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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.

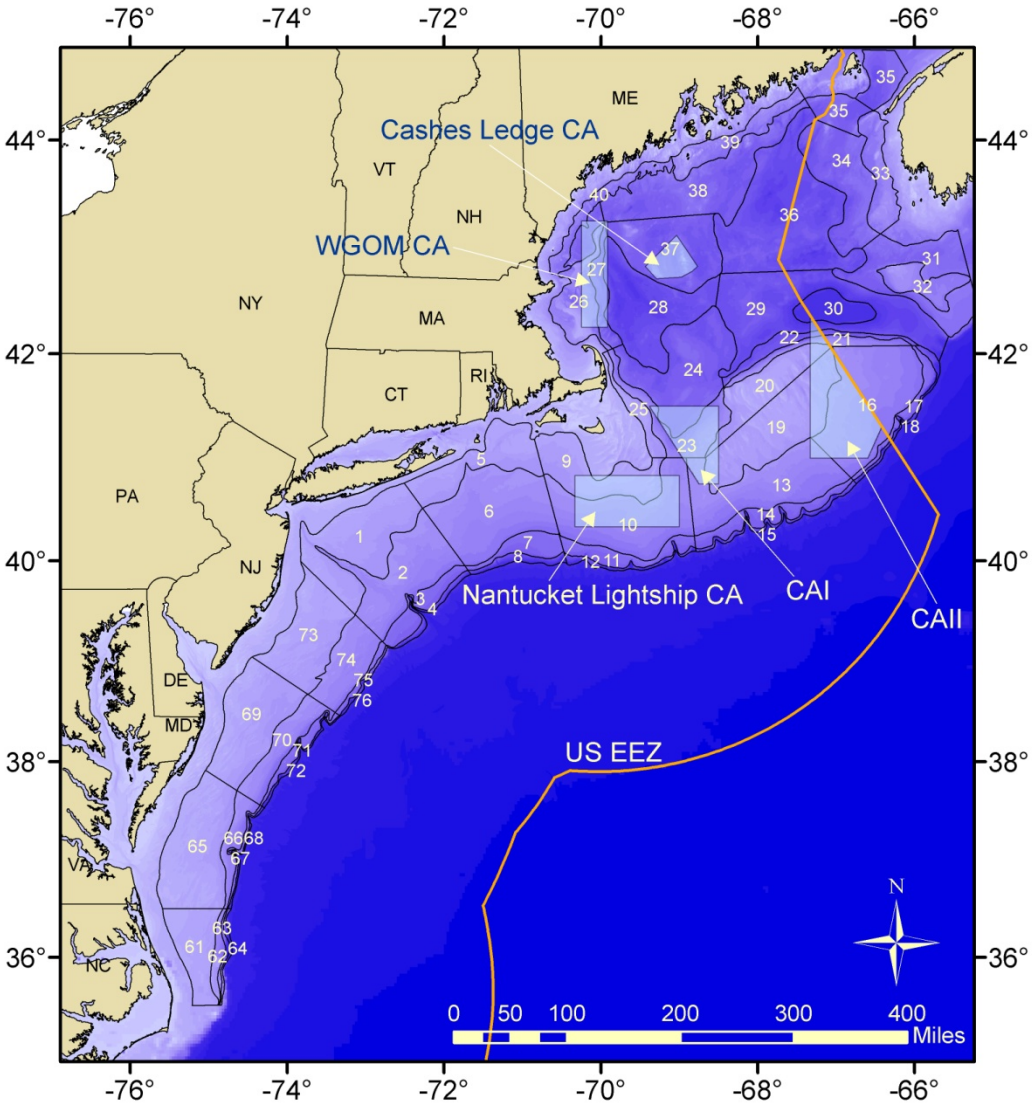
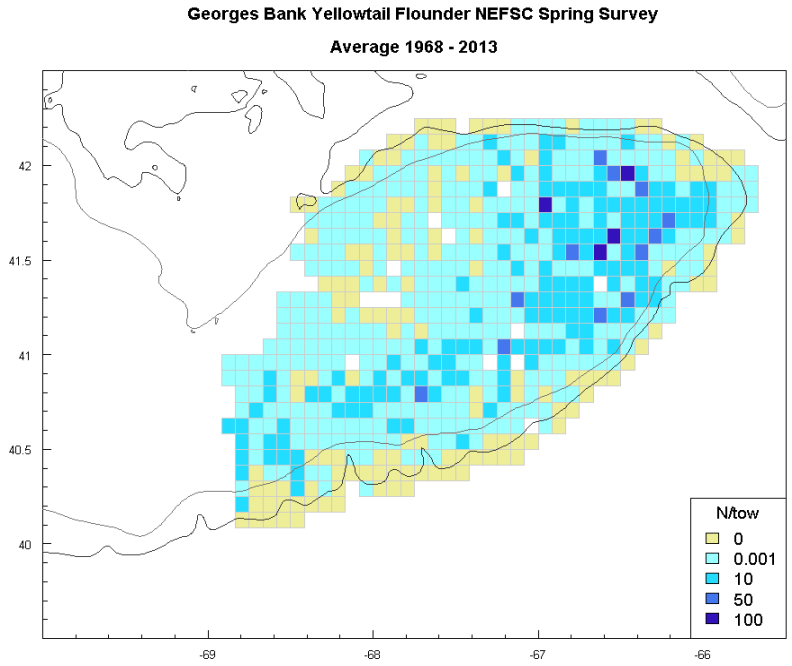
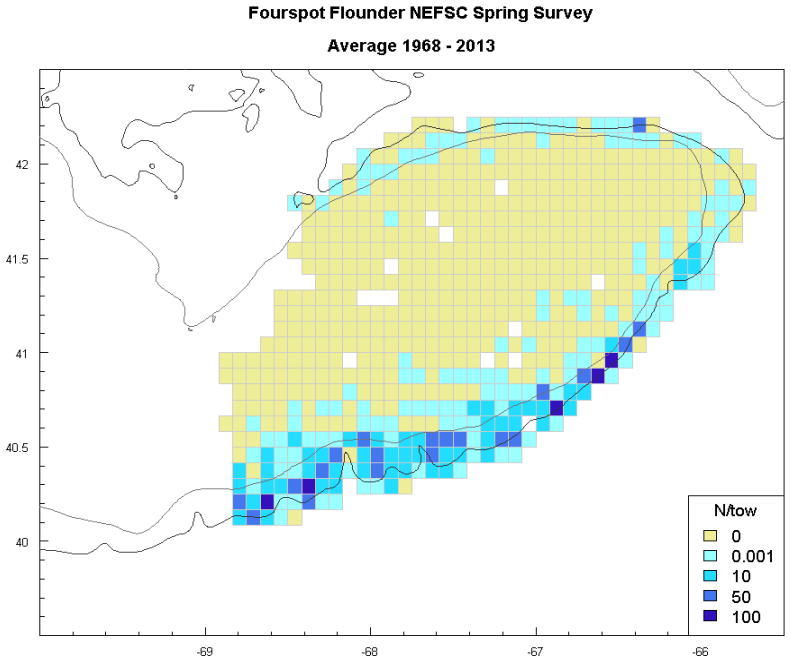
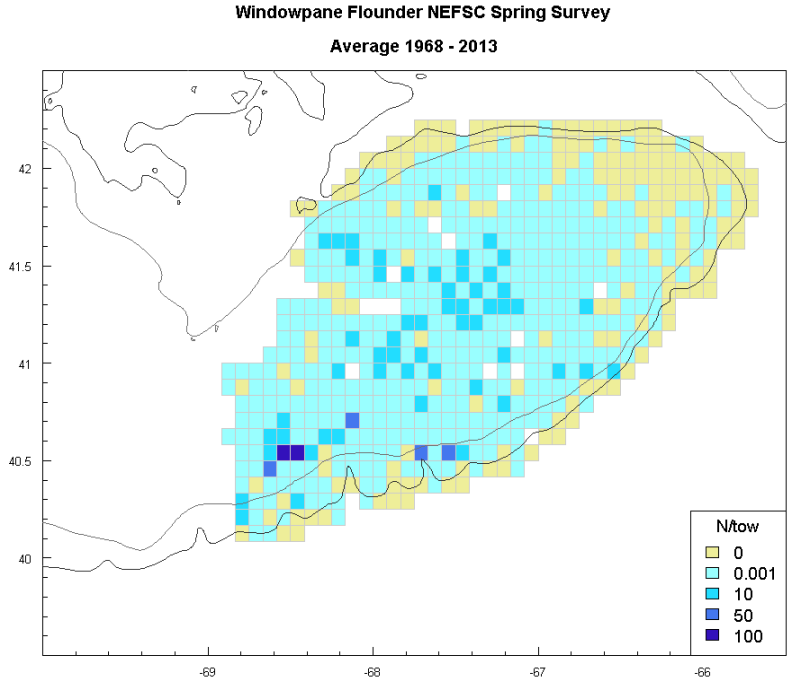


Figure 2. Distribution plots for the NEFSC's spring survey, averaged from 1968-2013, for strata 13-22.







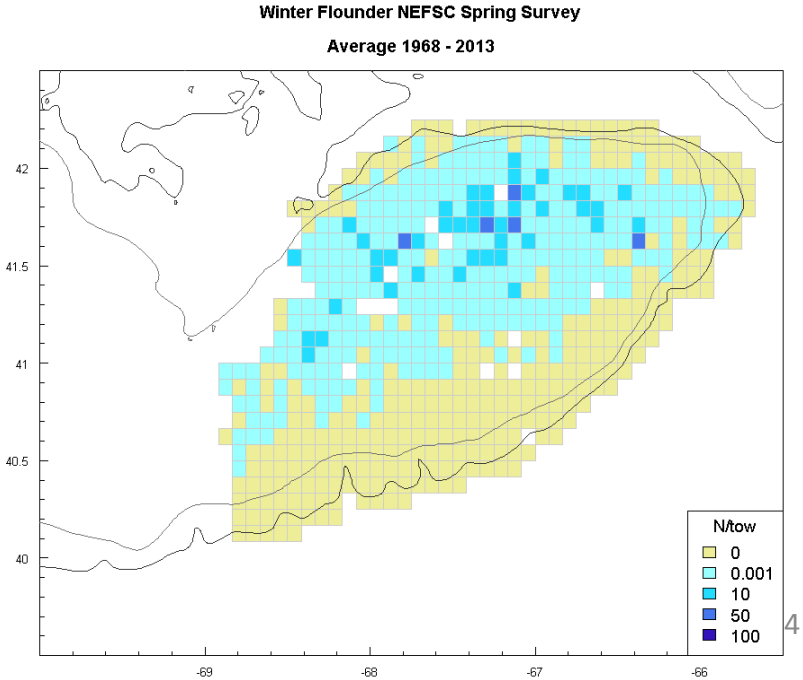
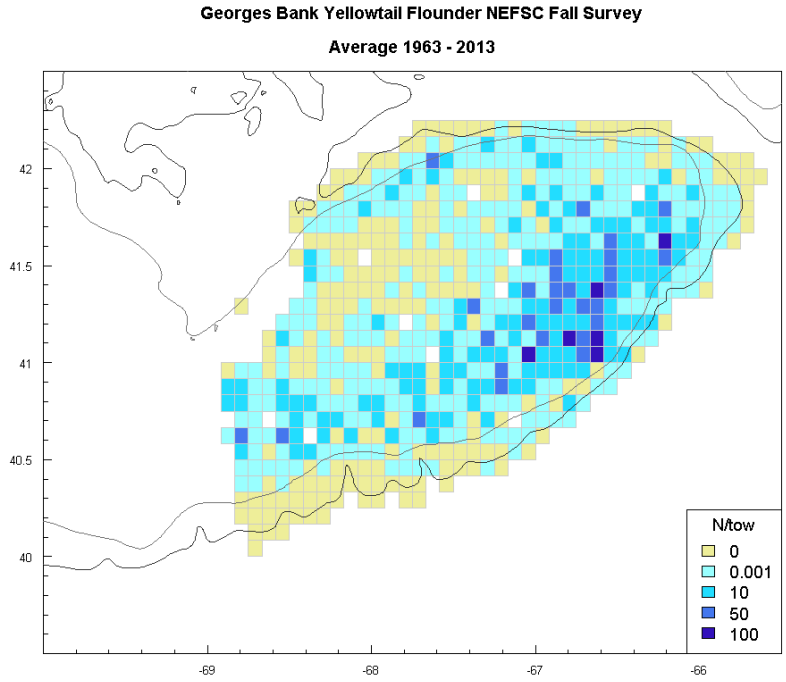
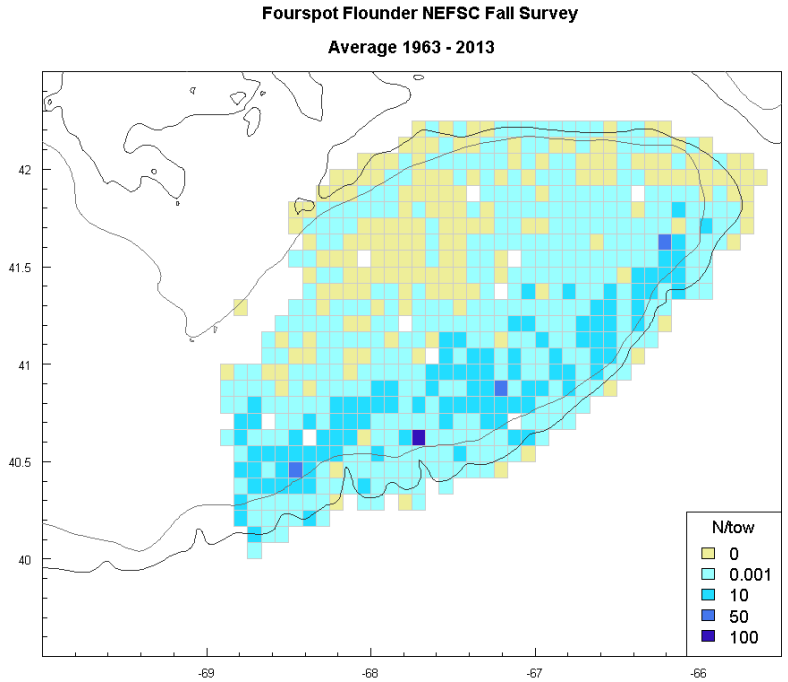
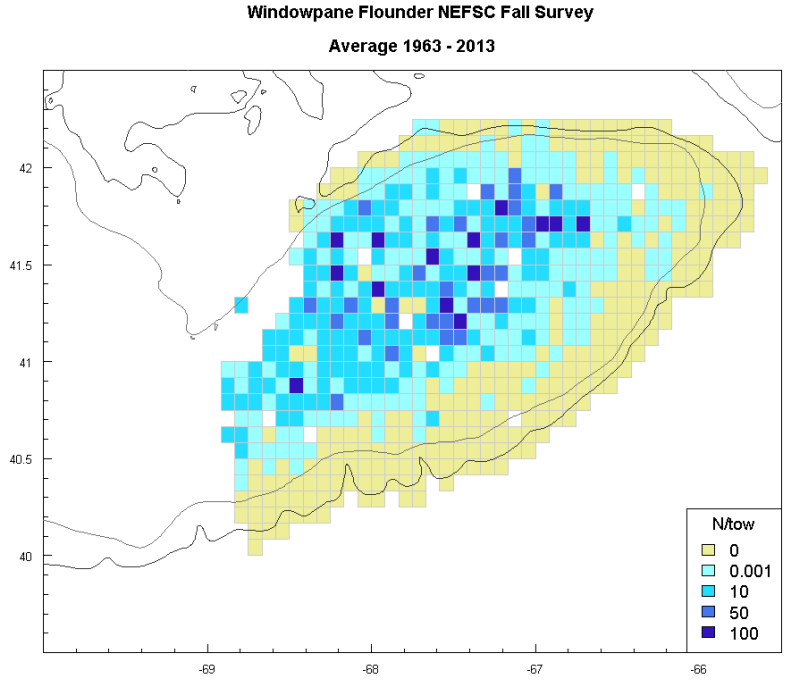


Figure 3. Distribution plots for the NEFSC's fall survey, averaged from 1963-2013, for strata 13-22.







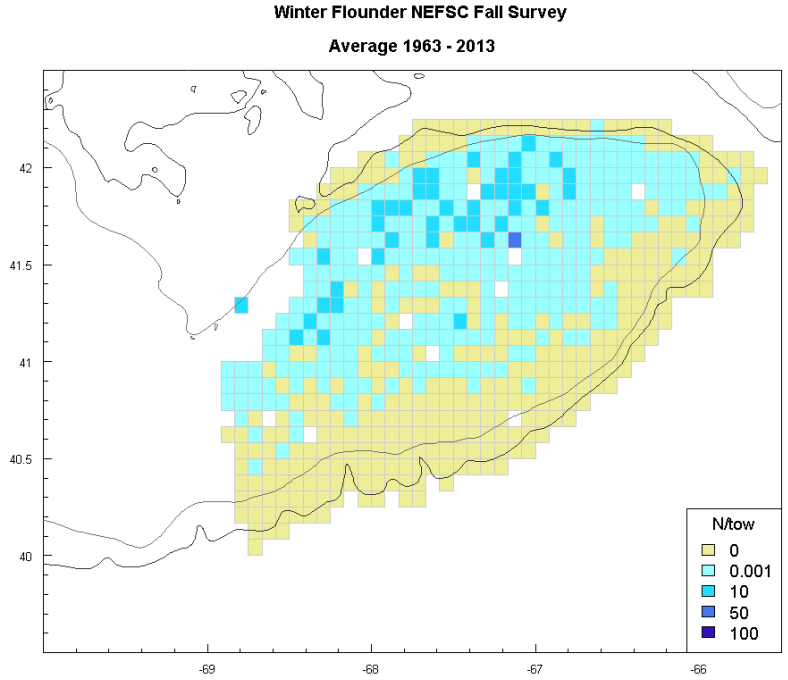
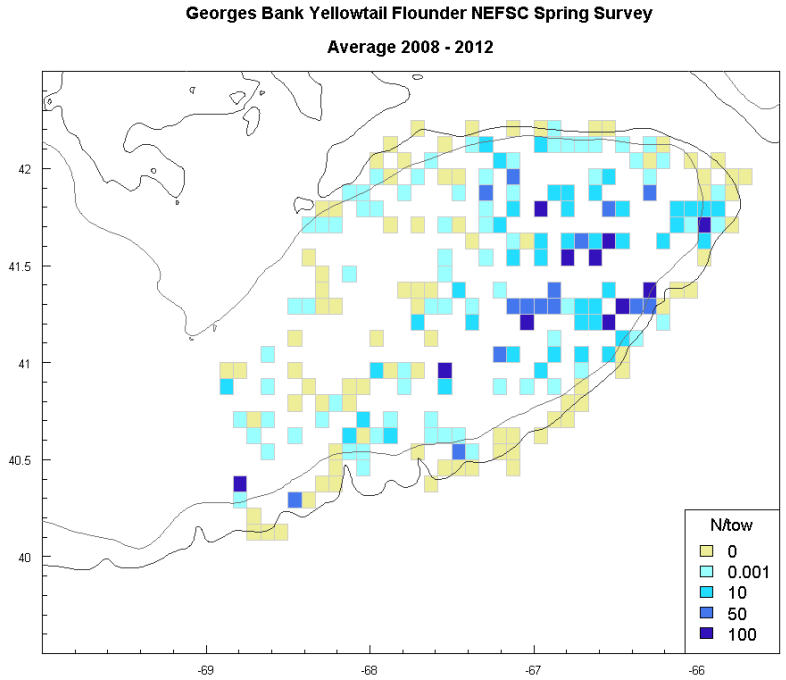
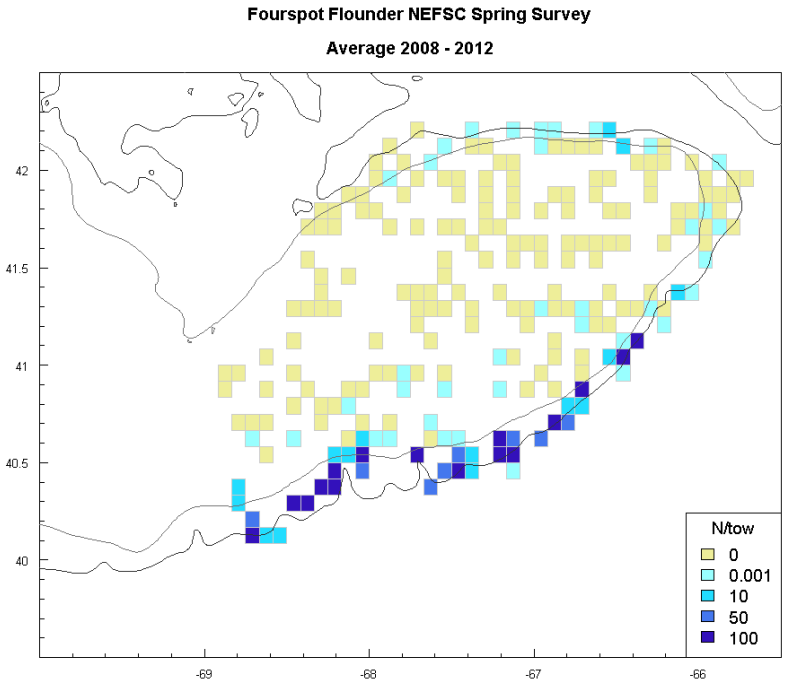
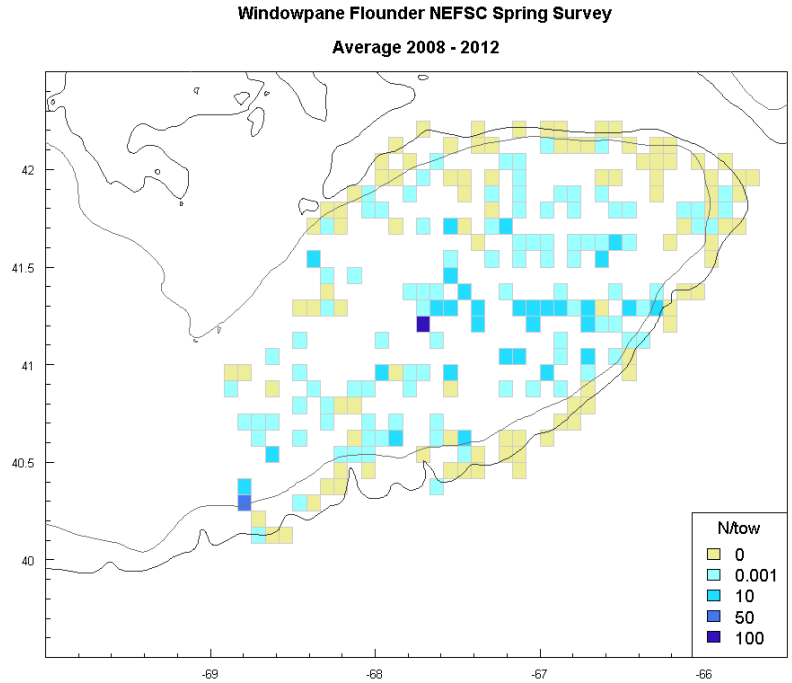


Figure 4. Distribution plots for the NEFSC's spring survey, averaged from 2008-2012, for strata 13-22.







