Comparison of distribution and prey of four flounders on Georges Bank

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This working paper is an exploratory evaluation of the spatial distribution of yellowtail, fourspot, windowpane, and winter flounders on Georges Bank as well as the proportion of prey consumed by each of these species. We focused on the Georges Bank yellowtail flounder’s assessment strata set of 13-22 (Figure 1) for our analyses. Based on the average abundance (numbers per tow) from the Northeast Fisheries Science Center’s (NEFSC) research surveys, the core distribution among the four flounders is more segregated in the spring (1968-2013, Figure 2) than in the fall (1963-2013). During the fall survey, the core distribution of the four flounders shifts slightly but still does not appear to overlap to a great extent (Figure 3). Yellowtail and fourspot overlap along the outer edge of Georges Bank, whereas windowpane and winter flounder appear to congregate more towards the middle of the Bank. The distribution of the four flounders during the spring and fall 2008-2012 surveys (Figures 4 and 5) exhibit similar patterns as the full time series. There may be little competition for food or space given the minimal overlap in distribution in both seasons.

Using the NEFSC’s Feeding Ecology Analysis and Statistics Toolkit (FEAST) program, we were able to examine the food habits of the four flounder species in the NEFSC’s offshore strata 13-22 during both spring and fall 2008-2012 surveys. Figures 6 and 7 show the overall stomach contents for each of the four species across all strata, specifically identifying the prey species that accounted for more than 10% of the diet (see Table 1 for prey definitions), whereas Figures 8-27 illustrate the overall stomach content for each individual stratum. Both sets of plots give a percentage of diet composition by taxonomic category. Sample sizes (n) were based on prey items that accounted for more than 10% of the diet in Figures 6 and 7 and on a five-year average of all prey items for Figures 8-27. Table 1 gives more detailed information on the stomach contents from the FEAST program.

The graphical results show that in examining the overall diet composition across all strata, decapods were commonly found in the diets of all four flounder species in the fall, and no particular pattern emerged among all four flounders in the spring (Figures 6 and 7). However, there is minimal overlap in the diet of yellowtail flounder compared to the diets of fourspot flounder, windowpane flounder and winter flounder, when looking at each stratum individually. The plots demonstrate that yellowtail flounder seem to prefer annelids and amphipods over the decapods, cnidarians, and crustaceans that fourspot, windowpane and winter flounders seem to prefer in certain strata (Figures 8-27). The highest number of samples taken for yellowtail, windowpane and winter flounders were in strata 13, 16, and 19, suggesting higher abundance in these strata than in the remaining strata.

A preliminary look at the NEFSC’s benthic data indicated that the highest abundance of individual animals occurred in strata 13, 16, and 19. The higher productivity in these strata could account for the higher abundance of flounders in these strata. A more detailed analysis is needed to explore the influence of bottom type and environmental indices, such as temperature and salinity on distribution. Such an analysis may be useful in determining if there are additional factors to explain the aggregations of flounders in these particular areas.
Figure 1. NEFSC survey strata map.
Figure 2. Distribution plots for the NEFSC’s spring survey, averaged from 1968-2013, for strata 13-22.
Figure 3. Distribution plots for the NEFSC’s fall survey, averaged from 1963-2013, for strata 13-22.
Figure 4. Distribution plots for the NEFSC’s spring survey, averaged from 2008-2012, for strata 13-22.
Figure 5. Distribution plots for the NEFSC’s fall survey, averaged from 2008-2012, for strata 13-22.
Figure 6. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for all strata (13-22) during NEFSC’s spring survey 2008-2012. Only percentages over 10% are plotted. The N values are the values for only the prey items in the chart.
Figure 7. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for all strata (13-22) during NEFSC’s fall survey 2008-2012. Only percentages over 10% are plotted. The N values are based on the 10% criteria.
Figure 8. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 13 during NEFSC’s spring survey 2008-2012.
Figure 9. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 14 during NEFSC’s spring survey 2008-2012.
Figure 10. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 15 during NEFSC’s spring survey 2008-2012.
Figure 11. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 16 during NEFSC’s spring survey 2008-2012.
Figure 12. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 17 during NEFSC’s spring survey 2008-2012.
Figure 13. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 18 during NEFSC’s spring survey 2008-2012.

