Changes in the Fish and Macroinvertebrate Assemblage of the Niantic River Over the Past 33 Years

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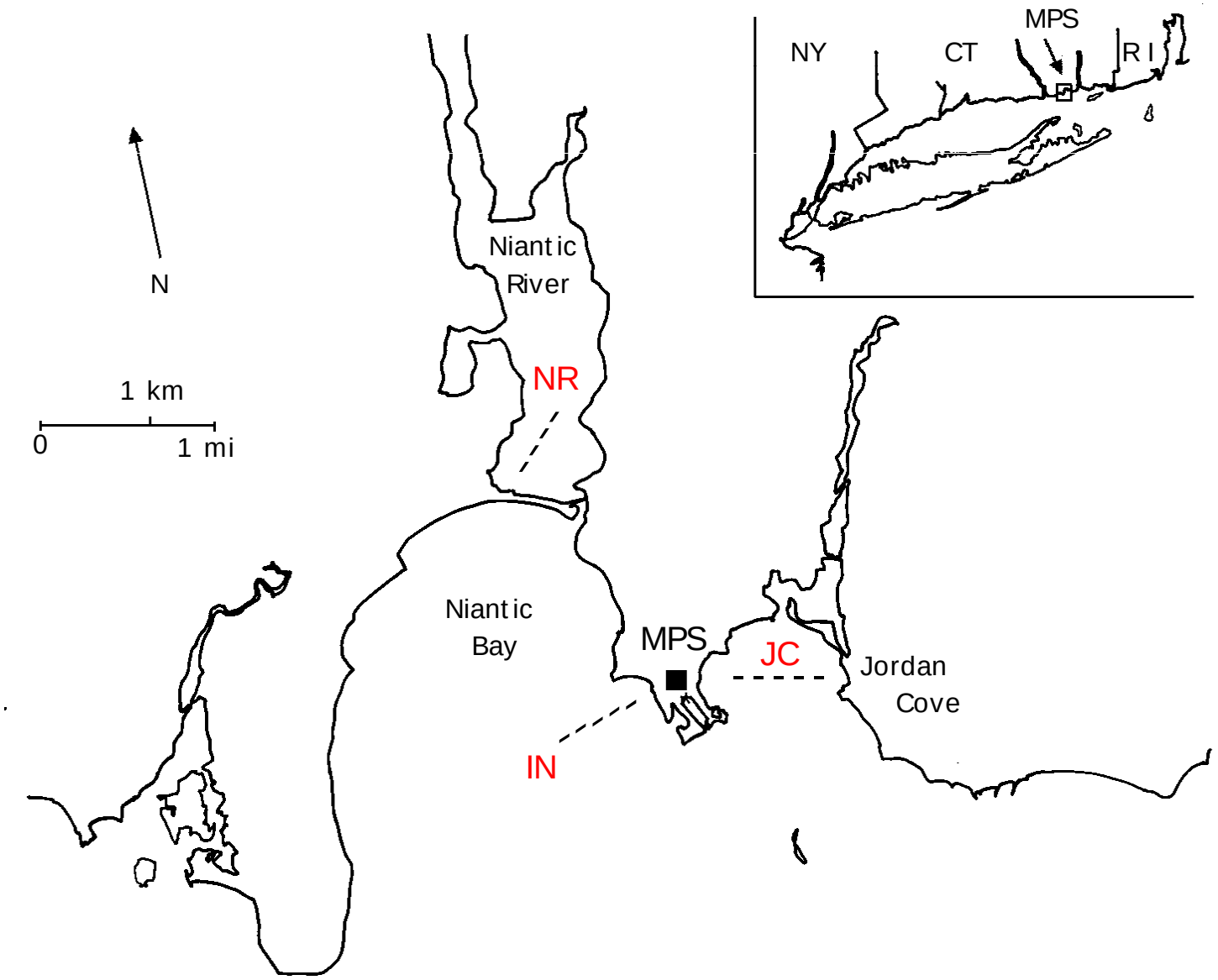
Source of Data