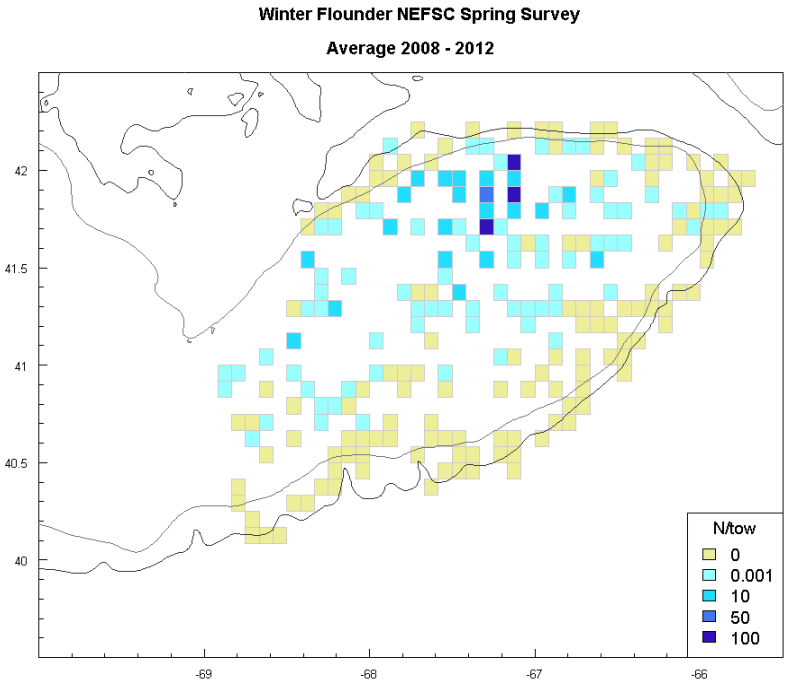
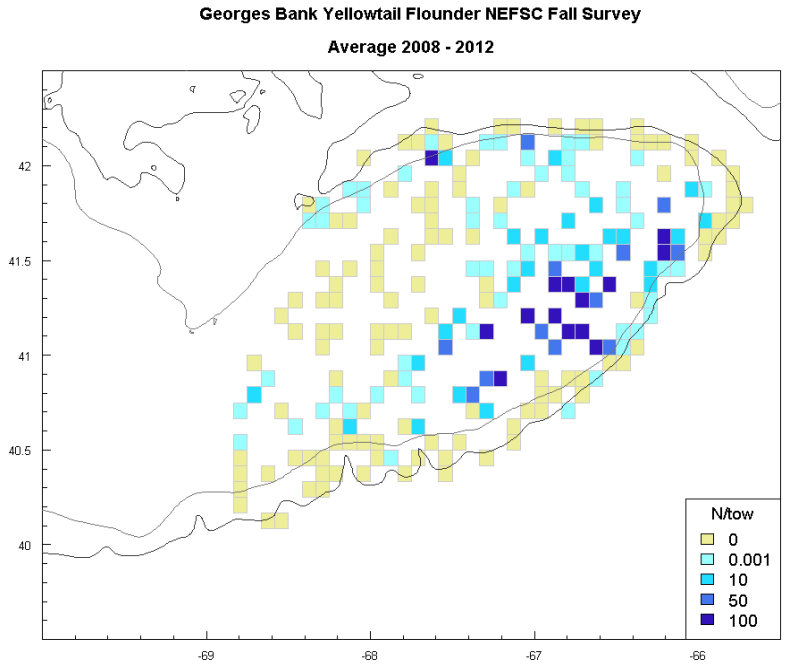
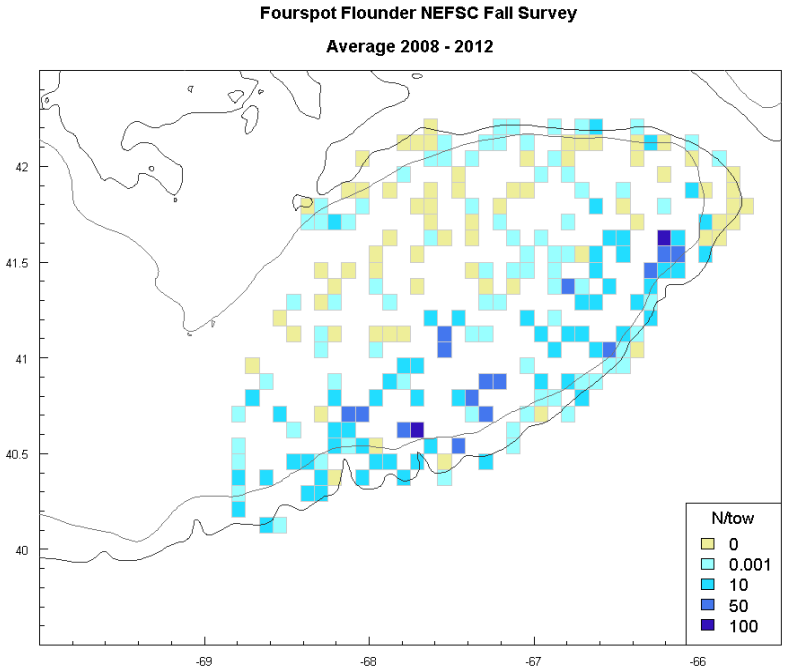
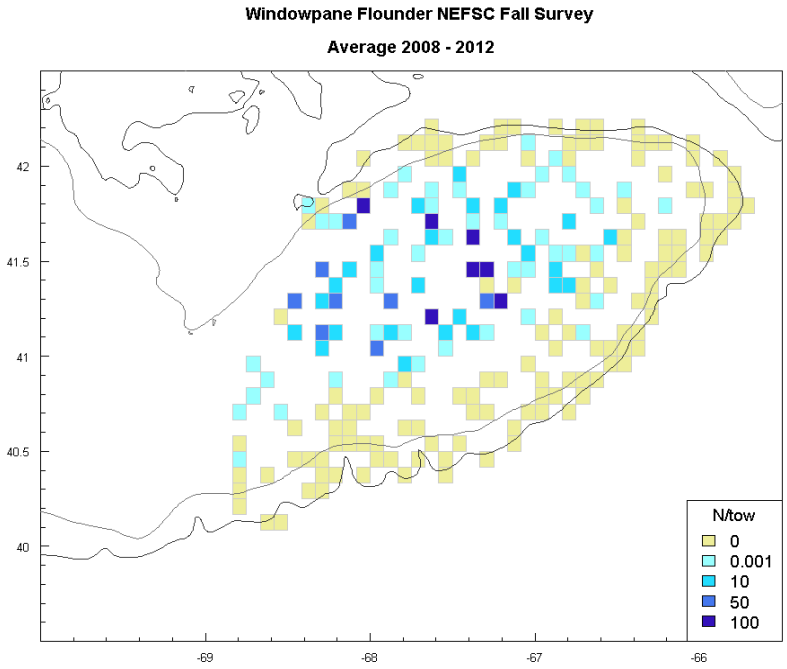


Figure 5. Distribution plots for the NEFSC's fall survey, averaged from 2008-2012, for strata 13-22.







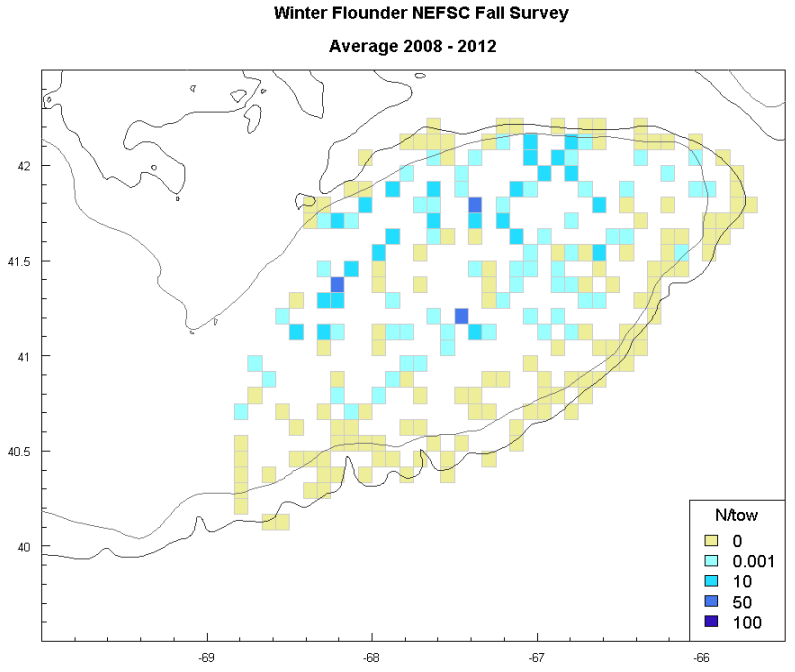
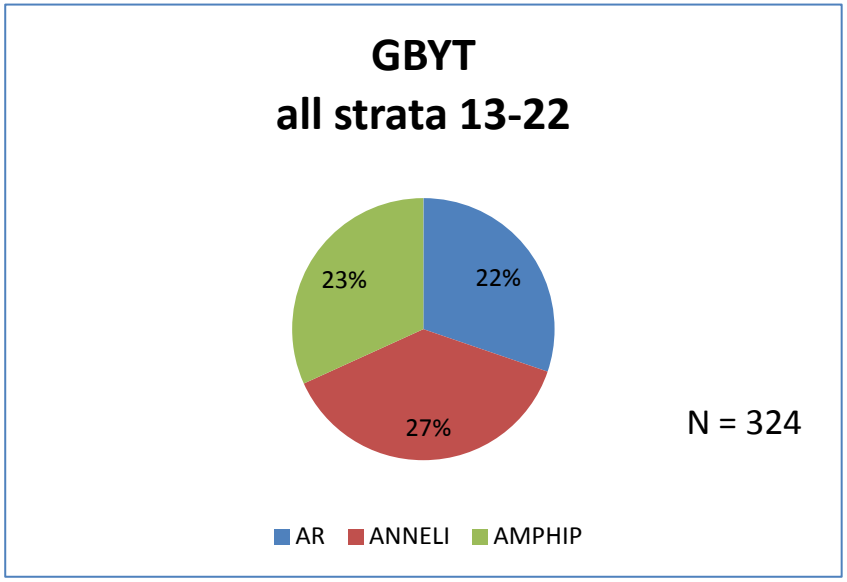
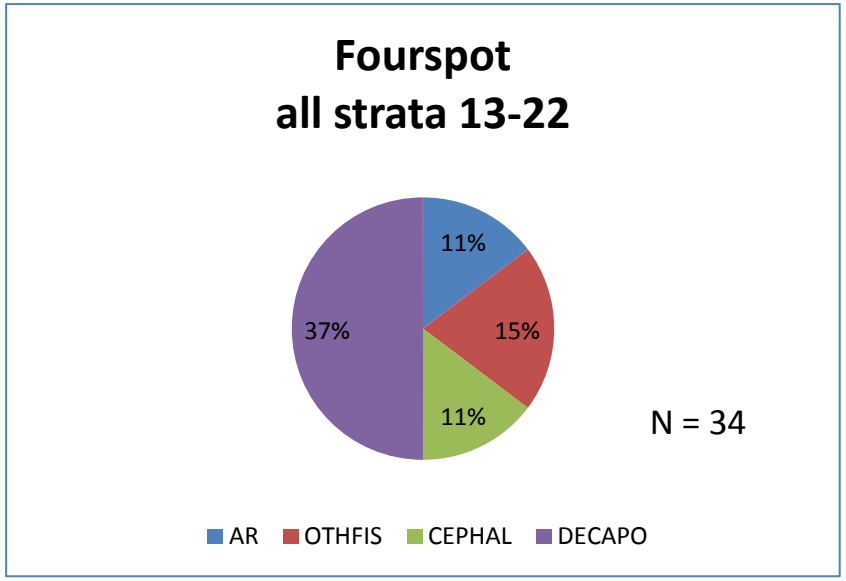
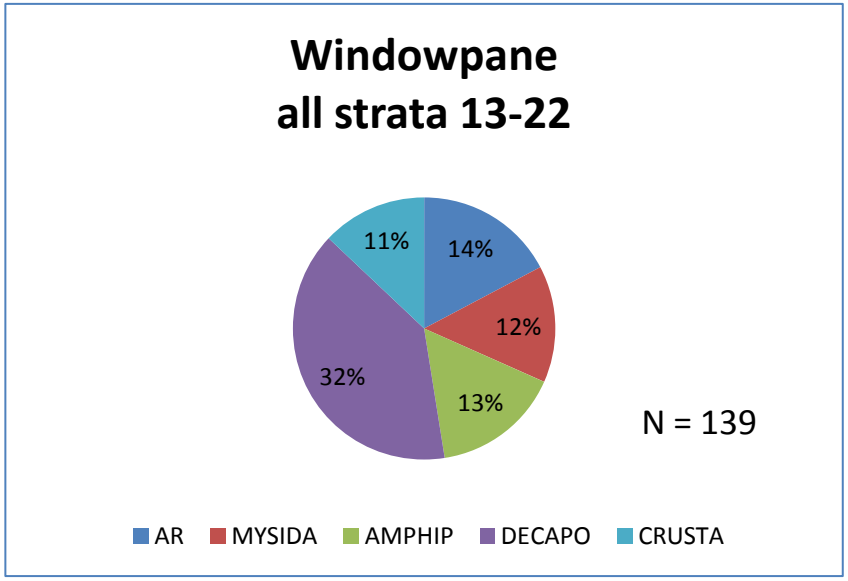


Figure 6. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for all strata (13-22) during NEFSC's spring survey 2008-2012. Only percentages over 10% are plotted. The N values are the values for only the prey items in the chart.







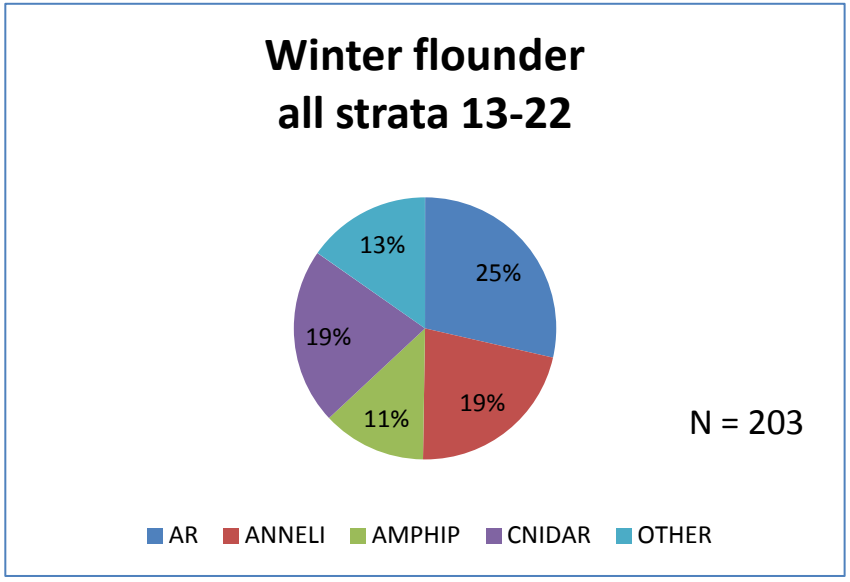
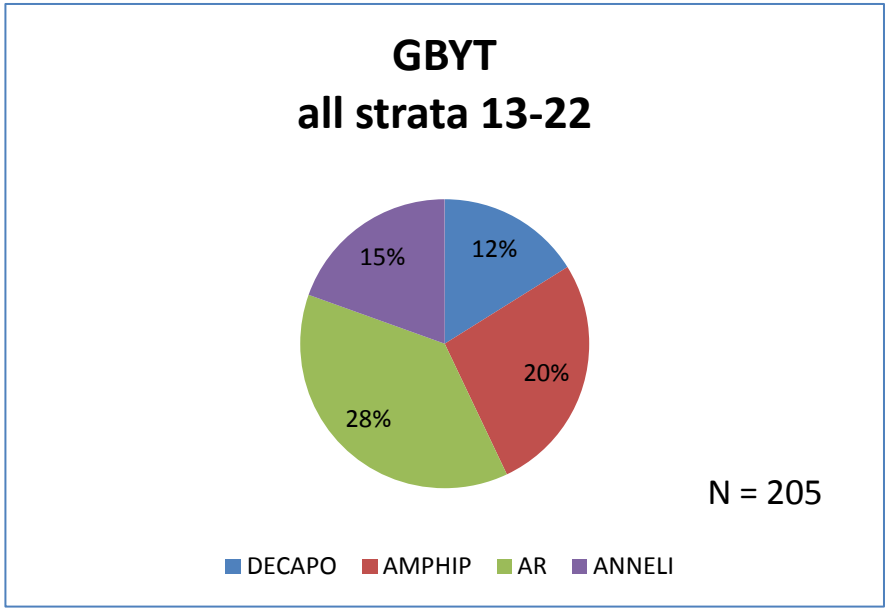
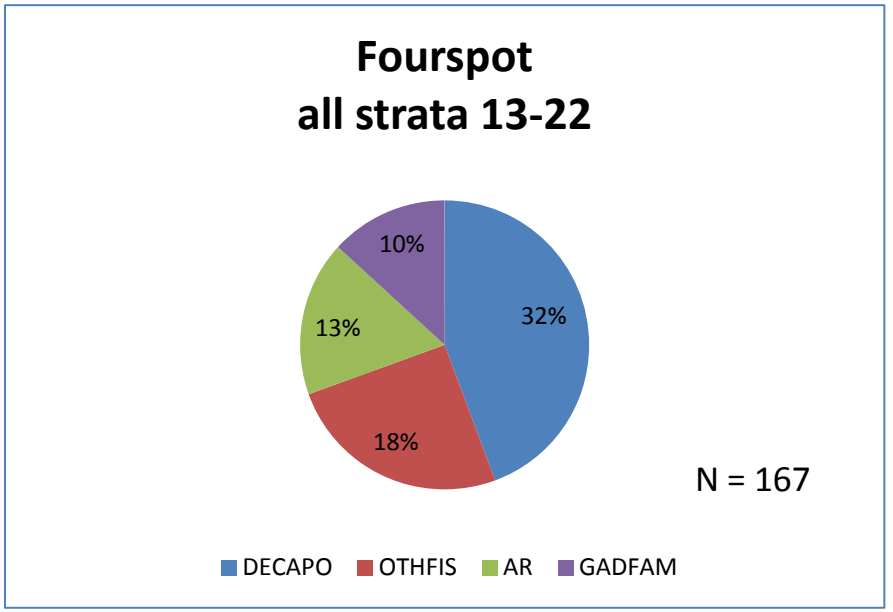
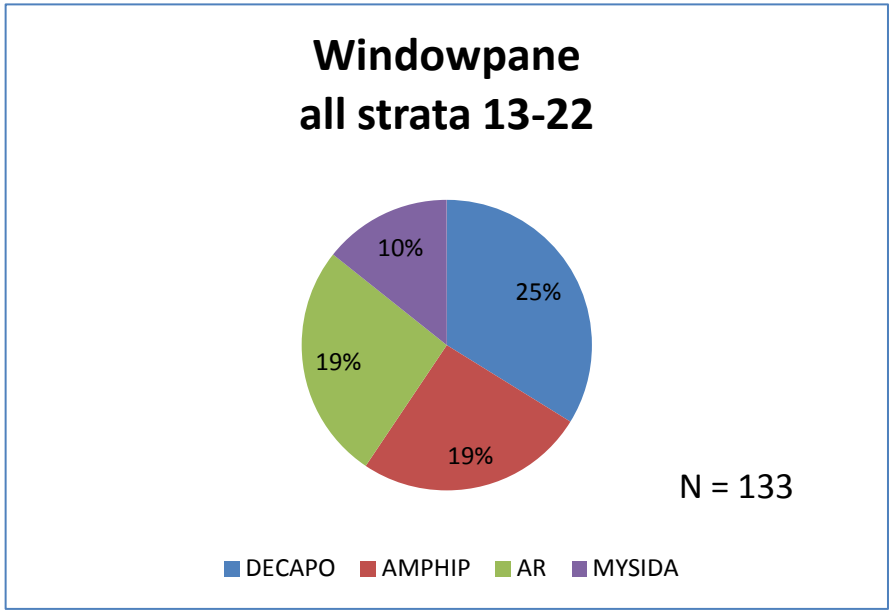


Figure 7. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for all strata (13-22) during NEFSC's fall survey 2008-2012. Only percentages over 10% are plotted. The N values are based on the 10% criteria.







