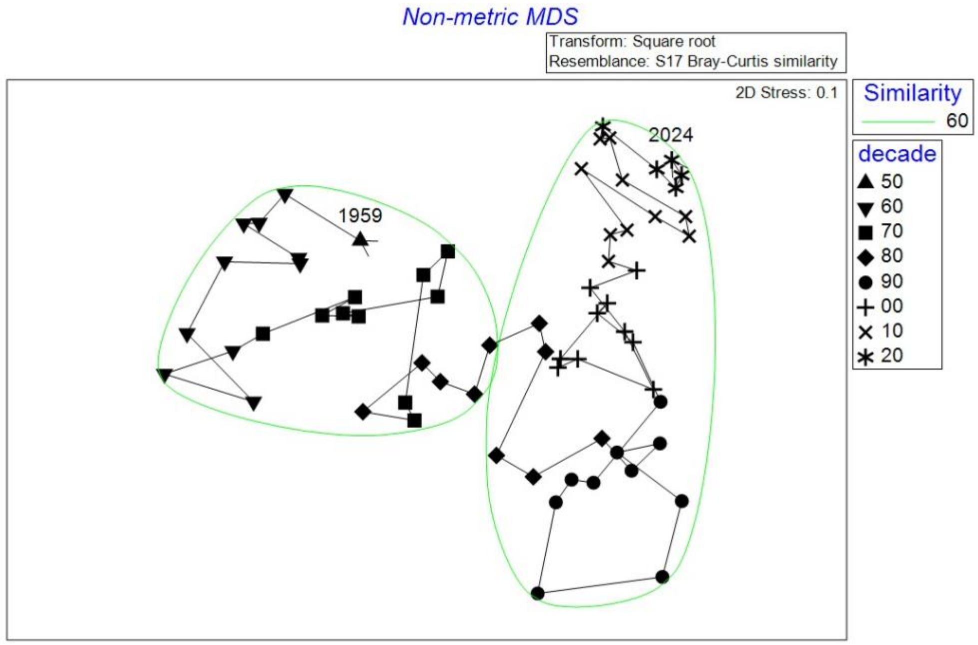
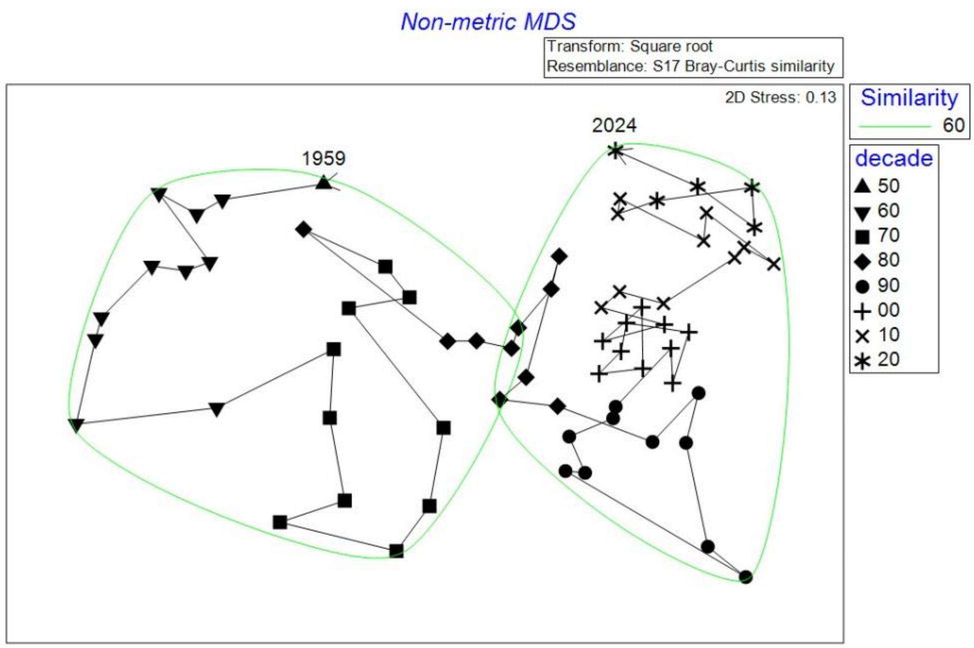