- Long-term trawl survey completed at three stations in vicinity of Millstone Point, CT, one of which in NR
- Stations sampled every other week continuously since June 1976
- Three replicate tows taken using a 30’ otter trawl
- Tows are standardized by distance
- For this analysis, effort-adjusted catch of each taxon summed over a June-May year from June 1976 through May 2009 (33 years)


1350
DOMINION
WATERFORD CT.


N
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River
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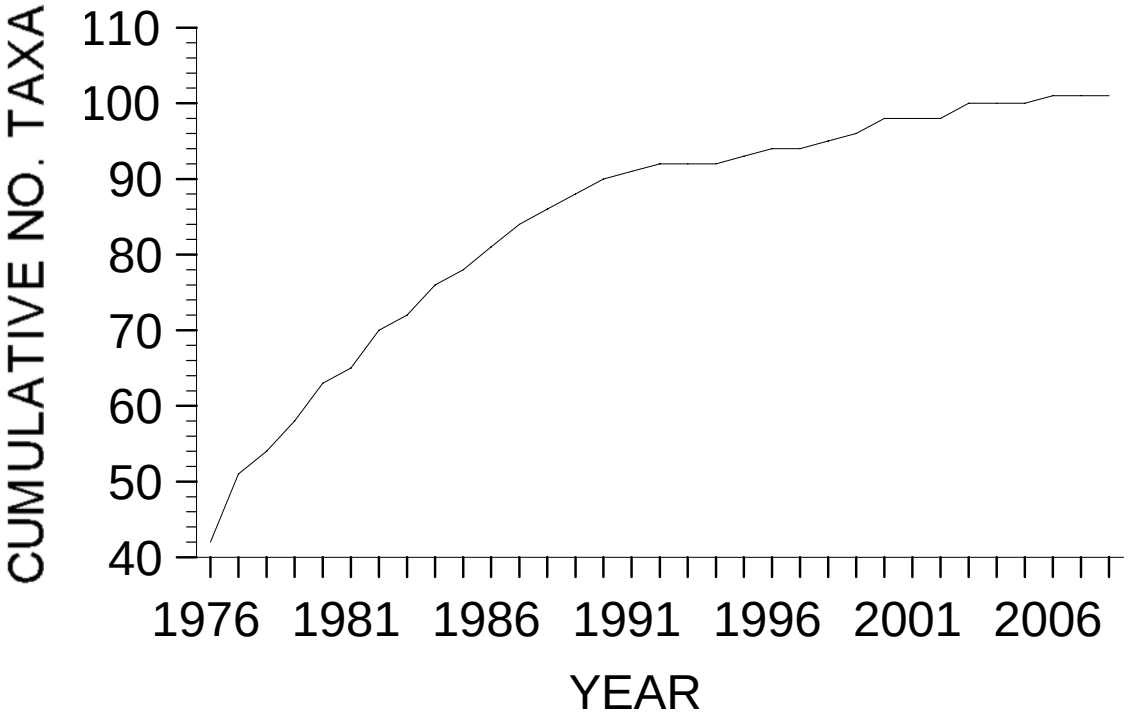
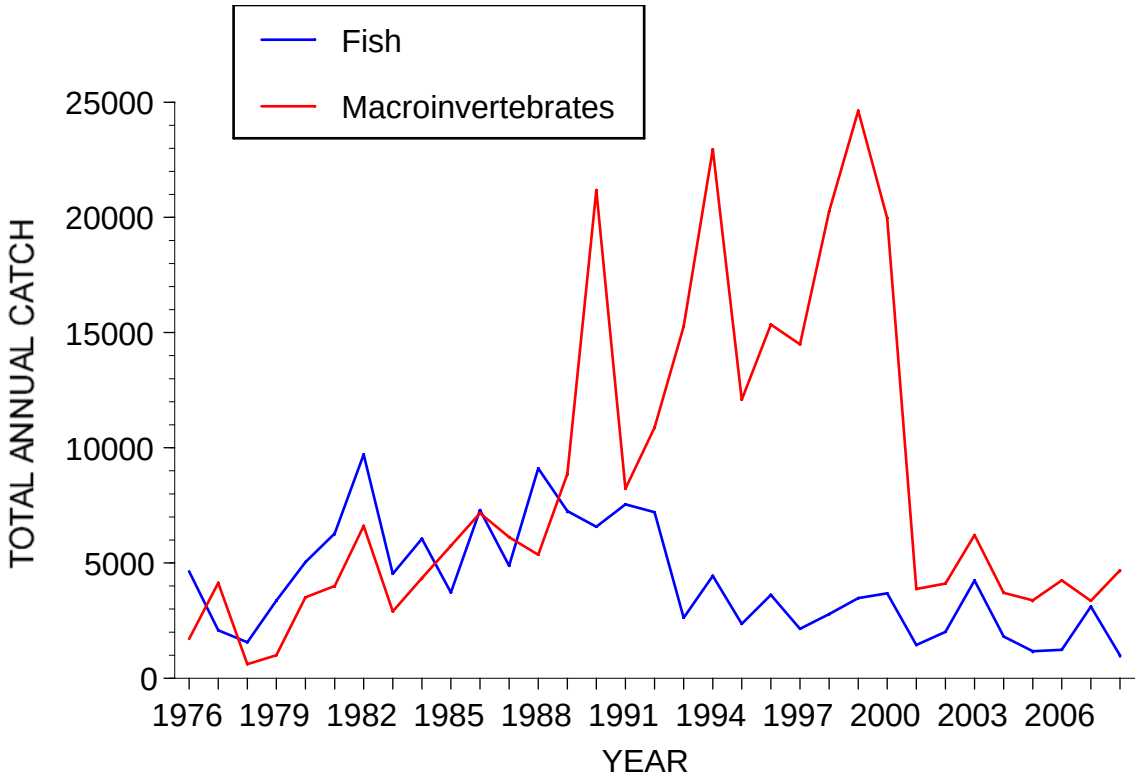
Abundance Totals – NR Station