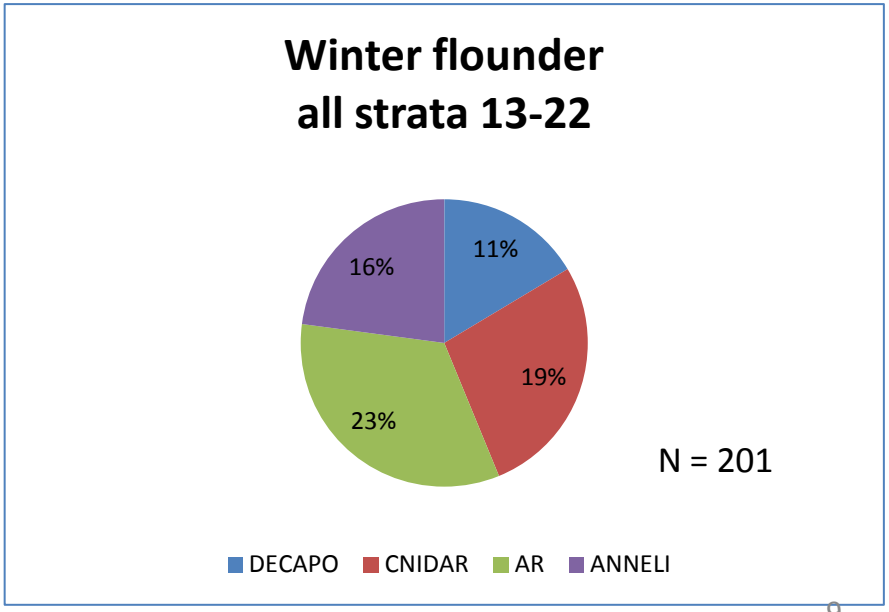
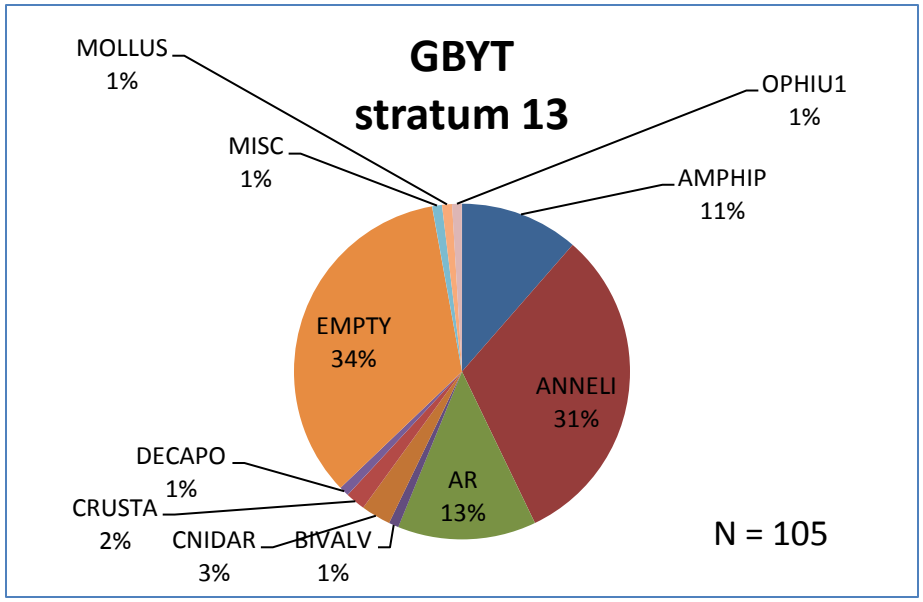
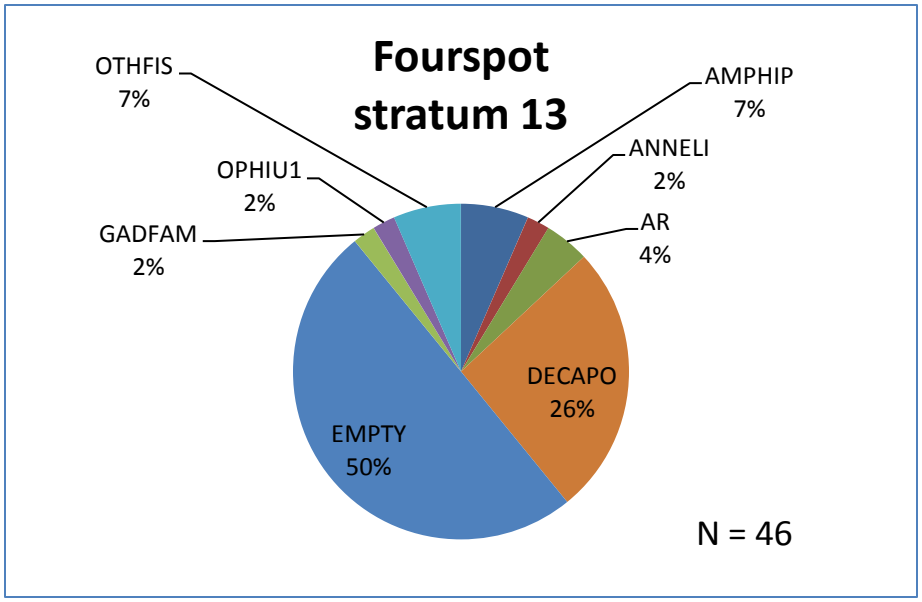
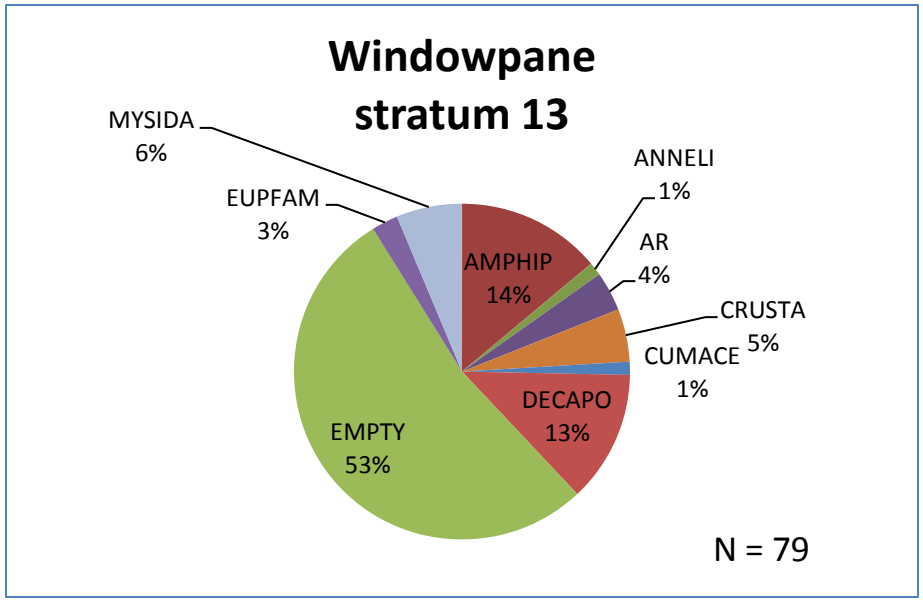


Figure 8. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 13 during NEFSC's spring survey 2008-2012.







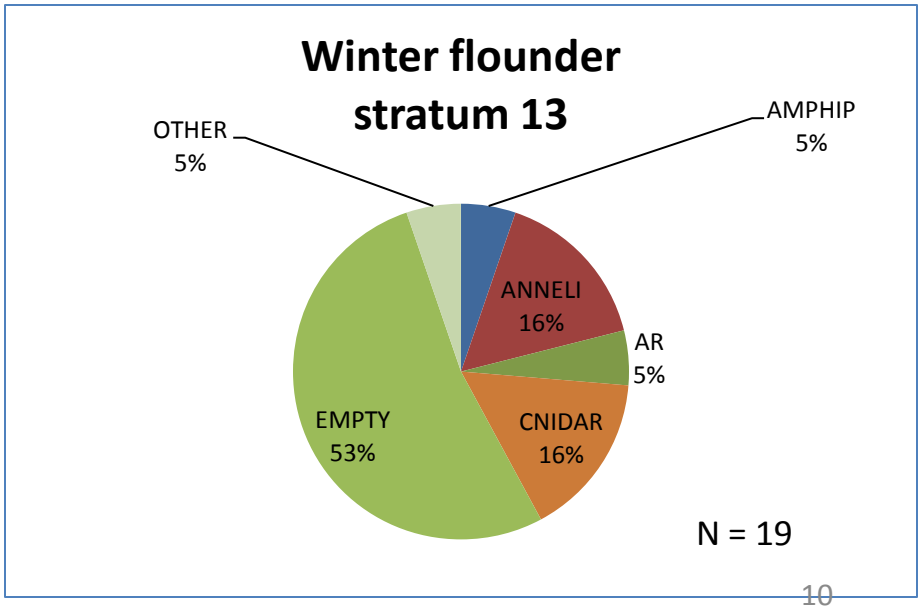
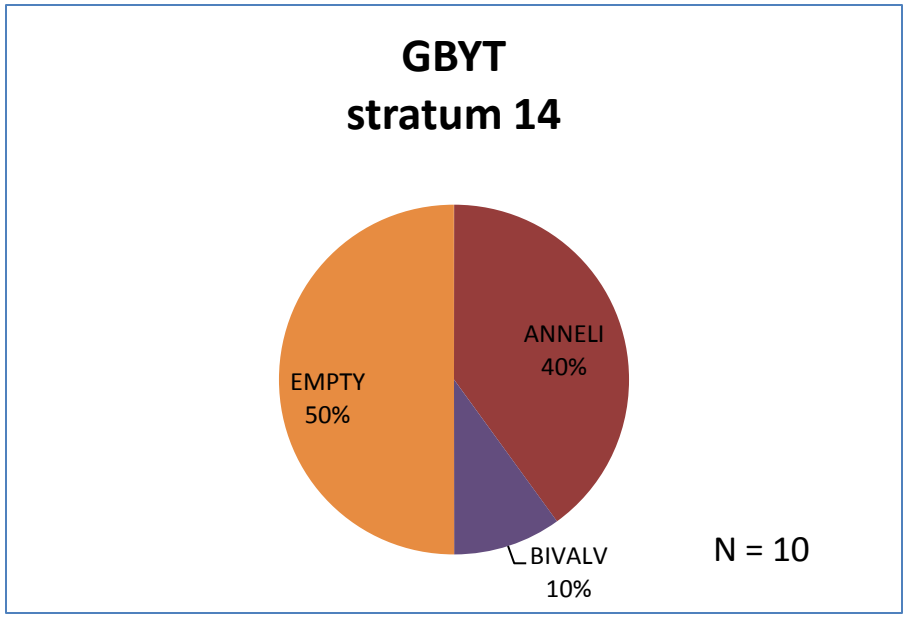
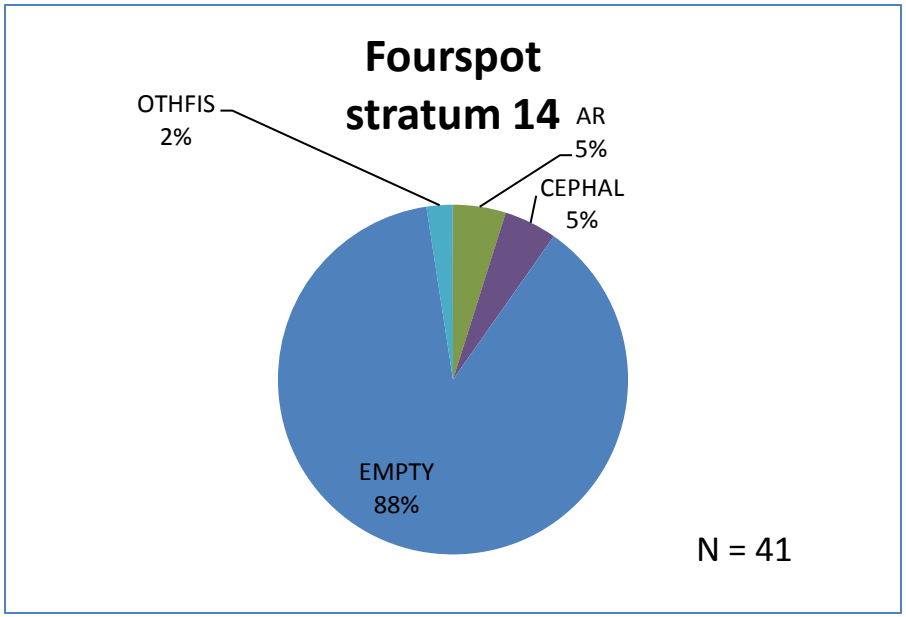


Figure 9. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 14 during NEFSC's spring survey 2008-2012.





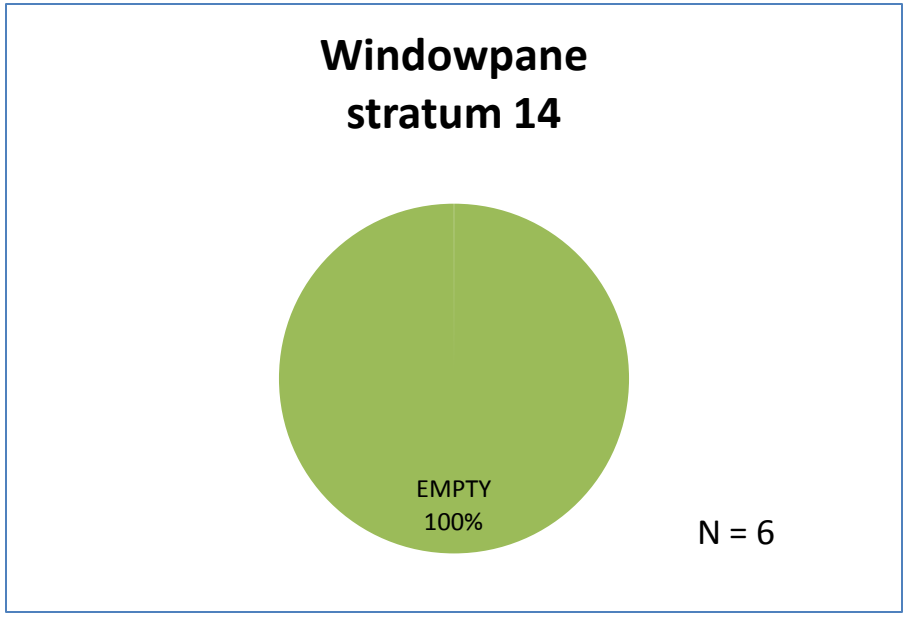
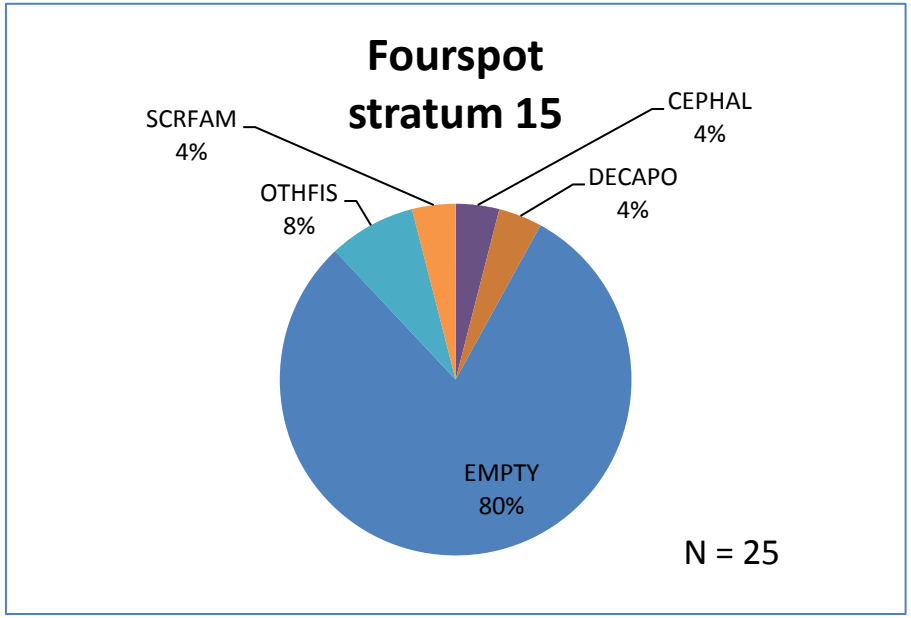


Figure 10. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 15 during NEFSC's spring survey 2008-2012.