Figure 3. Shifts in the relative abundance of species at (a) mid-bay station and (b) lower bay station (based on Collie et al. 2008, Fig. 2)



A)



B)

Figure 4. Ordination of abundances of 25 species since 1959: (a) mid-bay station; (b) lower bay station. The non-metric multidimensional scaling (MDS) was based on the Bray-Curtis similarity of square-root-transformed data. Each point represents one year; points that are closer to together have more similar species composition than distant points. Symbols indicate the decades: inverted triangles, 1960s; squares, 1970s; diamonds, 1980s; circles, 1990s; crosses, 2000s; Xs, 2010s, stars, 2020s. The contours enclose clusters with > 60% similarity (based on Collie et al. 2008, Fig. 3).

2024 ANNUAL FISH TRAWL SURVEY REPORT

Most species changed abundance dramatically since 1959 (Fig. 5). This suggests that the changes in species composition were driven by large magnitude shifts in the dominant bay species. Additionally, the nine species accounting for most of the shifts in the bay indicated dramatic changes in annual mean catch per tow (Fig. 6).

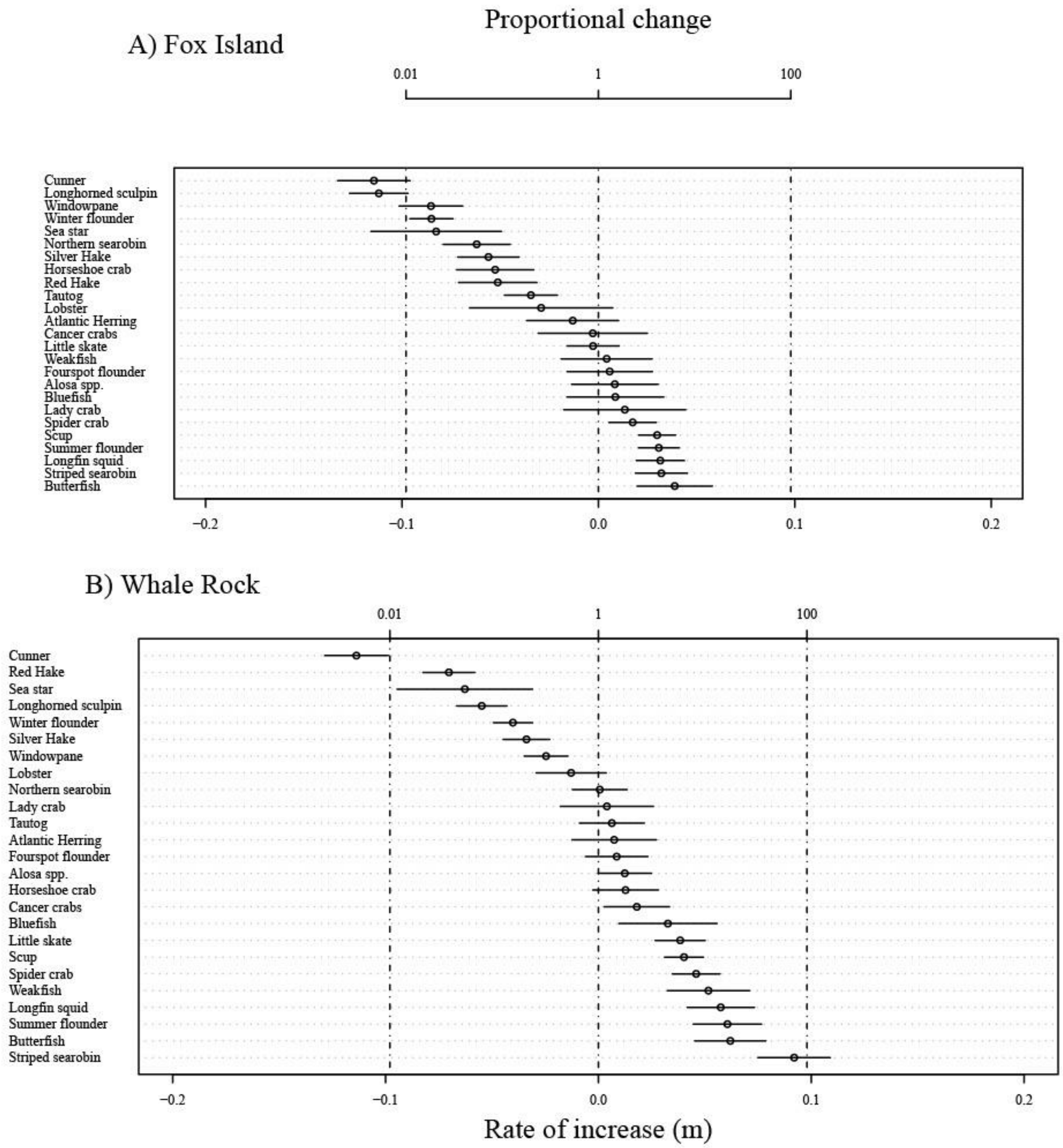


Figure 5. Rates of increase or decrease of 25 species: (a) mid-bay station; (b) lower bay station. The open circles represent the slopes (m) from regression of log-transformed abundances against time; the horizontal solid lines are the 95% confidence intervals of the slopes. The broken vertical lines indicate a 100-fold decrease (0.01), no change (1), and 100-fold increase (100) (based on Collie et al. 2008, Fig. 4).