- In 33 years of Millstone trawl studies, 124 fish taxa identified (some to higher level) and 17 macroinvertebrates enumerated
- Niantic River taxonomic catch:
  - 85 fish taxa + 17 macroinvertebrate taxa
- Niantic River totals:
  - 137,967 fish + 280,728 macroinvertebrates

Cumulative Catch of Taxa at NR



Total Annual Catch at NR



Catch of Fish at the NR Station

- Catch dominated (59%) numerically by winter flounder 
- Silversides (7%) and grubby (6%) also common  
- Making up another 12% were summer flounder, windowpane, scup, and tautog   

Catch of Macroinvertebrates at the NR Station

- Nearly two-thirds were green crab
- 21% were spider crabs

- Also relatively common through the years were lady crab (6%), Atlantic rock crab (3%), and bay scallop (2%)

Multivariate Analyses Used to Examine Trawl Data

- PRIMER (v. 6) software package used for the data analysis
- Hierarchical clustering and nonmetric multidimensional scaling (MDS) ordination techniques used

Bray-Curtis Similarity Index

- Bray-Curtis similarity index an important component of this analysis:

$$S_{jk} = \frac{\sum_{i=1}^{n} 2 \min (X_{ij} , X_{ik})}{\sum_{i=1}^{n} (X_{ij} + X_{ik})}$$