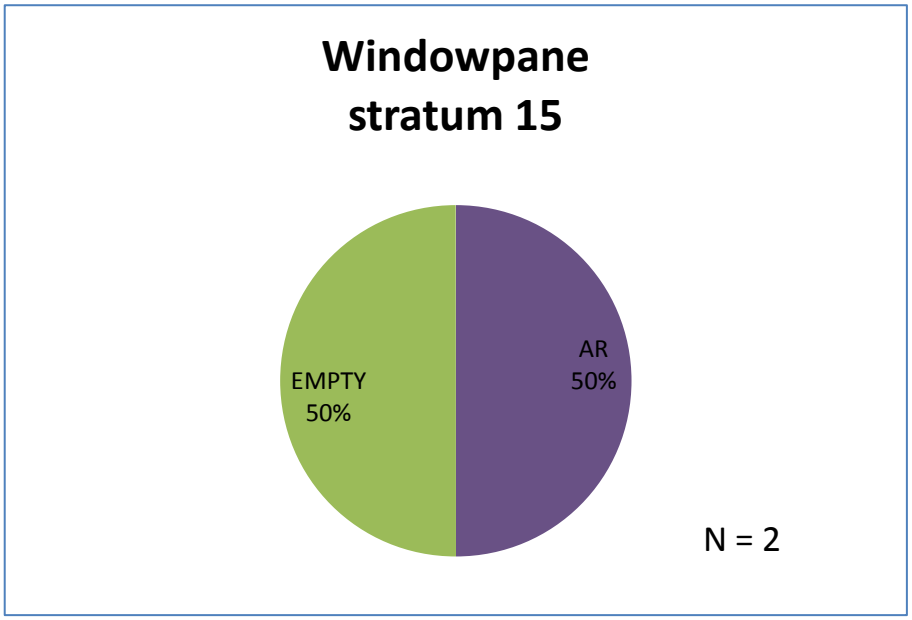
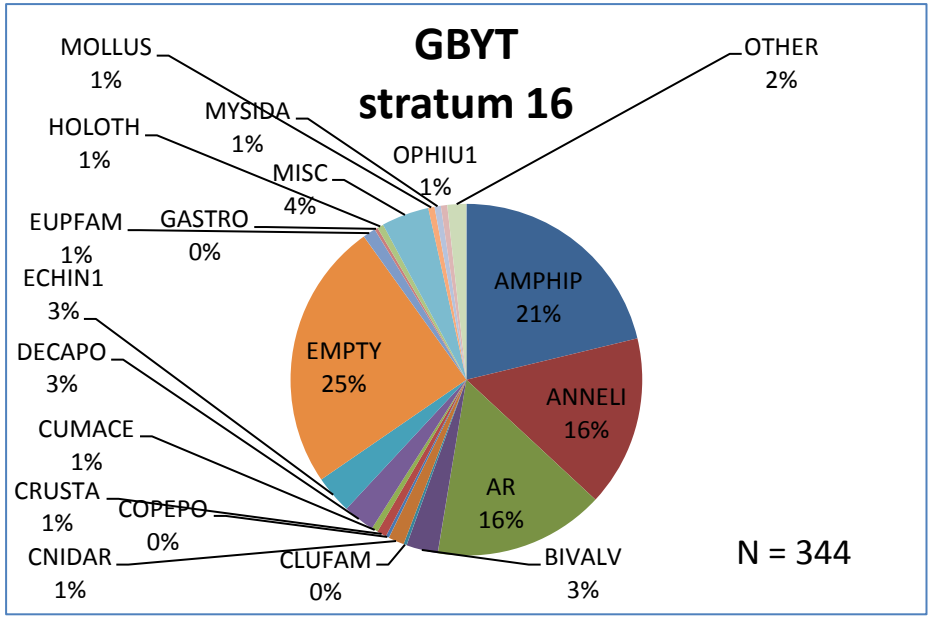
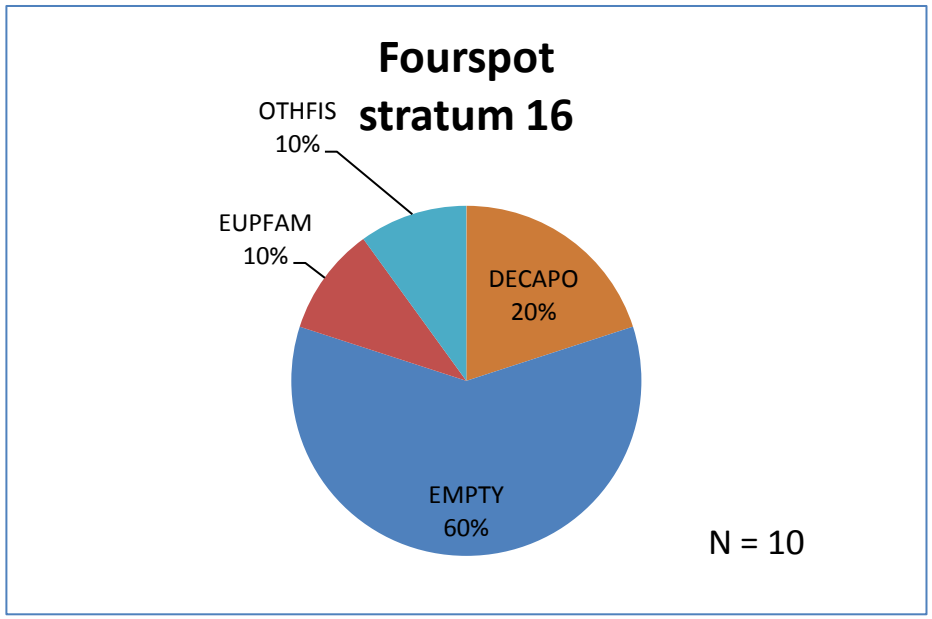
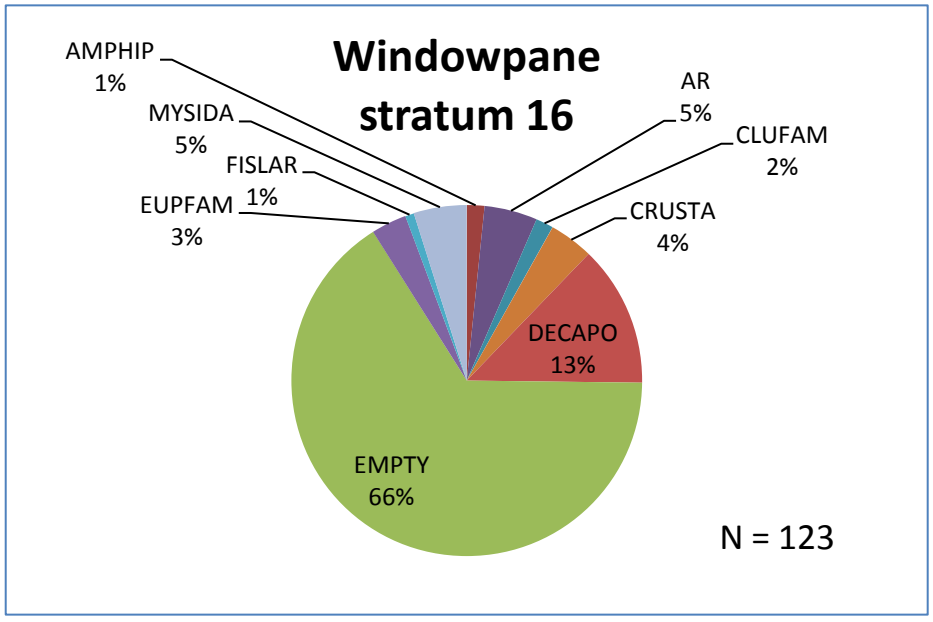


Figure 11. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 16 during NEFSC's spring survey 2008-2012.







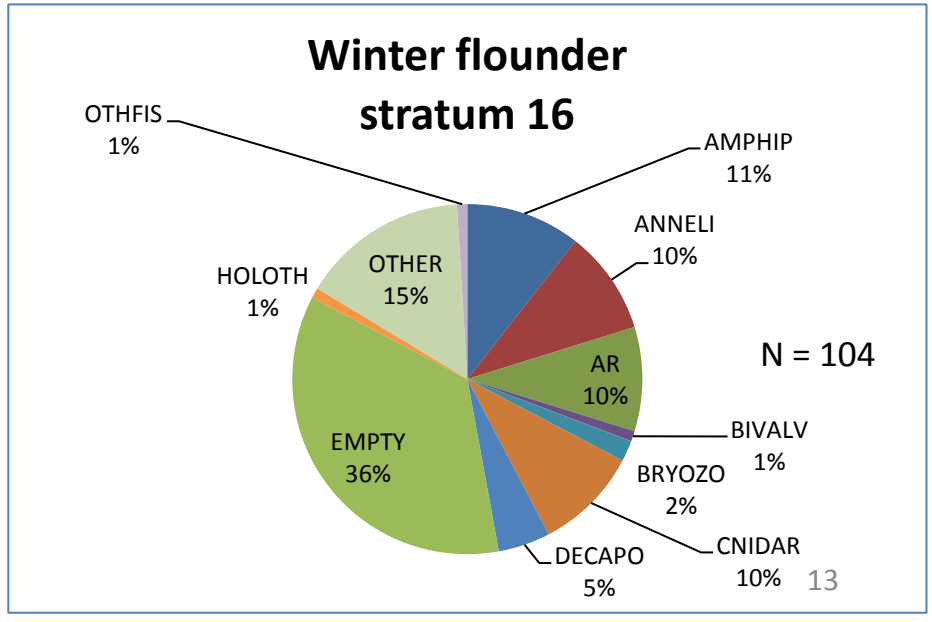
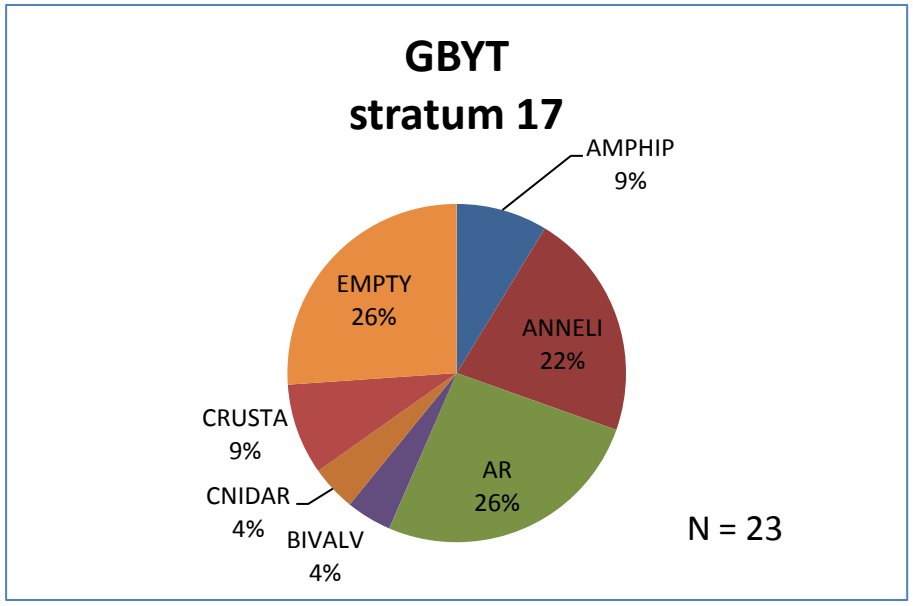
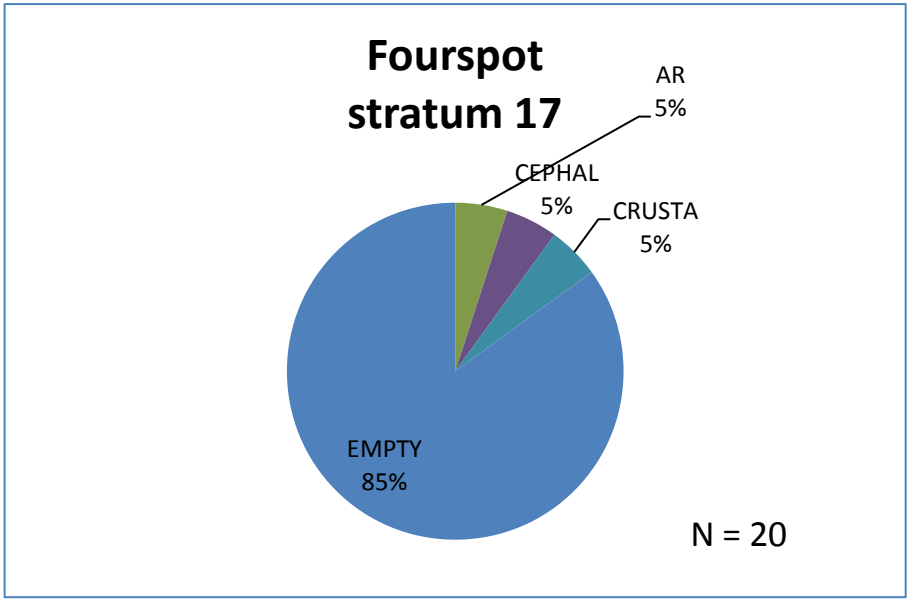
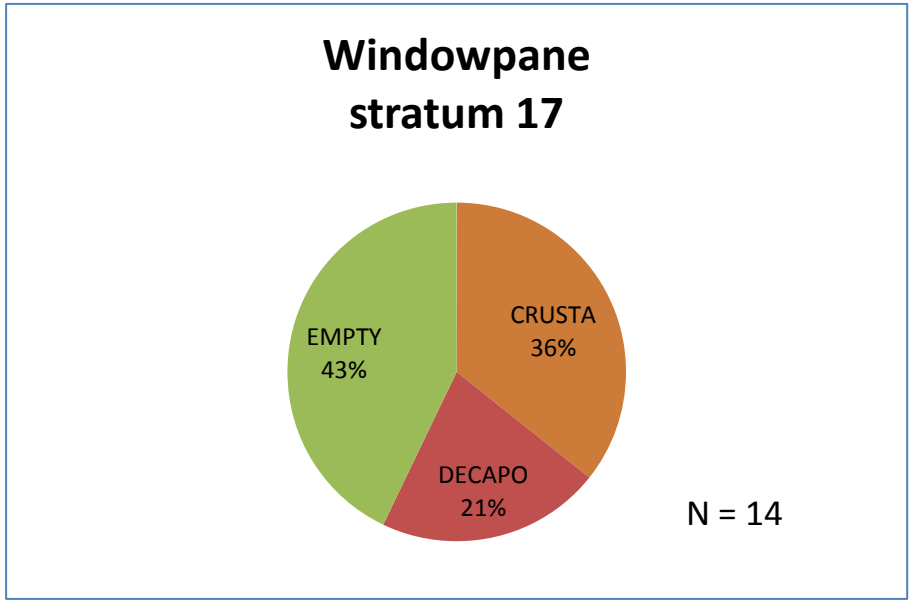


Figure 12. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 17 during NEFSC's spring survey 2008-2012.







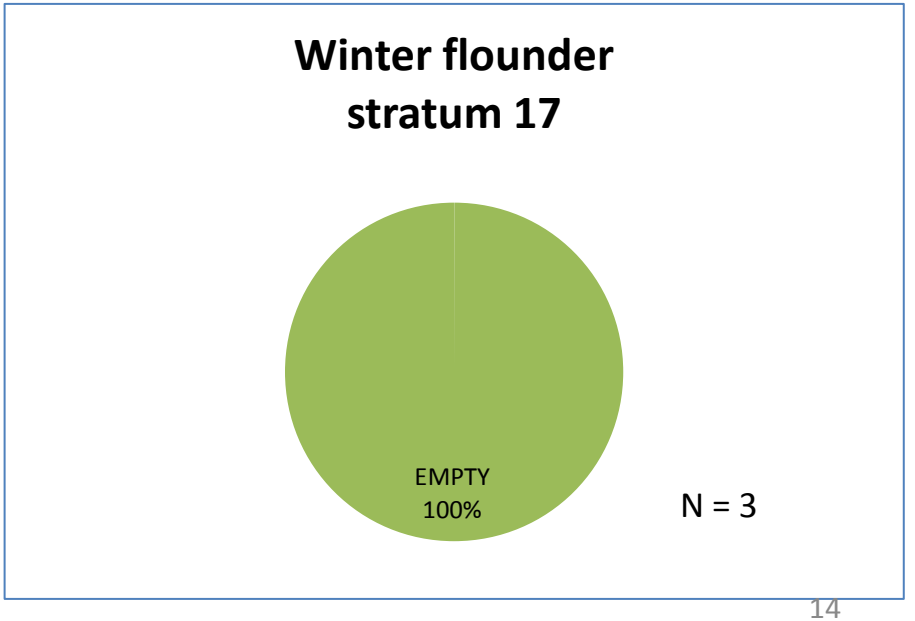
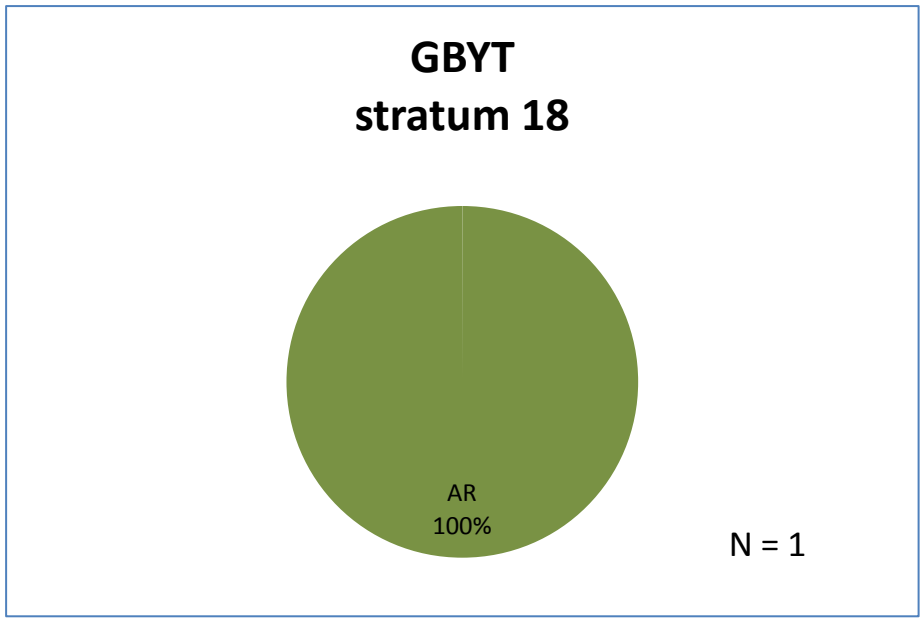


Figure 13. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 18 during NEFSC's spring survey 2008-2012.



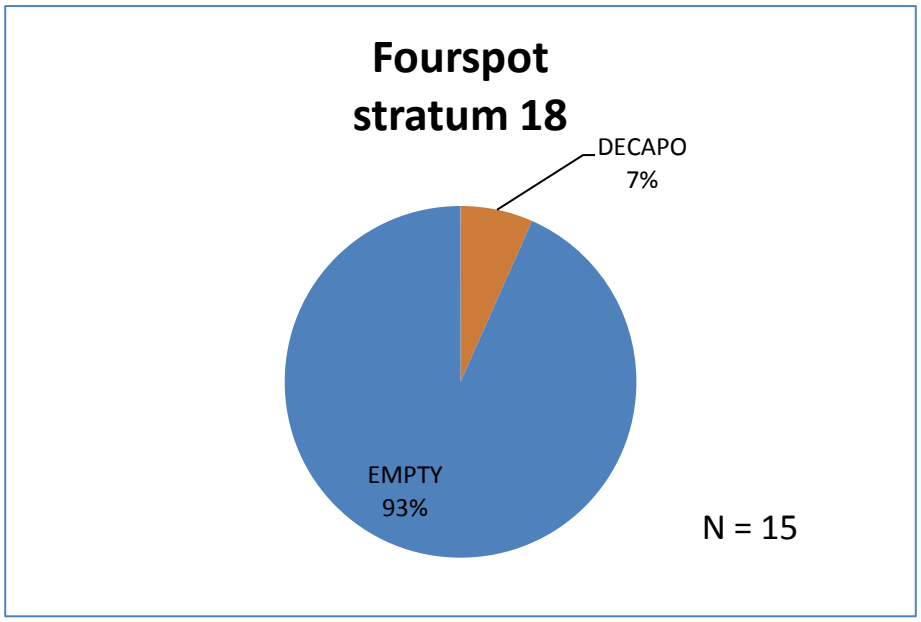
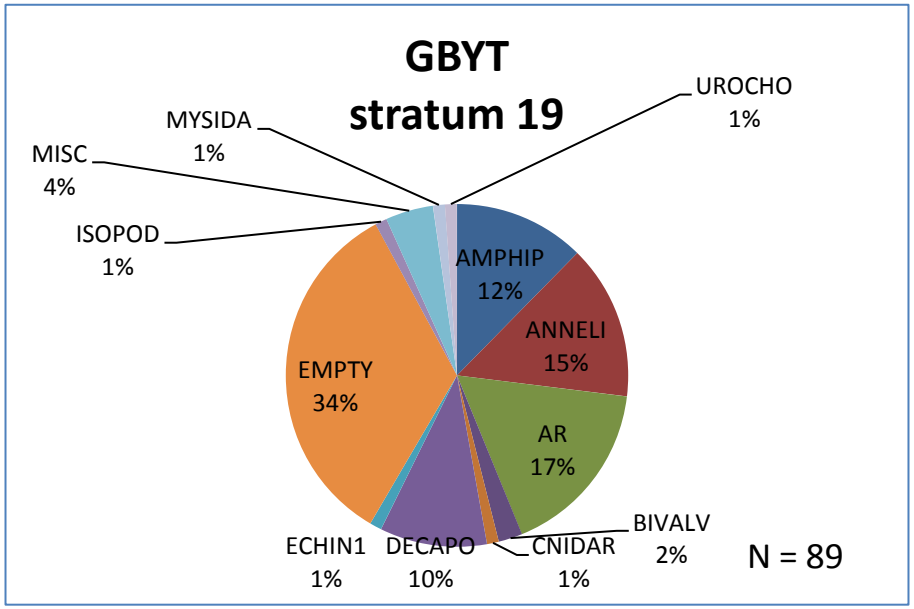
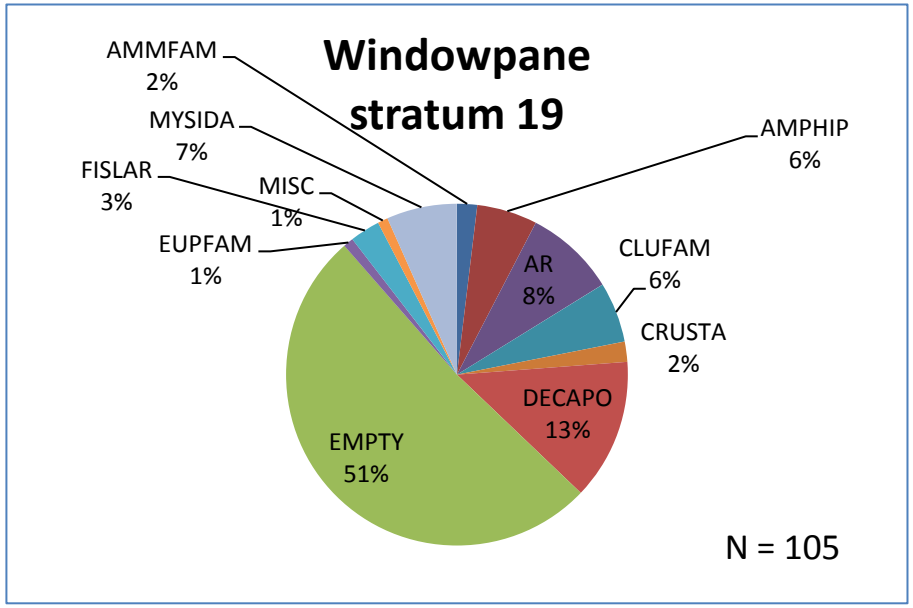


Figure 14. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 19 during NEFSC's spring survey 2008-2012.