2024 ANNUAL FISH TRAWL SURVEY REPORT

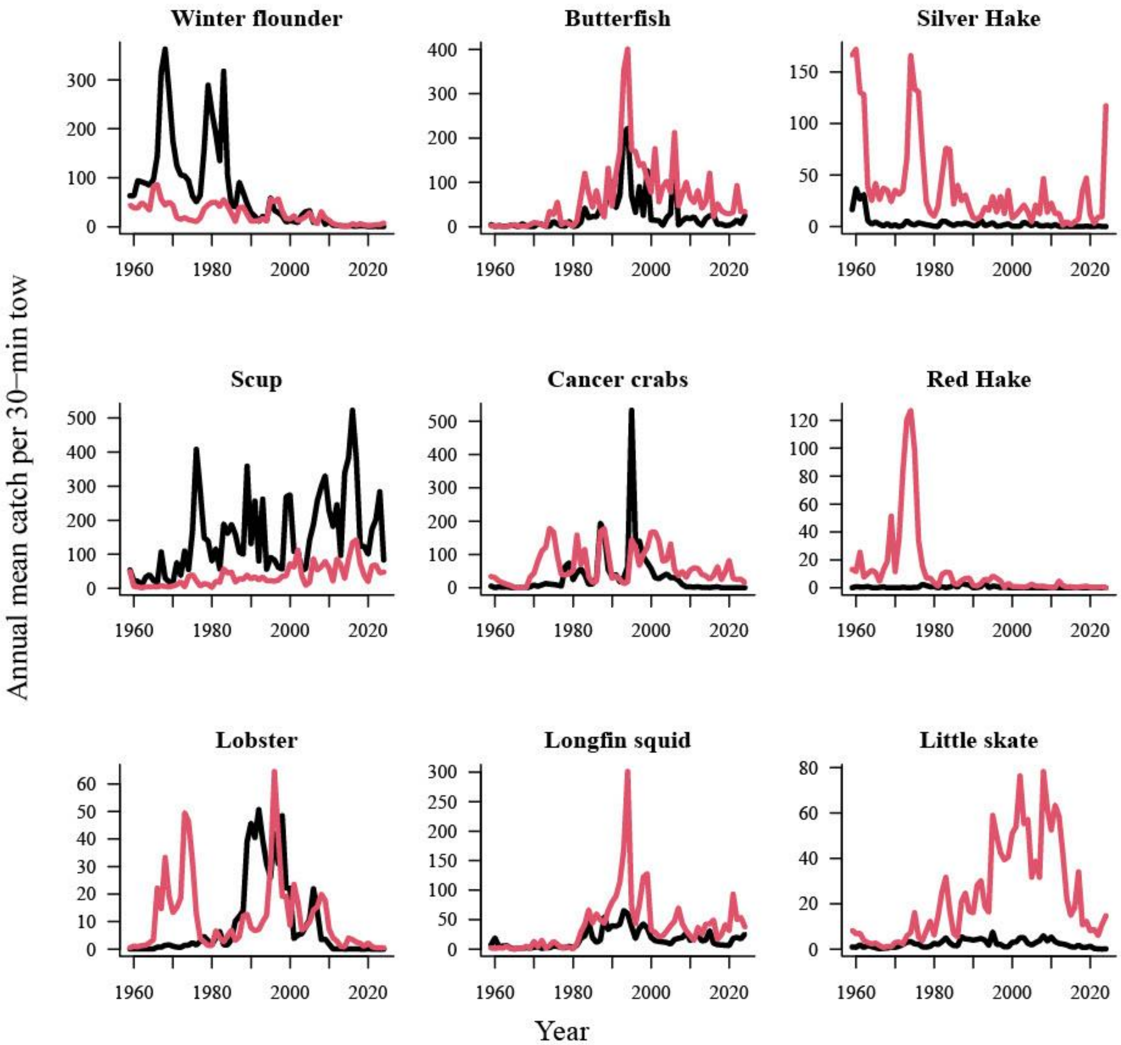


Figure 6. Annual mean abundances of the nine species that are primarily responsible for the ordinations in Fig. 4: mid-bay station, black; lower bay station, red. These nine species account for most of the pattern at the mid-bay station. The six species in the middle and right columns explain the pattern seen at the lower bay station (based on Fig. 5, Collie et al. 2008).

Mean catch per tow of all 25 species increased at both stations over the time series (Fig. 7a), reaching peak abundances sometime between 1993 and 1995 and declining since. Despite variability, there seemed to be an increase in taxonomic distinctness since 1959 (Fig. 7b). Annual pelagic-demersal ratios indicate a shift to pelagic species at both stations by the mid-1990s (Fig. 7c). Despite the increase in catch per tow between 1959 and the mid-90s, species caught in recent years have smaller body size (Fig. 7d). Weighted mean maximum length declined at both stations. Weighted temperature preferences also increased at both stations, indicating the species caught in recent years tend to prefer warmer temperatures that are more commonly found in the bay (Fig. 1, 7e, 7f).