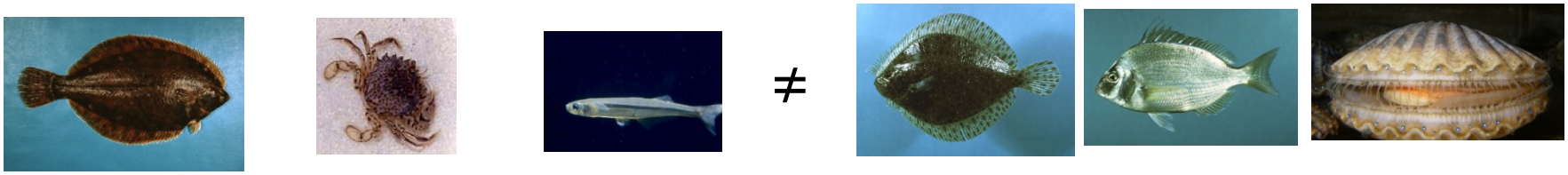
- Quantitative measure of how similar the species composition and abundance are between pairs of samples

- Converse measure is dissimilarity

Similarity in a Nutshell

- Basically,

- But,



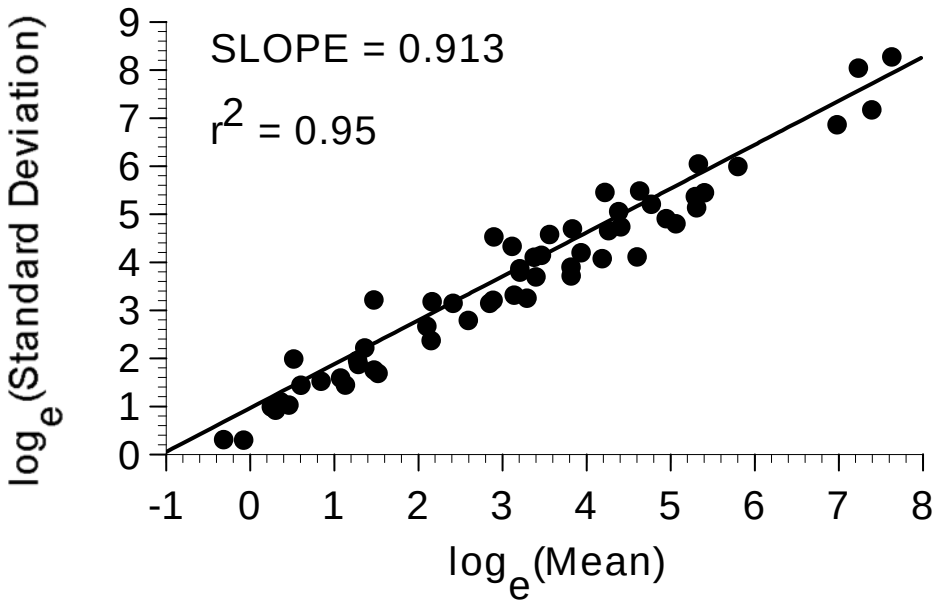
Data Sub-setting

- Catch data screened to remove taxa with high proportions of zero catches in a year
- Criteria for inclusion:
  - $\geq$0.02% of total numerical catch and found in at least 7 of the 33 years
- Analyses used 43 of 102 taxa (42%), but 99.9% of total catch:
  - 32/85 fishes and 11/17 macroinvertebrates