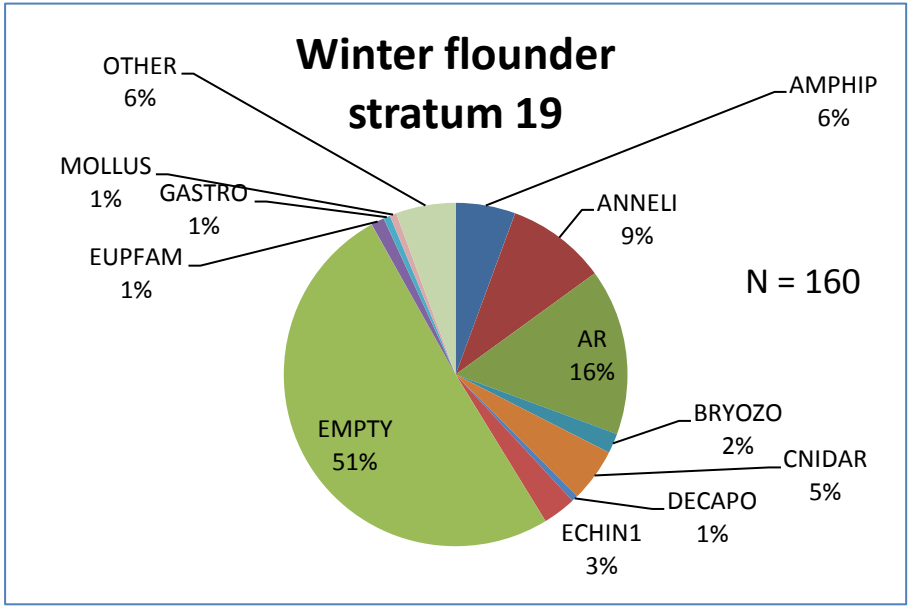
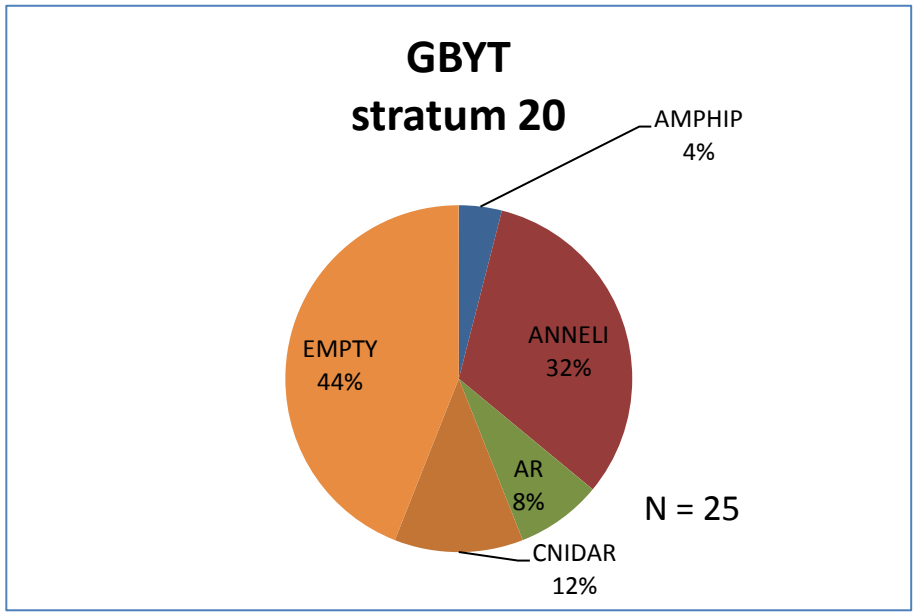
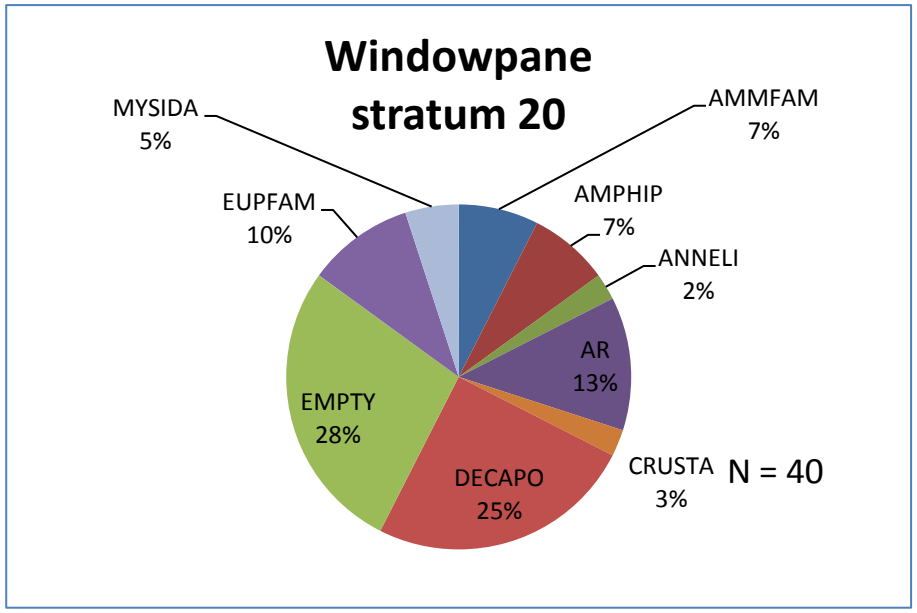


Figure 15. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 20 during NEFSC's spring survey 2008-2012.





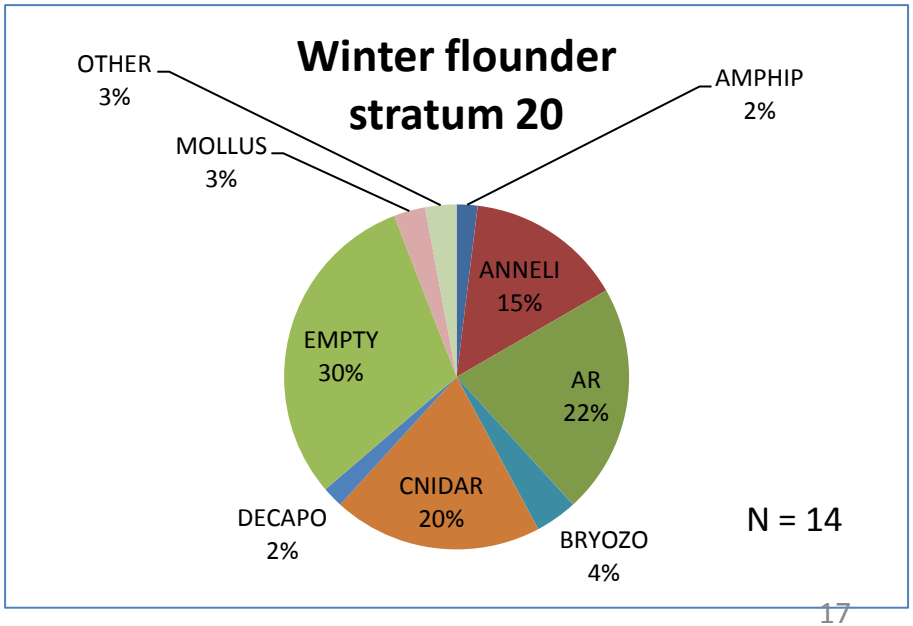
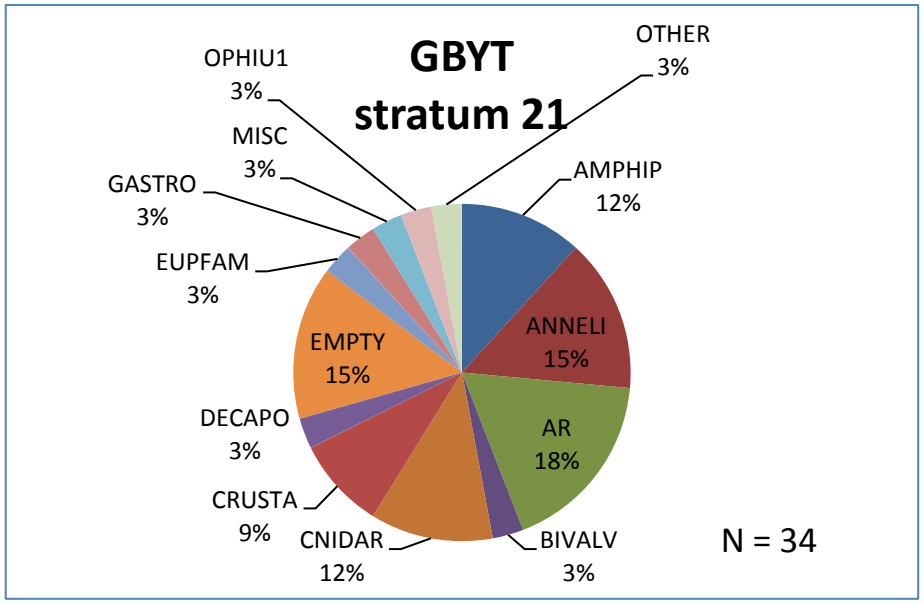
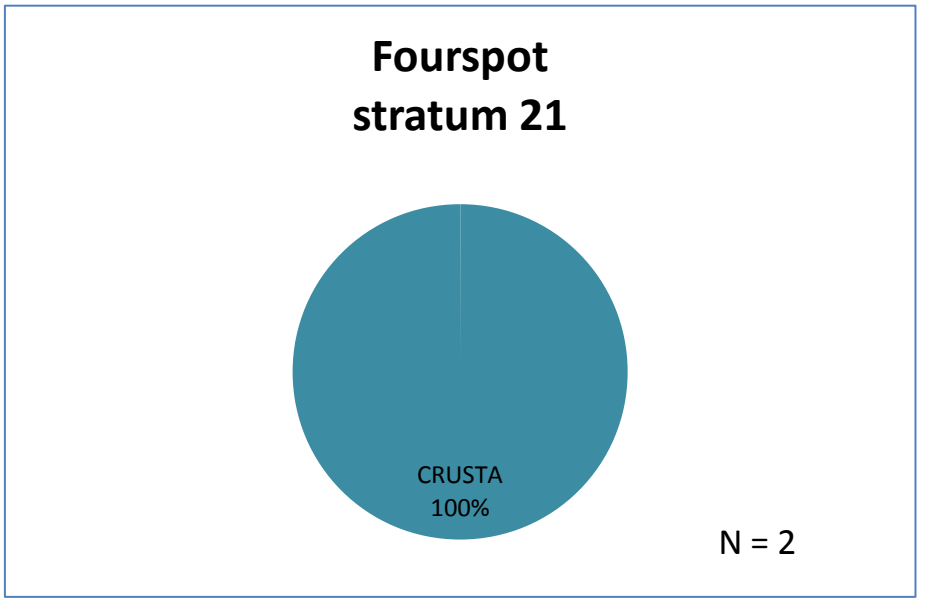
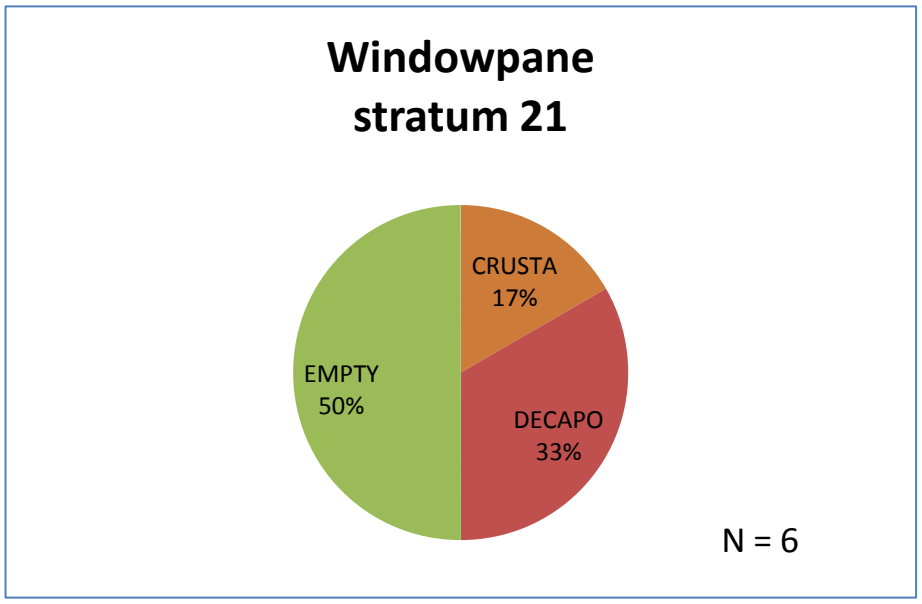


Figure 16. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 21 during NEFSC's spring survey 2008-2012.







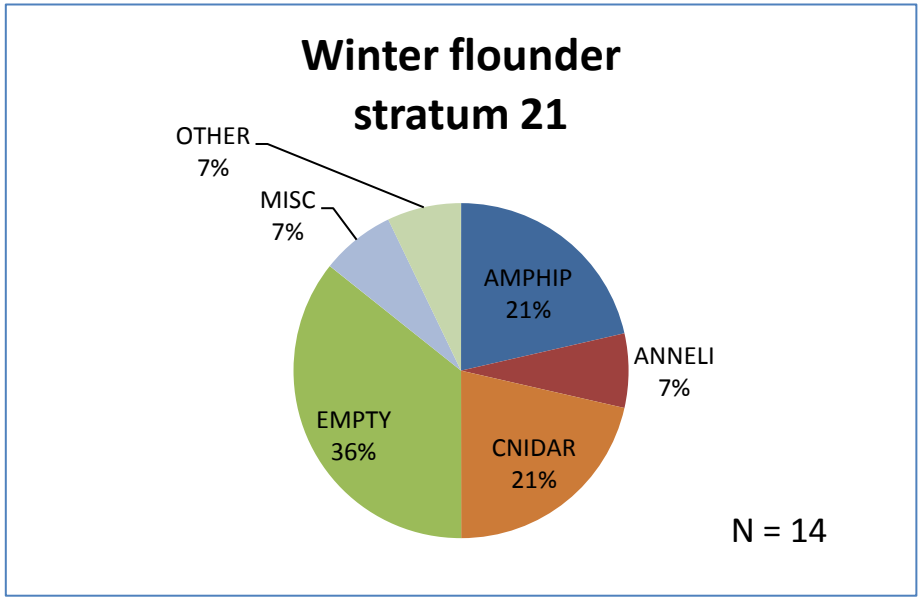
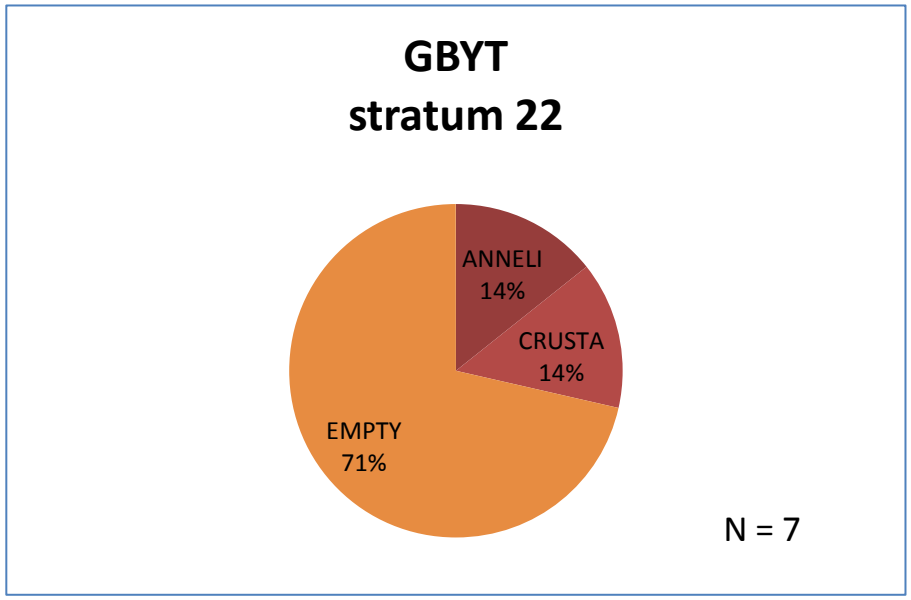
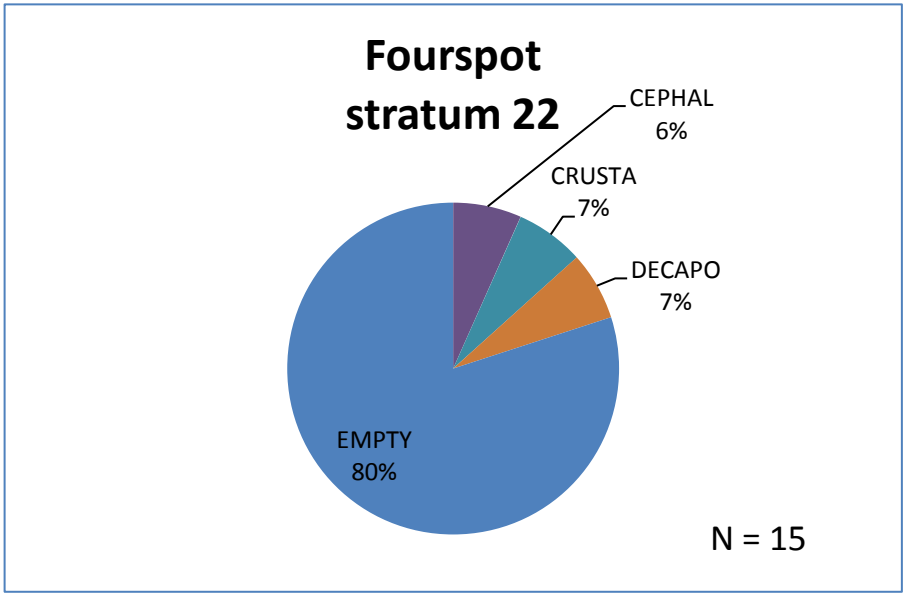


Figure 17. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 22 during NEFSC's spring survey 2008-2012.