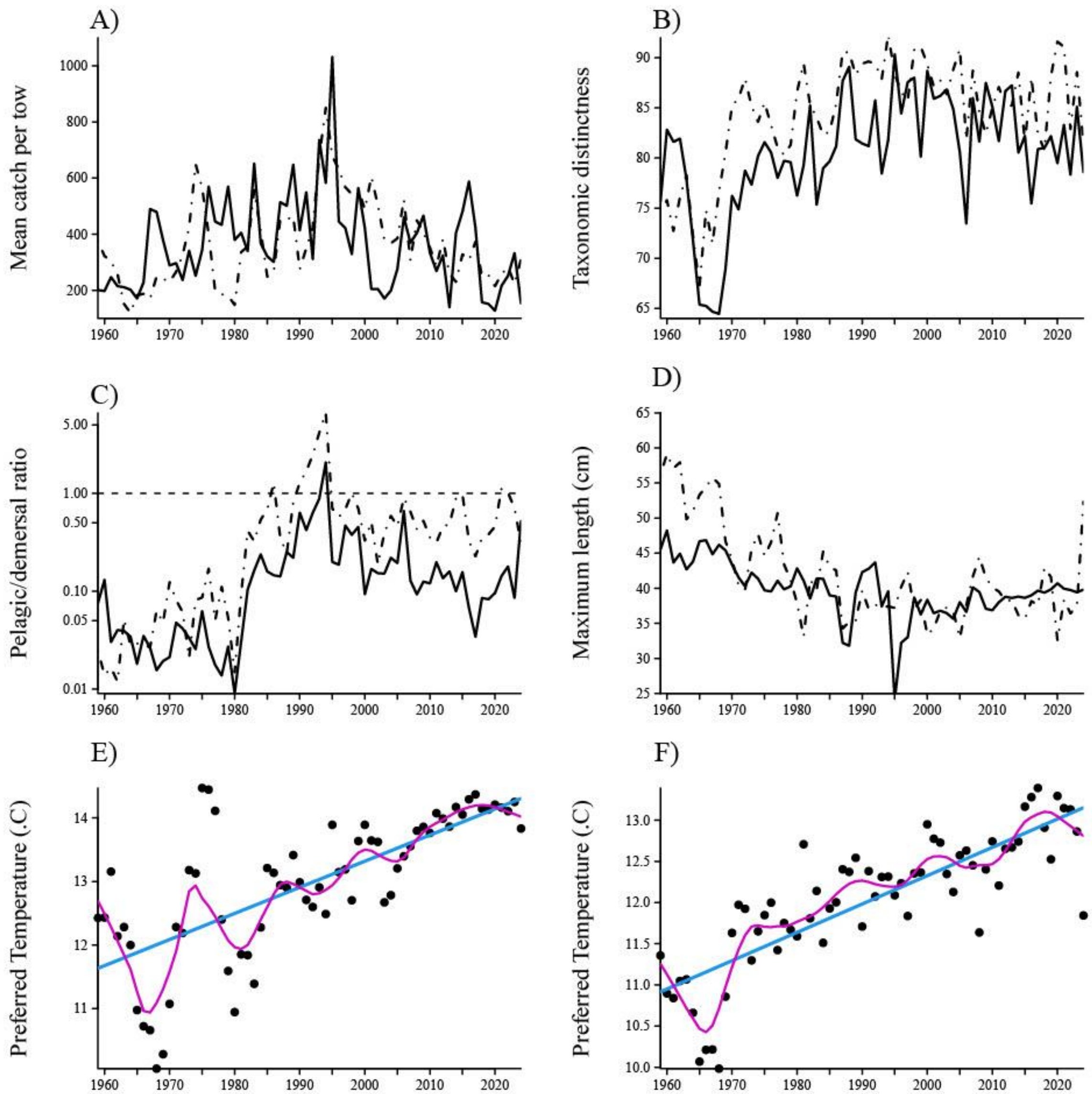


Figure 7. Community metrics calculated for the mid-bay station (solid lines) and lower bay station (broken lines): (a) total mean catch pet 30-min tow; (b) taxonomic distinctness; (c) pelagic-demersal ratio; (d) weighted mean maximum length, L_{max}; (e and f) weighted mean preferred temperature, T_{pref}, at (e) the mid-bay station and (f) the lower bay station. The violet lines in (e) and (f) are lowess smoothers and the blue lines are the linear time trends (based on Collie et al. 2008, Fig. 6).

2024 ANNUAL FISH TRAWL SURVEY REPORT

Heat Wave Analysis

Marine heatwaves have been increasing in frequency and intensity across the globe and are expected to intensify even further under projected climate change scenarios (Hobday et al. 2016). While organisms can endure a certain level of environmental stochasticity, extreme heat events disrupt biological systems and even cause mortality events. For the two Narragansett Bay stations, a "heat wave" is defined as two consecutive sampling dates with temperatures above the 90th percentile "threshold" based on percentiles from the entire time series (adapted from Hobday et al. 2006).