Data Transformation

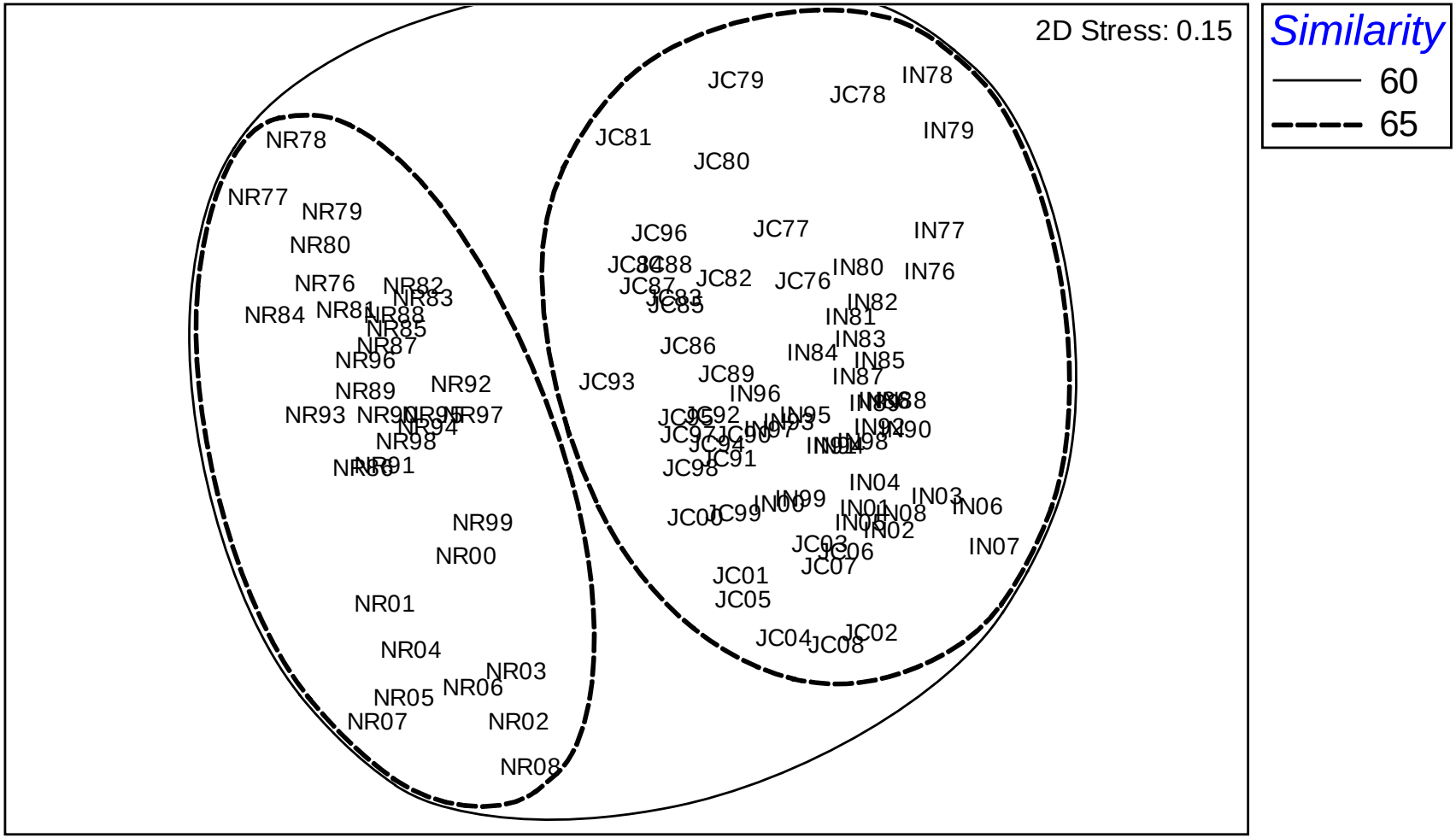
- Data were transformed to help balance differing contributions of both abundant and less common taxa
- Graphical technique suggested:
  - slope of $\log_e$ mean abundance vs. $\log_e$ standard deviation indicates appropriate data transformation