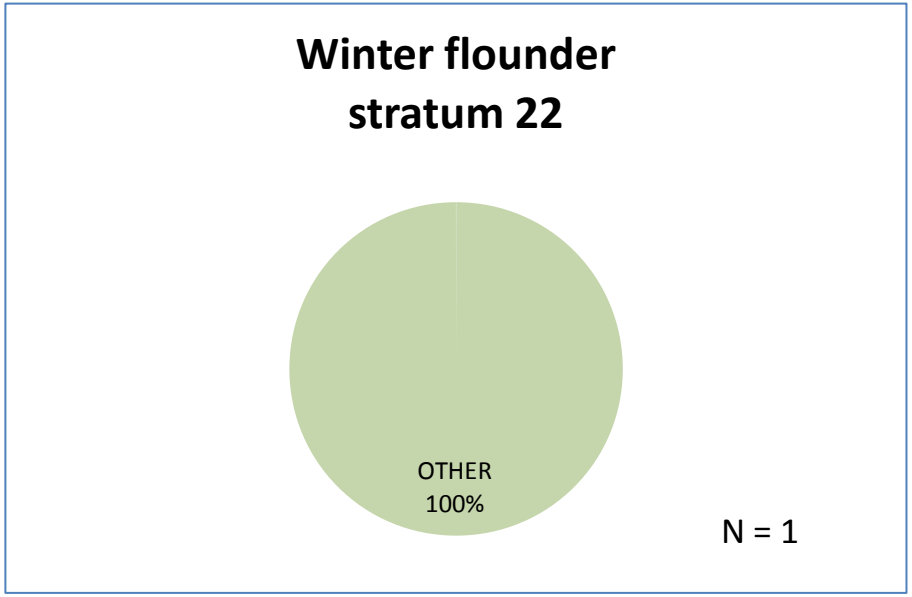
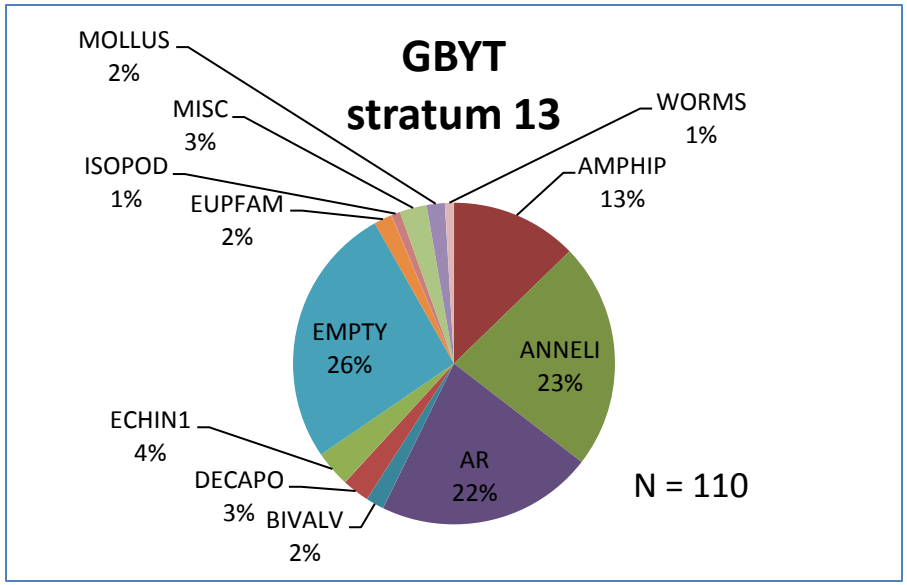
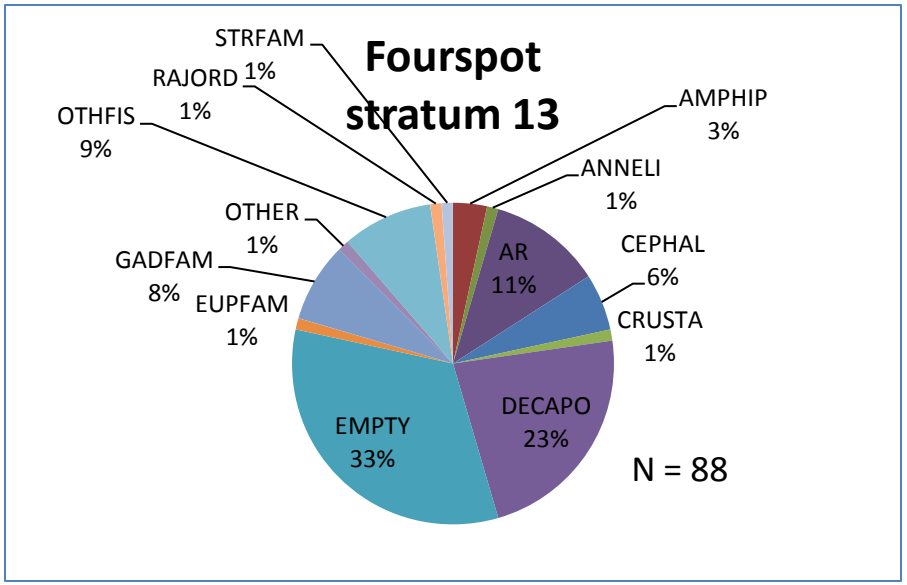
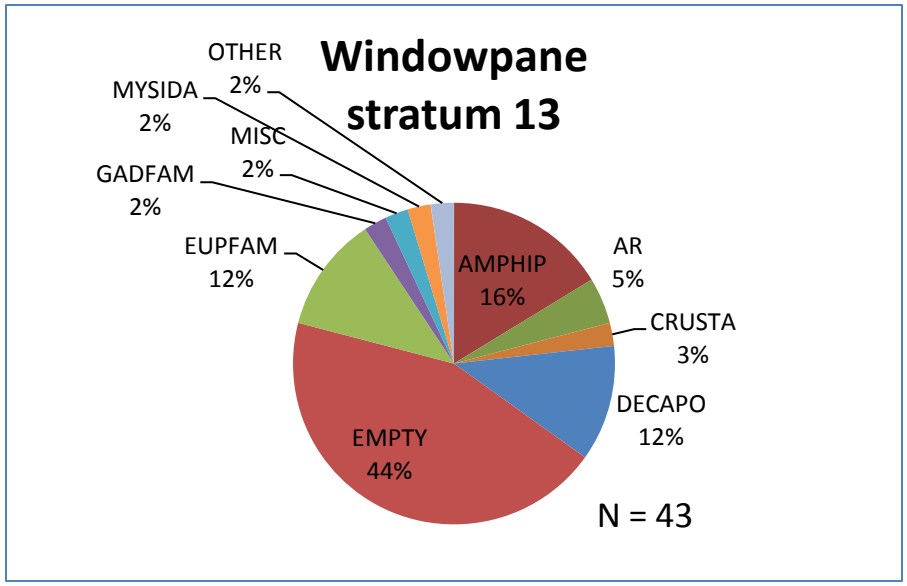


Figure 18. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 13 during NEFSC's fall survey 2008-2012.







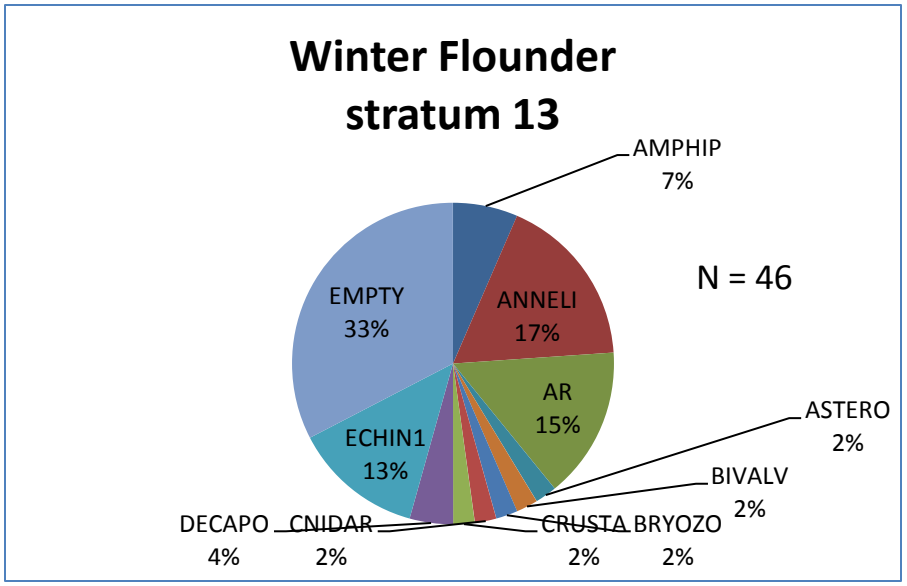
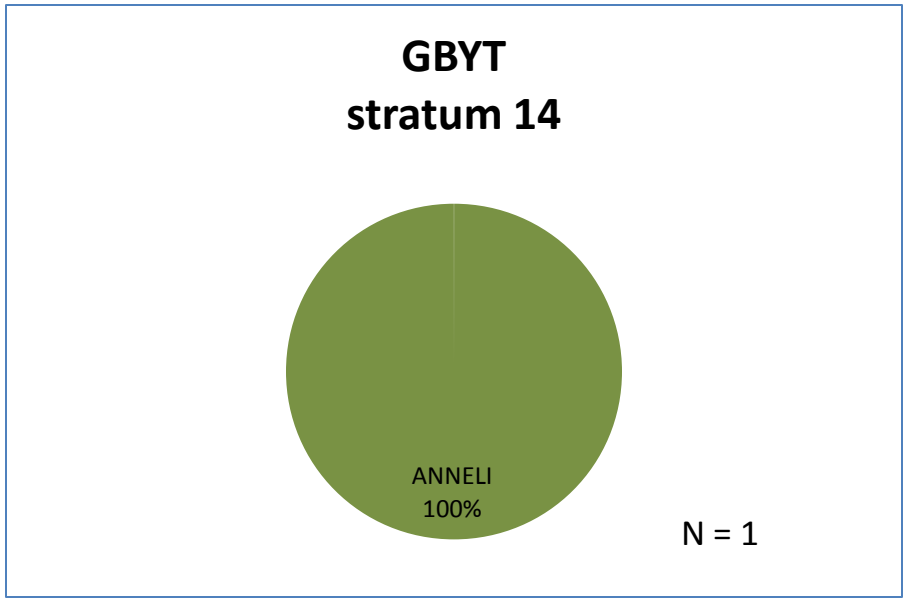


Figure 19. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 14 during NEFSC's fall survey 2008-2012.



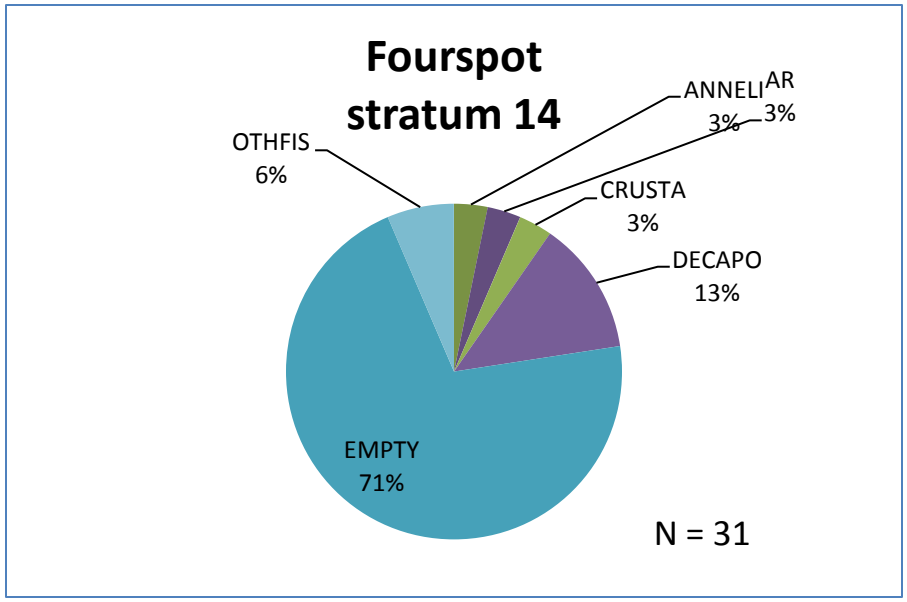
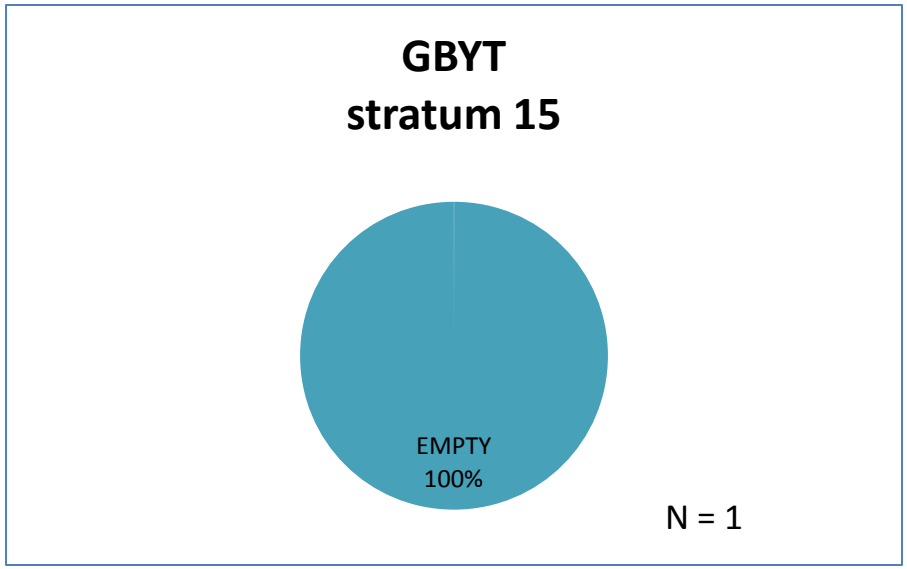


Figure 20. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 15 during NEFSC's fall survey 2008-2012.



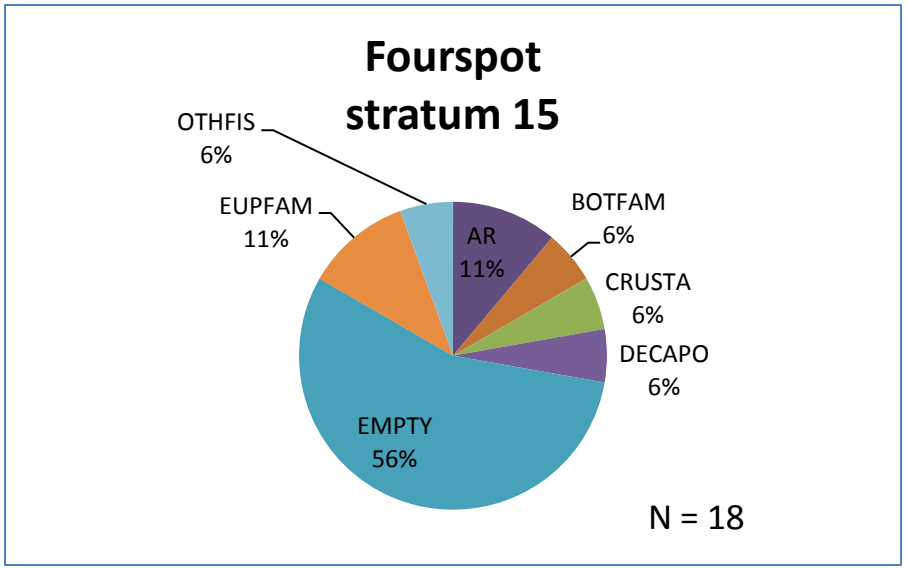
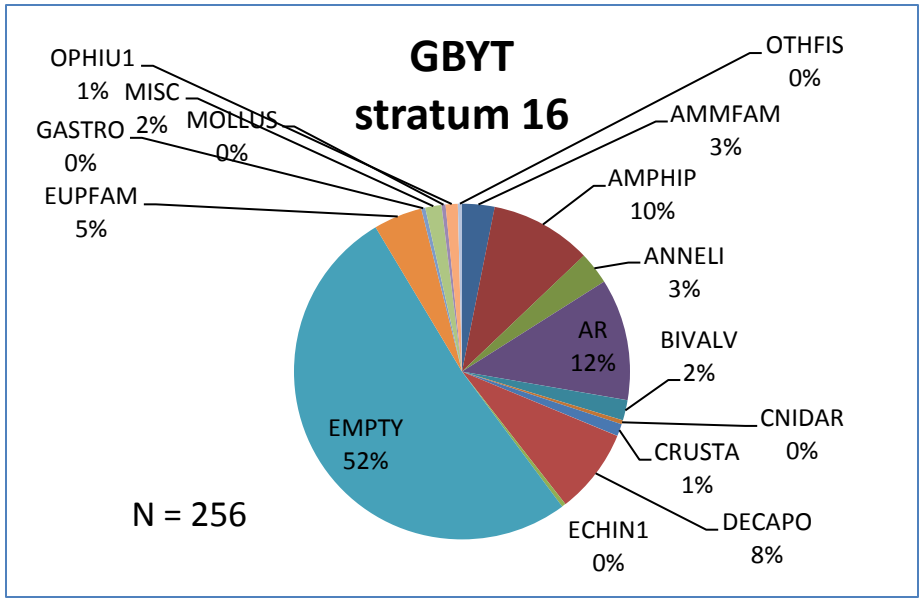
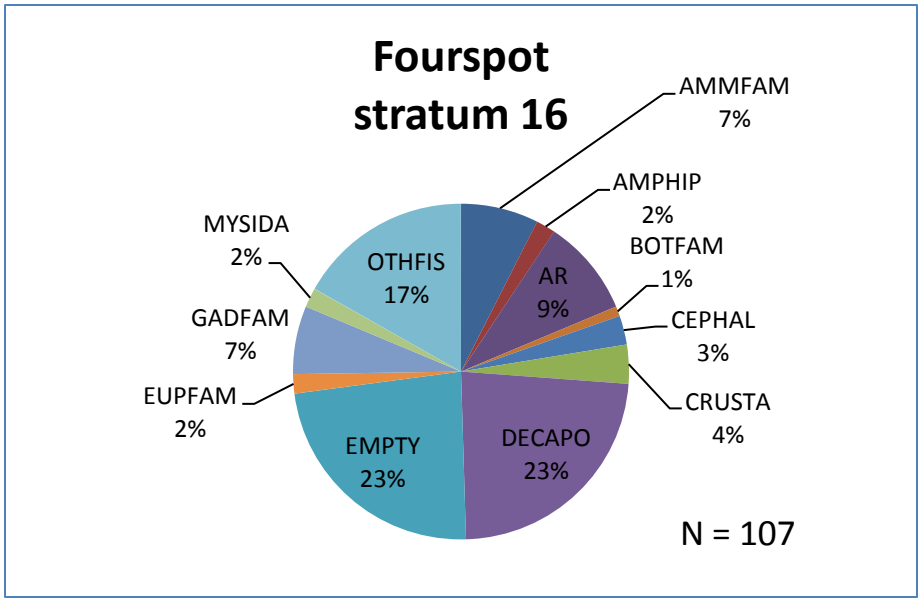
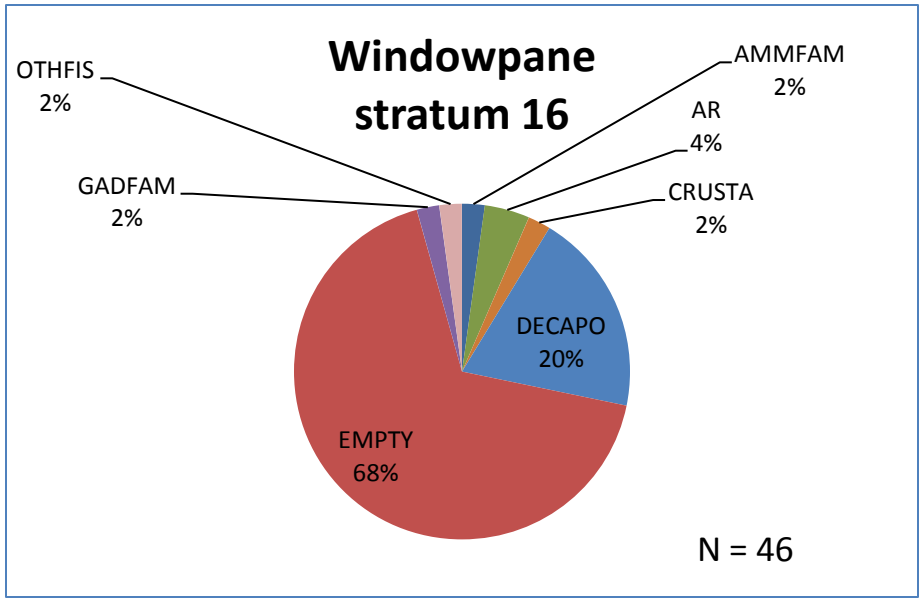


Figure 21. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 16 during NEFSC's fall survey 2008-2012.