**GBYT stratum 18**
- AR 100%
- N = 1

**Fourspot stratum 18**
- EMPTY 93%
- DECAPO 7%
- N = 15
Figure 14. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 19 during NEFSC’s spring survey 2008-2012.
Figure 15. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 20 during NEFSC’s spring survey 2008-2012.
Figure 16. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 21 during NEFSC's spring survey 2008-2012.
Figure 17. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 22 during NEFSC’s spring survey 2008-2012.

**GBYT stratum 22**
- EMPTY: 71%
- ANNELI: 14%
- CRUSTA: 14%

**Fourspot stratum 22**
- EMPTY: 80%
- CEPHAL: 6%
- CRUSTA: 7%
- DECAPO: 7%

**Winter flounder stratum 22**
- OTHER: 100%
Figure 18. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 13 during NEFSC’s fall survey 2008-2012.
Figure 19. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 14 during NEFSC’s fall survey 2008-2012.

GBYT stratum 14

ANNELI 100%

N = 1

Fourspot stratum 14

EMPTY 71%

ANNELI 3%

CRUSTA 3%

DECAPO 13%

OTHFIS 6%

N = 31
Figure 20. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 15 during NEFSC’s fall survey 2008-2012.
Figure 21. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 16 during NEFSC’s fall survey 2008-2012.

GBYT stratum 16
- Empty: 52%
- Decapod: 8%
- Amphipod: 3%
- Annelida: 3%
- Ophiuroid: 1%
- Others: 2%
- 12% AR
- OTHFIS: 0%
- Echinoderm: 0%
- Gastrotrich: 0%
- Mollusk: 0%
- Miscellaneous: 2%

N = 256

Fourspot stratum 16
- Empty: 23%
- Decapod: 23%
- Annelid: 15%
- Myzostomum: 17%
- Others: 2%
- AMPHIP: 7%
- CEPHAL: 3%
- CRUSTA: 4%
- BOTFAM: 1%

N = 107

Windowpane stratum 16
- Empty: 68%
- Decapod: 20%
- Annelid: 15%
- Amphipod: 6%
- Myzostomum: 2%
- Others: 2%
- AR: 4%
- Echinoderm: 2%
- CRUSTA: 1%
- GASTRO: 1%
- MOLLUS: 1%
- Miscellaneous: 1%

N = 46

Winter Flounder stratum 16
- Empty: 23%
- Decapod: 16%
- Cnidarian: 18%
- Annelid: 15%
- Myzostomum: 12%
- Others: 2%
- AMPHIP: 6%
- Mollusk: 1%
- Bivalve: 3%
- Bryozoa: 2%
- Arachnida: 11%
- GASTRO: 1%

N = 105
Figure 22. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 17 during NEFSC’s fall survey 2008-2012.
Figure 23. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 18 during NEFSC’s fall survey 2008-2012.
Figure 24. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 19 during NEFSC’s fall survey 2008-2012.
Figure 25. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 20 during NEFSC’s fall survey 2008-2012.
Figure 26. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 21 during NEFSC’s fall survey 2008-2012.
Figure 27. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 22 during NEFSC’s fall survey 2008-2012.

GBYT
stratum 22

N = 3

EMPT Y
100%

Fourspot
stratum 22

N = 16

EMPTY
44%

CEPHAL
13%

DECAPO
19%

GADFAM
6%

OTHFIS
13%

AR
6%
Table 1. Prey items found in the stomachs of Georges Bank yellowtail, fourspot, windowpane, and winter flounders.
Table 1 (cont). Prey items found in the stomachs of Georges Bank yellowtail, fourspot, windowpane, and winter flounders.

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