At the mid-bay station, there were two small heat wave events at the surface early in the year, one from January 2nd to January 8th and the other from January 31st to February 5th. In the bottom waters, there was one longer more sustained heat wave from January 2nd to February 19th. At the lower-bay station, there were two small heat wave events at the surface, one from January 2nd to January 8th and the other from November 18th to December 2nd. There was a more sustained heat wave in the bottom waters from January 2nd to February 12th, similar to the bottom waters at the mid-bay station. In the Winter of 2023-2024, there was a positive phase of the El Nino Southern Oscillation, which contributed to elevated water temperatures in Narragansett Bay.

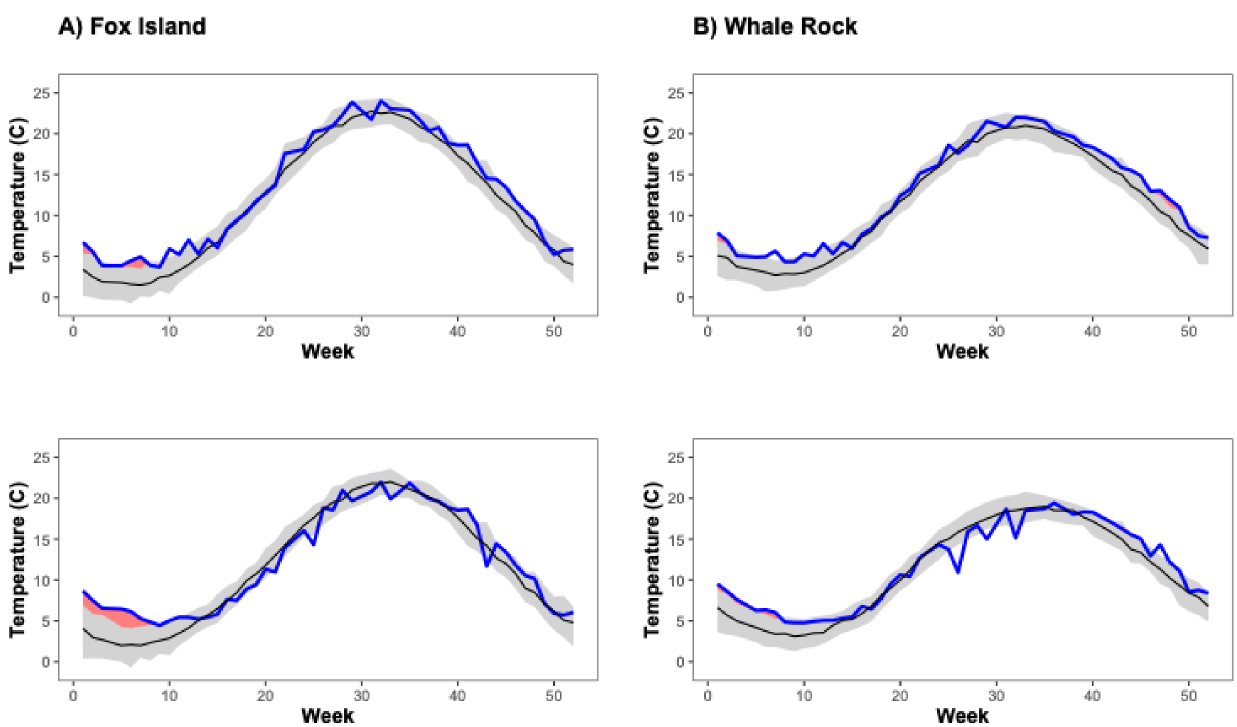


Figure 8. Heat waves during 2024 at A) the upper-bay station and B) the lower-bay station (top panels represent surface waters, bottom panels represent bottom waters). Solid blue lines represent the measured temperatures, and solid black lines are the median historical values. The lower and upper bounds of the shaded gray area are the 10th and 90th historical percentiles, respectively.

References

Collie, J. S., Wood, A. D., & Jeffries, H. P. (2008). Long-term shifts in the species composition of a coastal fish community. Canadian Journal of Fisheries and Aquatic Sciences, 65(7), 1352-1365.