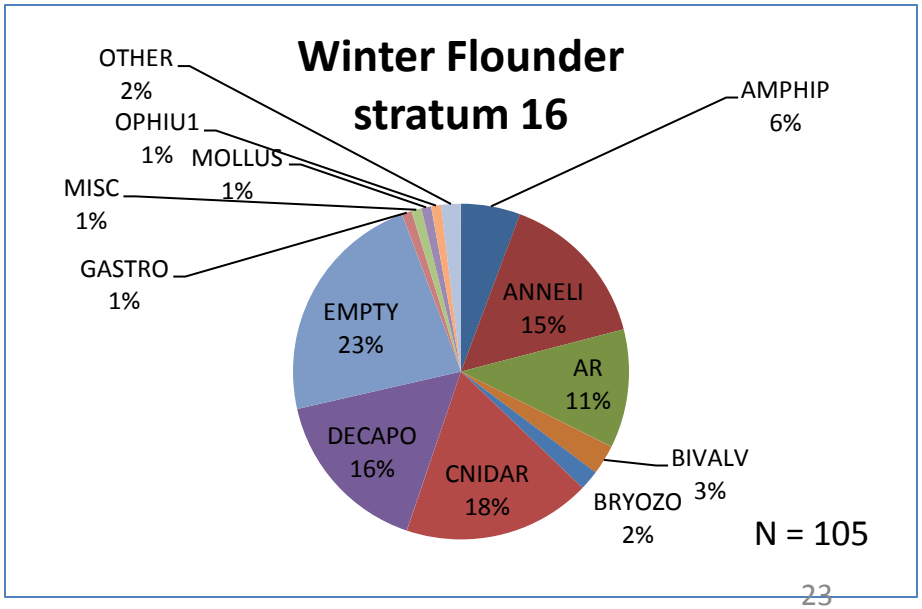
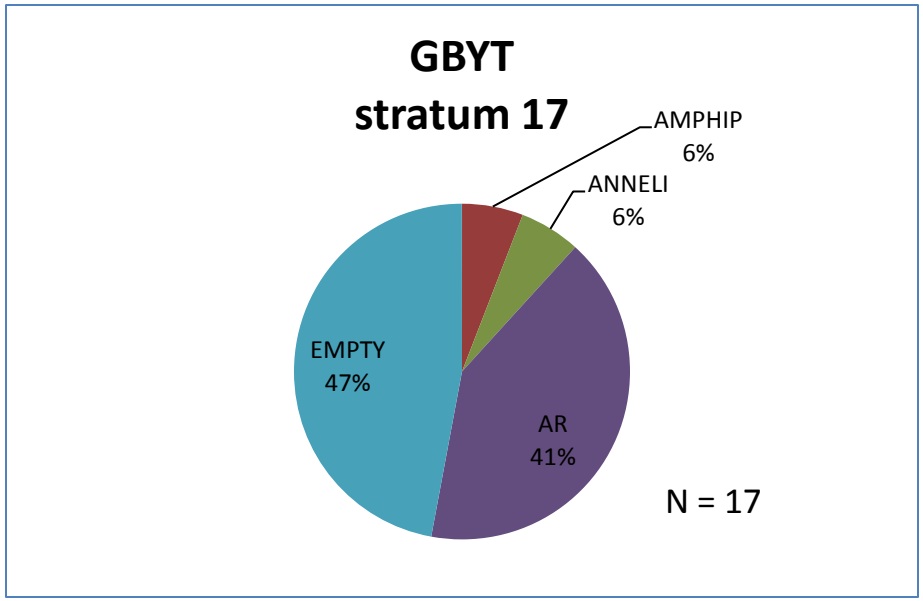


Figure 22. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 17 during NEFSC's fall survey 2008-2012.



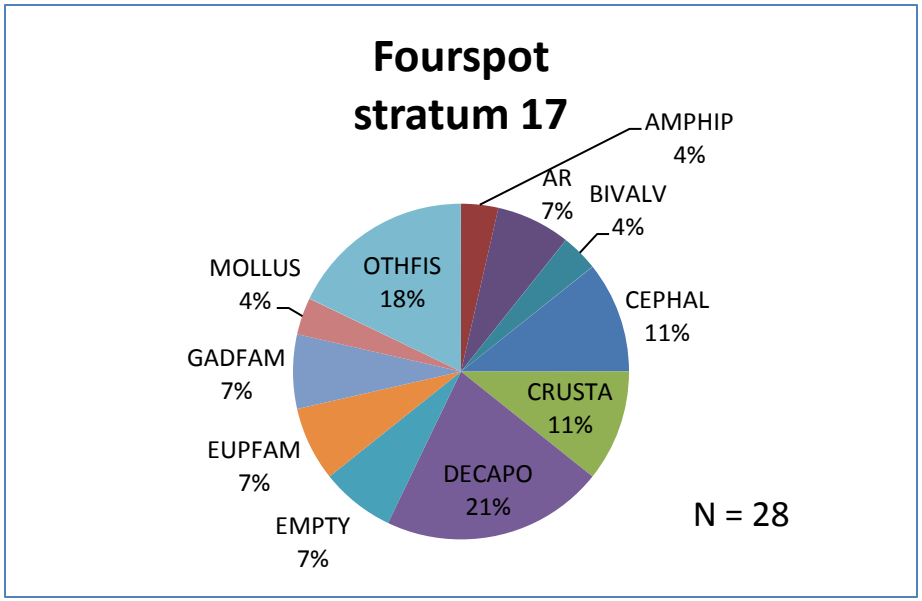
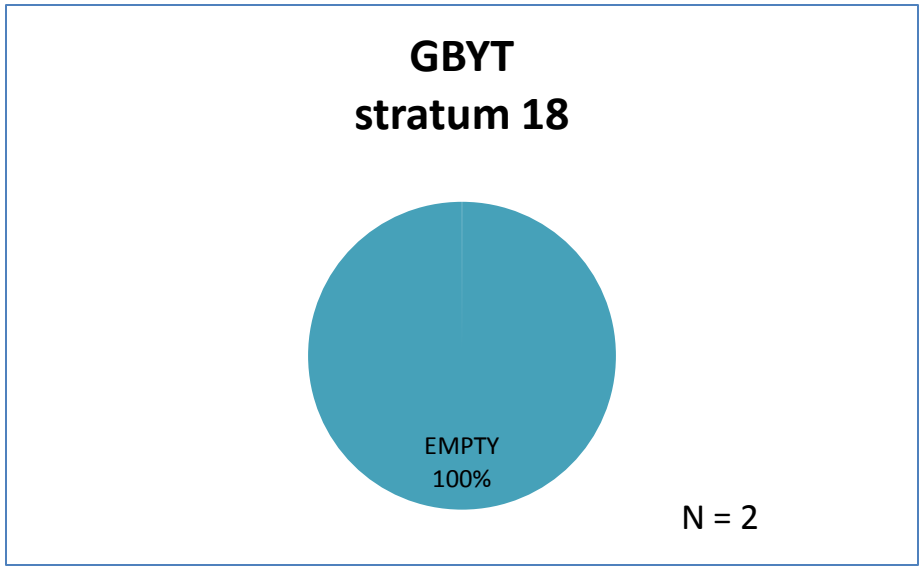


Figure 23. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 18 during NEFSC's fall survey 2008-2012.



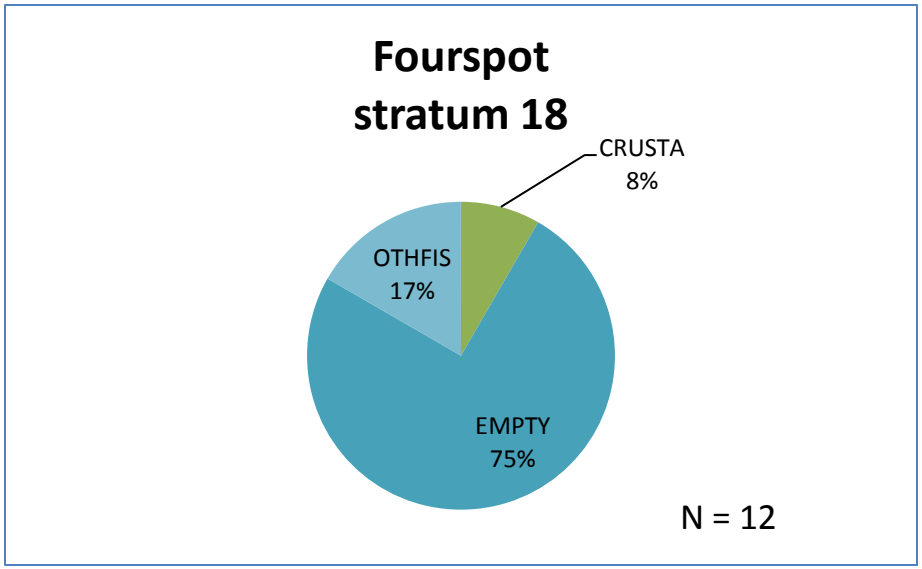
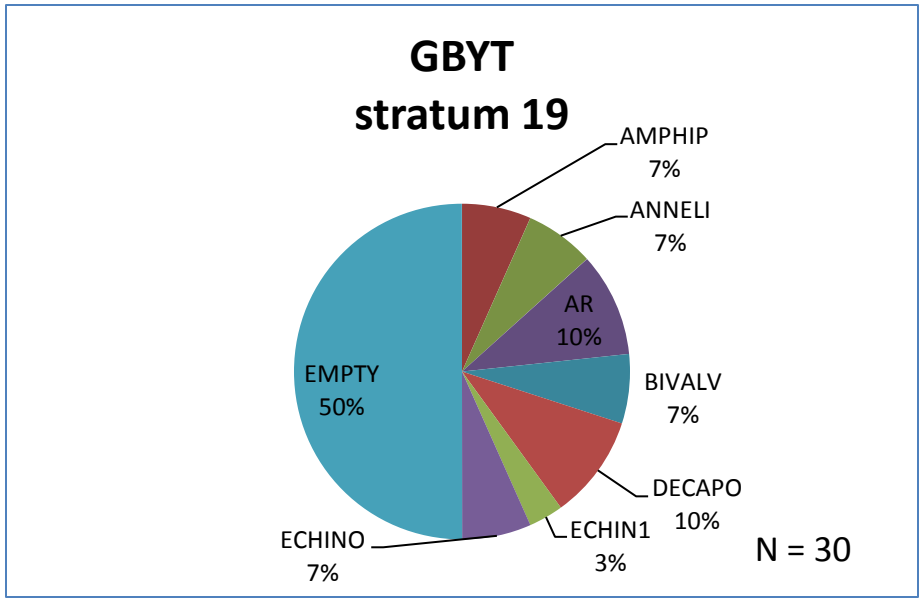
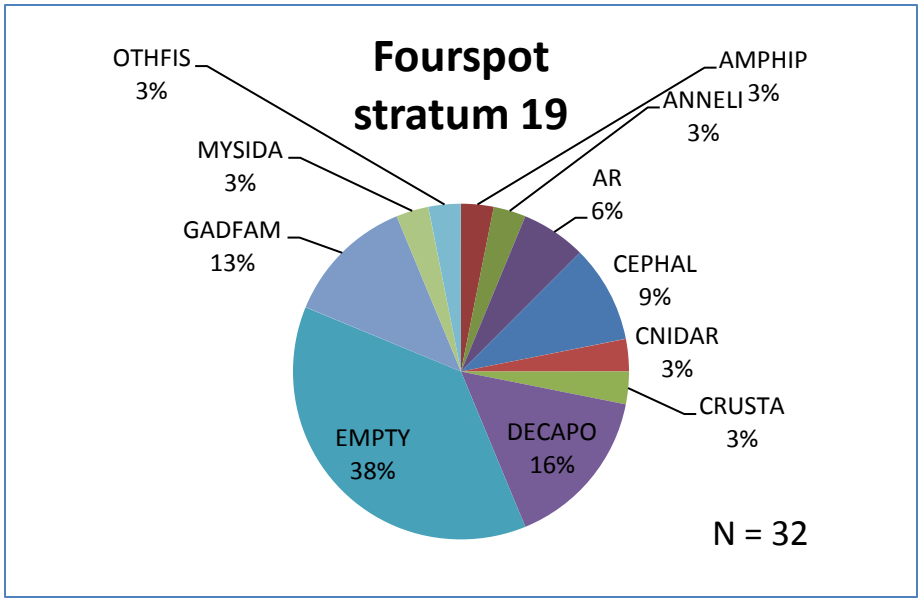
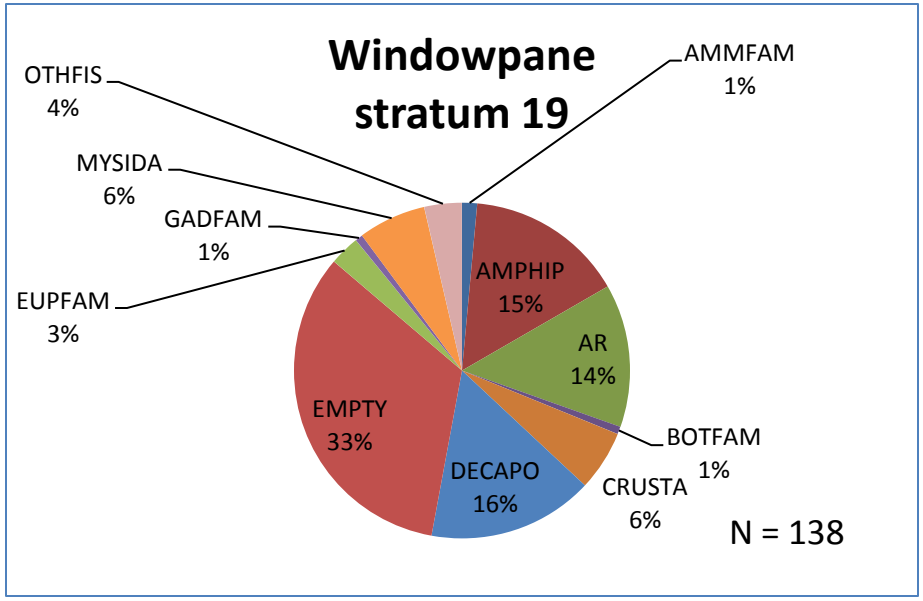


Figure 24. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 19 during NEFSC's fall survey 2008-2012.







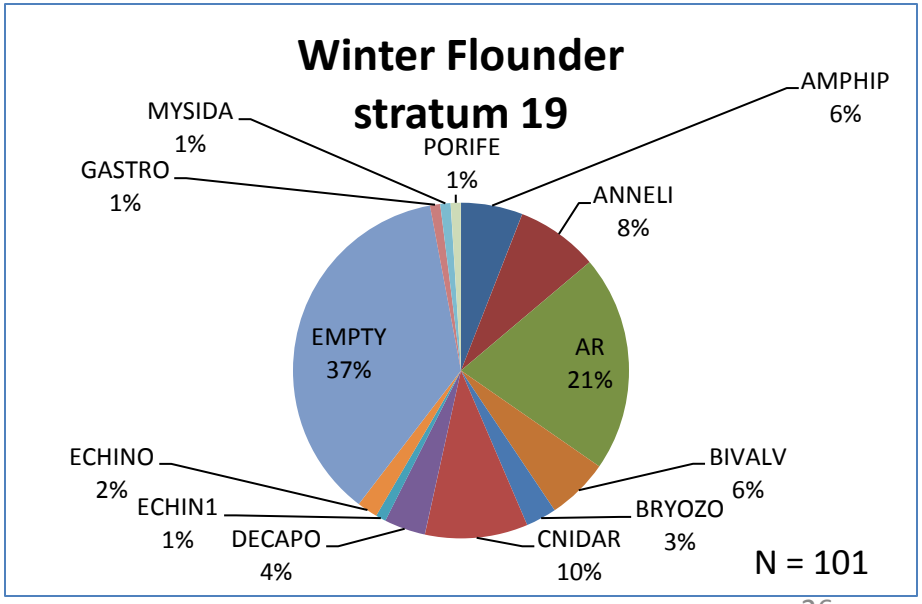
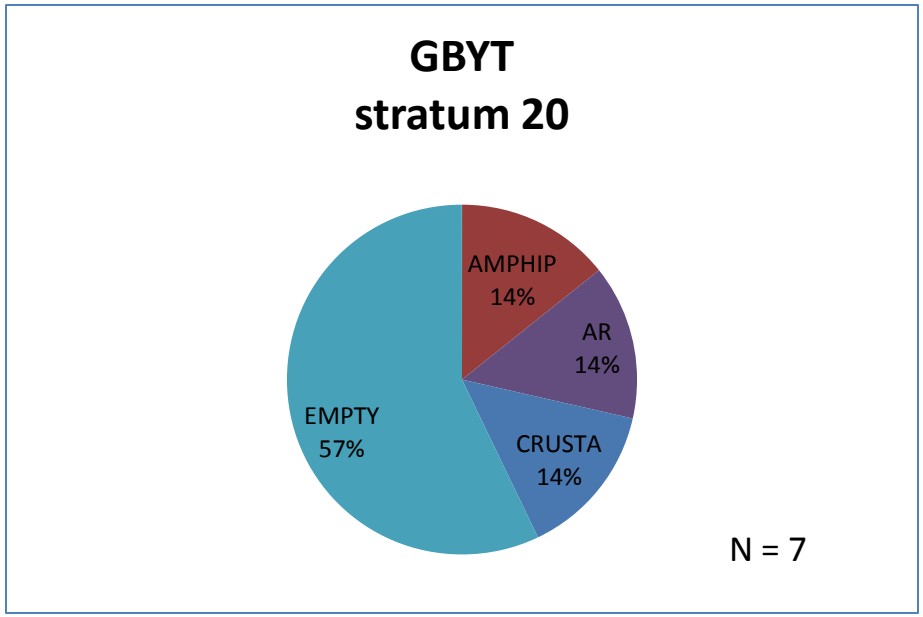
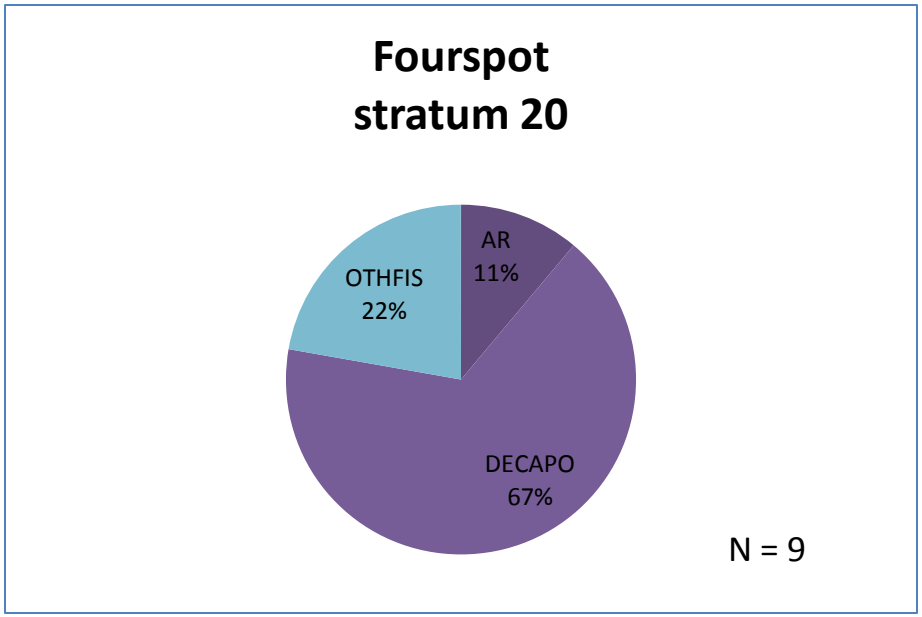
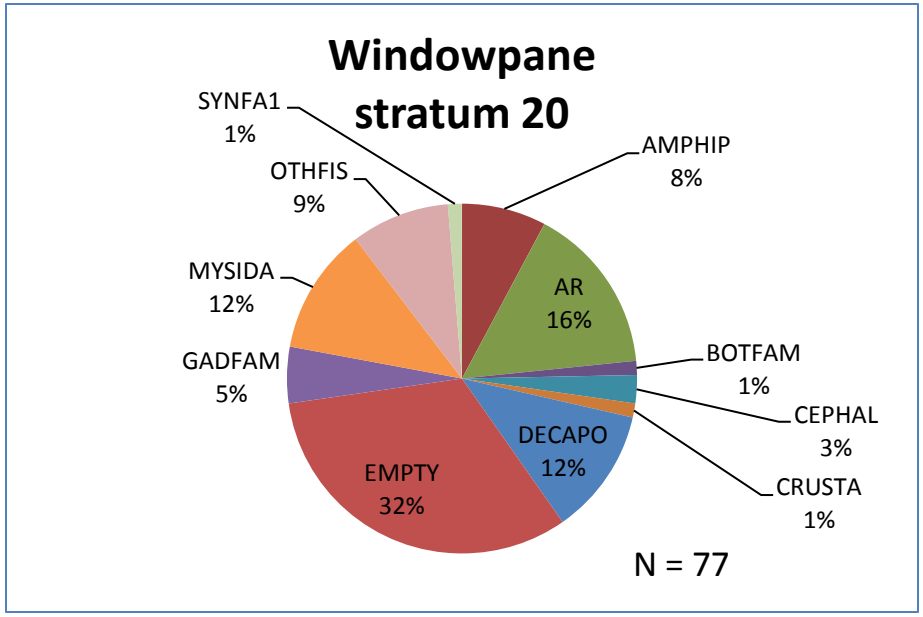


Figure 25. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 20 during NEFSC's fall survey 2008-2012.







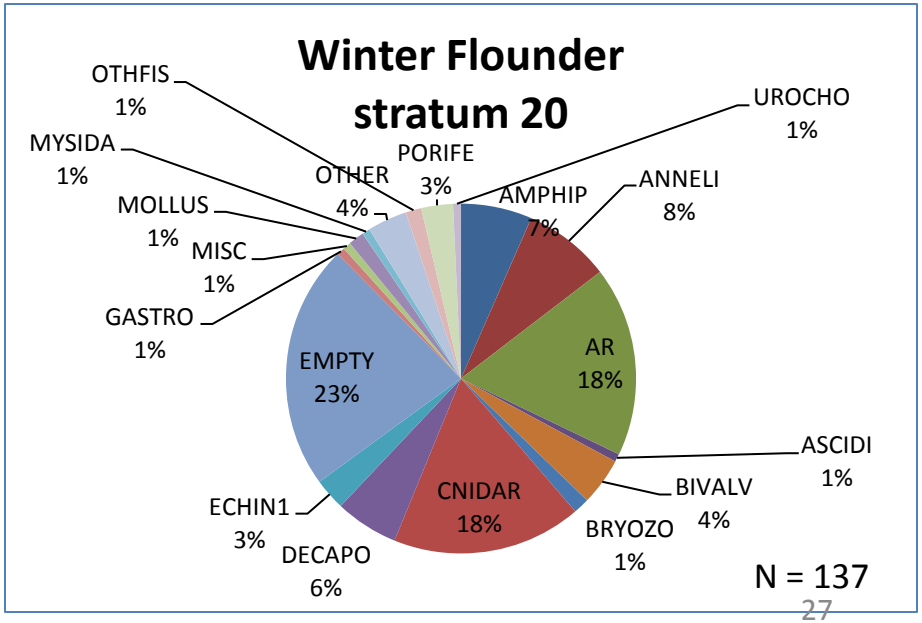
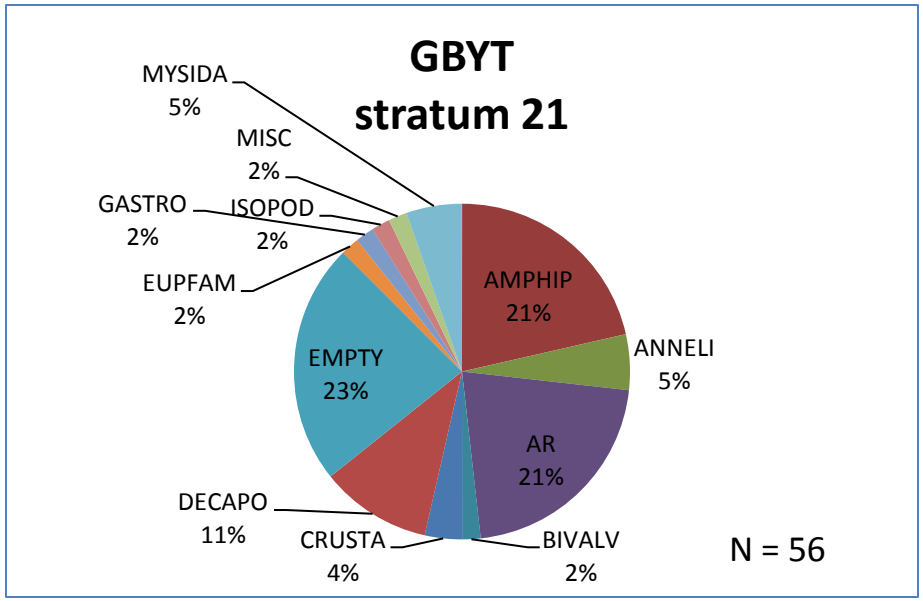
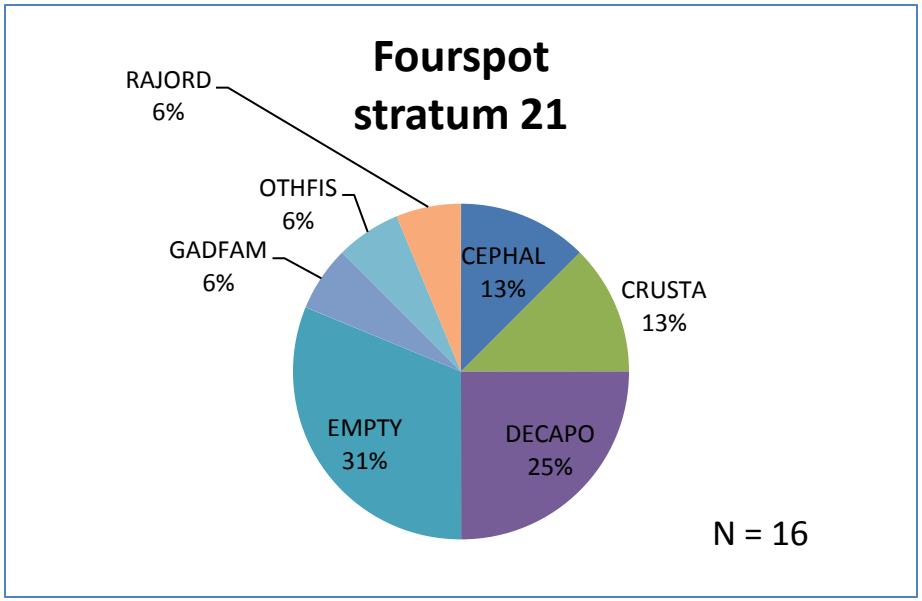


Figure 26. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 21 during NEFSC's fall survey 2008-2012.





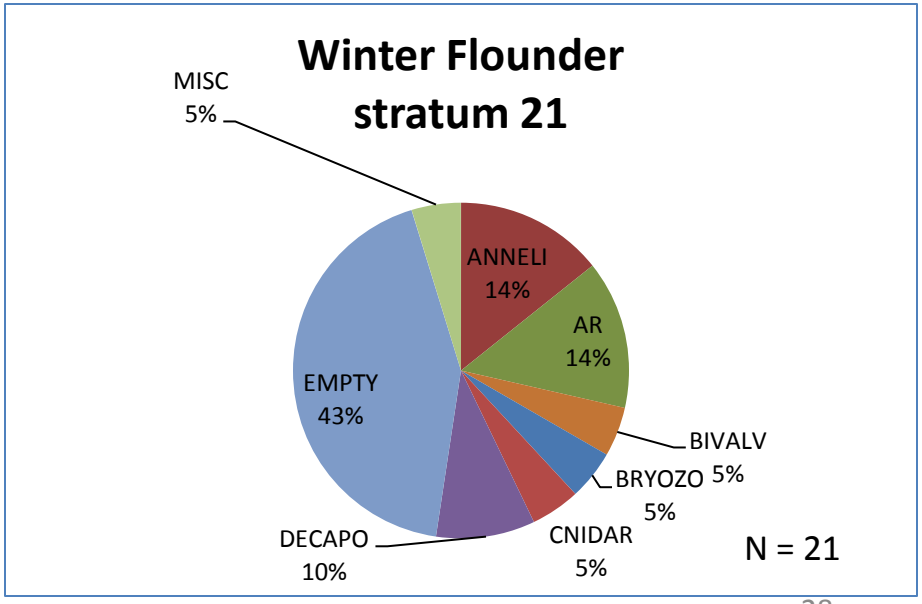
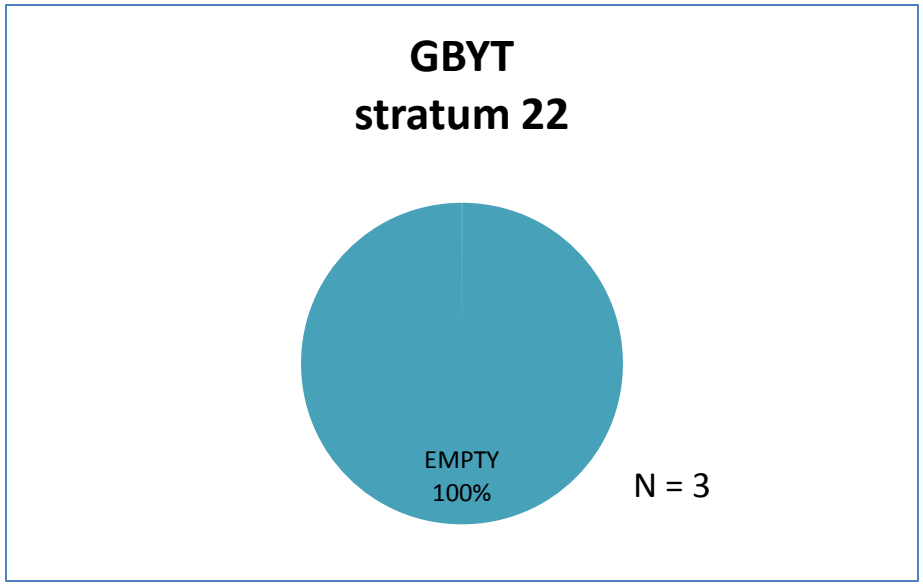


Figure 27. Stomach contents for Georges Bank yellowtail, fourspot, windowpane, and winter flounders for stratum 22 during NEFSC's fall survey 2008-2012.



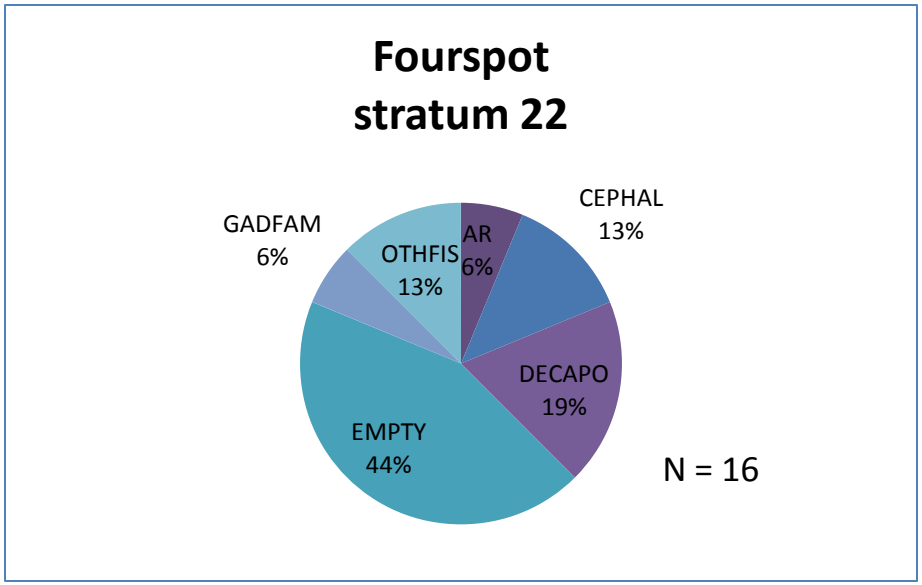


Table 1. Prey items found in the stomachs of Georges Bank yellowtail, fourspot, windowpane, and winter flounders.

AMMFAM	
AMMFAM	SAND LANCES
AMMOSP	SAND LANCES
AMMDUB	SAND LANCES

AMPHIP	
AMPHIP	AMPHIPODA
GAMMAR	GAMMARIDEA
CAPFA1	CAPRELLIDAE
HYPFAM	HYPERIIDAE

ANNELI	
HIRUDI	LEECHES
OLIGOC	EARTHWORMS
POLYCH	POLYCHAETA
APHFAM	SEA MOUSE

AR	
AR	ANIMAL REMAINS

ASCIDI	
ASCIDI	TUNICATES

ASTERO	
ASTERO	STARFISH

BIVALV	
BIVALV	CLAMS, MUSSELS
PECFA1	SCALLOPS
PECFA2	SCALLOPS
PECFA3	SCALLOPS
ARCISL	OCEAN QUAHOG
ARCIS2	OCEAN QUAHOG VISCERA
ARCIS3	OCEAN QUAHOG SHELL

BOTFAM	
BOTFAM	LEFTEYE FLOUNDERS
BOTHSP	
CITHSP	
CITARC	GULF STREAM FLOUNDER
CITMAC	SPOTTED WHIFF
ETROSP	
ETRMIC	SMALLMOUTH FLOUNDER
ANCQUA	OCELLATED FLOUNDER
PARAS1	PARALICHTHID FLOUNDER
PARDEN	SUMMER FLOUNDER
PAROBL	FOURSPOT FLOUNDER
SCOAQU	WINDOWPANE

BRYOZO	
BRYOZO	FLOWER ANIMALS

CEPHAL	
CEPHAL	SQUIDS, CUTTLEFISH AND OC
LOLISP	LONGFIN SQUID
LOLPEA	LONGFIN SQUID
LOLBRE	ATLANTIC BRIEF SQUID
ABRVER	RUPPEL'S ABRALIA
OMMBEA	
ILLESP	SHORTFIN SQUID-GENUS
ILLILL	NORTHERN SHORTFIN SQUID
SEPFAM	CUTTLEFISH
SEMTEN	LESSER SHINING BOBTAIL
OCTOPO	OCTOPODA

CLUFAM	
CLUFAM	HERRINGS
ALOSSP	
ALOAES	BLUEBACK HERRING
ALOPSE	ALEWIFE
ALOSAP	AMERICAN SHAD
BRETYR	ATLANTIC MENHADEN
CLUHAR	ATLANTIC HERRING
ETRTER	ROUND HERRING
SARAUR	SPANISH SARDINE
OPIOGL	ATLANTIC THREAD HERRING

CNIDAR	
CNIDAR	CNIDARIA
HYDROZ	HYDROZOA
ANTHOZ	CORALS, ANENOMES
SCYPHO	JELLYFISH

COPEPO	
COPEPO	COPEPODA

CRUSTA	
CRUSTA	CRUSTACEA
CRUEGG	CRUSTACEAN EGGS
CRULAR	CRUSTACEAN LARVAE
CRUSHR	CRUSTACEAN SHRIMP

CUMACE	
CUMACE	CUMACEA

DECAPO	
DECAPO	DECAPODA
DECLAR	DECAPODA LARVAE
DECCRA	DECAPODA CRAB
DECSHR	DECAPODA SHRIMP
CANFAM	CANCER CRABS
CRAFAM	CRAGONID SHRIMP
HOMAME	LOBSTER
PAGFAM	HERMIT CRABS
PANFAM	PANDALIDAE
PENFAM	PENAEIDAE
CALSAP	BLUE CRAB
SCYFAM	SLIPPER LOBSTERS

ECHIN1	
ECHIN1	URCHINS, SAND DOLLARS

ECHINO	
ECHINO	ECHINODERMATA

EMPTY	
EMPTY	EMPTY

EUPFAM	
EUPFAM	KRILL

FISLAR	
FISLAR	FISH LARVAE

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

GADFAM	
GADFAM	CODFISHES
BROBRO	CUSK
ENCCIM	FOURBEARD ROCKLING
GADMOR	ATLANTIC COD
MELAEG	HADDOCK
MERALB	OFFSHORE HAKE
MERBIL	SILVER HAKE
POLVIR	POLLOCK
UROPSP	HAKE UNCL
UROCHE	LONGFIN HAKE
UROCHU	RED HAKE
UROREG	SPOTTED HAKE
UROTEN	WHITE HAKE

GASTRO	
GASTRO	SNAILS
PTERO	PTEROPODA

HOLOTH	
HOLOTH	SEA CUCUMBERS

ISOPOD	
ISOPOD	ISOPODA

MISC	
MISC	MISCELLANEOUS

MOLLUS	
MOLLUS	MOLLUSCA

MYSIDA	
MYSIDA	MYSIDACEA

NEMATO	
NEMATO	NEMATODA

OPHIU1	
OPHIU1	BRITTLE STARS

OTHFIS	
OTHFIS	OTHER FISH
FISOTO	FISH OTOLITHS
OSTEIC	BONY FISHES
SCOSAU	ATLANTIC SAURY
POLLOW	BEARDFISH
MAUWEI	MULLER'S PEARLSIDES
POLCLA	SHORTSPINE TENPLATE
CYPVAR	SHEEPSHEAD MINNOW
LAVISP	HITCHES
FISTSP	CORNETFISHES
MACSCO	LONGSPINE SNIPEFISH
ANTRAD	SINGLESPOT FROGFISH
PARFAM	BARRACUDINAS
SYNFA2	LIZARDFISHES
SYNINT	SAND DIVER
TRAMYO	SNAKEFISH
ALEFA2	LANCETFISH
ALEFER	LONGNOSE LANCETFISH
STOBOA	BOA DRAGONFISH
CHUSLO	VIPERFISH
PERORD	
ASPMON	ALLIGATORFISH
LOPCHA	TILEFISH
CRYMAC	WRYMOUTH
CYCLUM	LUMPFISH
LIPASP	SNAILFISH

OTHFIS (cont)	
LIPATL	ATLANTIC SEASNAIL
LIPINQ	INQUILINE SNAILFISH
PHLFAM	GUNNELS
PHOGUN	ROCK GUNNEL
ORTCHR	PIGFISH
LUMLUM	SNAKEBLENNY
LUMMAC	DAUBED SHANNY
ULVSUB	RADIATED SHANNY
BLEFAM	BLENNY UNCLASSIFIED
MICFAM	WORMFISHES
CALFA3	DRAGONET FISH
FOEAGA	SPOTFIN DRAGONET
ZENCON	BUCKLER DORY

PORIFE	
PORIFE	SPONGES

RAJORD	
RAJORD	RAYS AND SKATES U
RAJASP	SKATES
RAJEGG	SKATE EGG CASE
RAJEGL	CLEARNOSE SKATE
RAJERI	LITTLE SKATE
RAJGAR	ROSETTE SKATE
RAJRAD	THORNY SKATE
RAJSEN	SMOOTH SKATE

SCRFAM	
SCRFAM	ROCKFISHES, SCORPIONFISHES
HELDAC	BLACKBELLY ROSEFISH
SEBFAS	ACADIAN REDFISH

STRFAM	
STRFAM	BUTTERFISHES
ARIBON	SILVER RAG
PEPTRI	BUTTERFISH
PEPALE	HARVESTFISH

SYNFA1	
SYNFA1	PIPEFISHES AND SEAHORSES
HIPPSP	SEAHORSES
HIPERE	LINED SEAHORSE
SYNGSP	
SYNFUS	NORTHERN PIPEFISH

UNOBS	
UNOBS	UNOBS

UROCHO	
UROCHO	UROCHORDATA

WORMS	
PLATYH	FLATWORMS
WORMS	WORMS