Data Transformation



$Log_e(X + 1)$ data transformation indicated

Station Differences



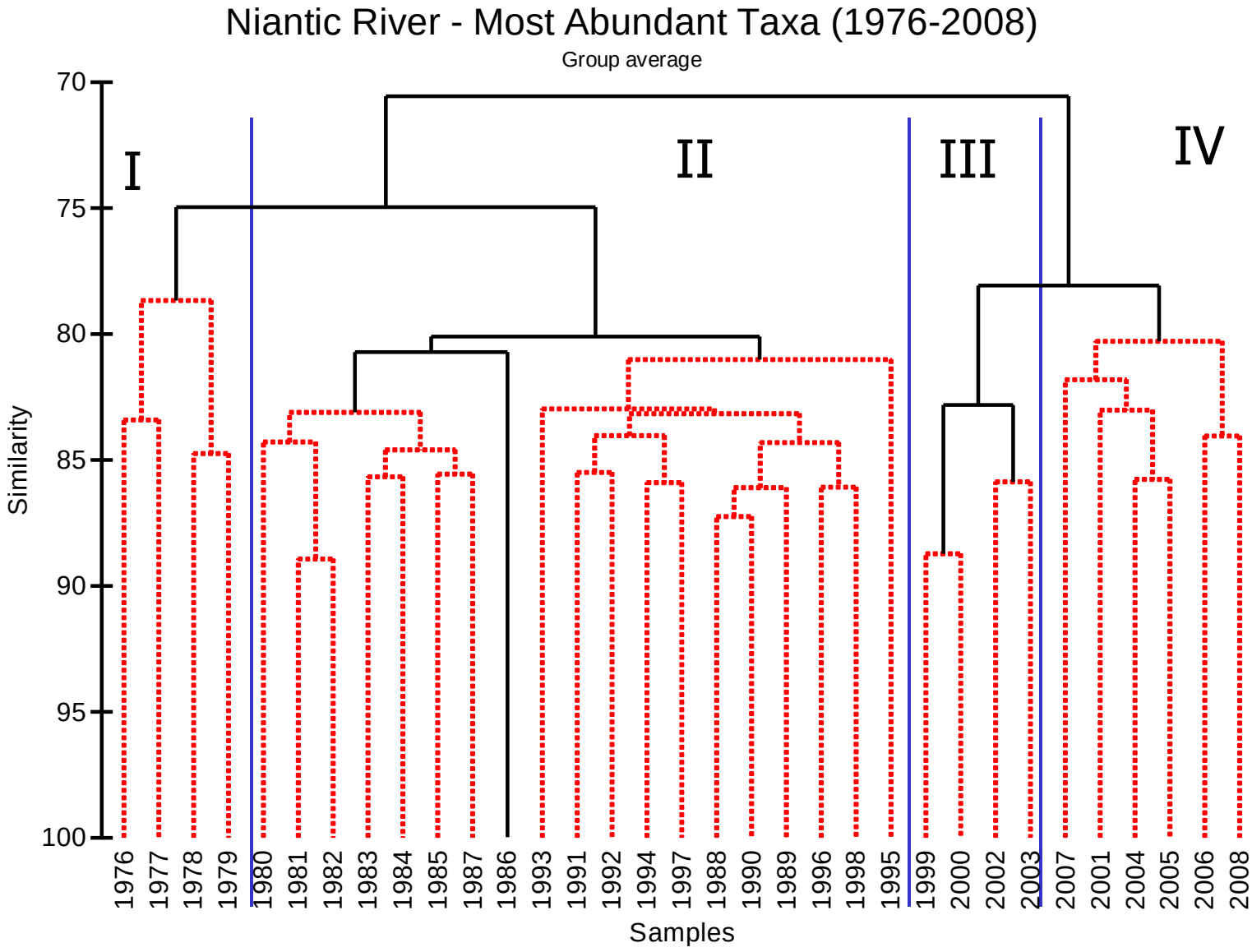
Station Differences

- Intra-station similarities were 75-78%
- Stations represent distinctly different habitats, with JC and IN showing more inter-station similarity (73%) than either had with NR (62-66%)
- 17-20 taxa accounted for half of the dissimilarities between stations

Informative or Distinctive Taxa

- IN characterized more by marine species:
  - Longfin squid, whelks, flatclaw hermit crab, skates, scup, smallmouth flounder, Atlantic cod, silver hake, northern searobin
- NR characterized more by estuarine species:
  - Green crab, lady crab, horseshoe crab, oyster toadfish, sticklebacks
- JC had some of each:
  - Green crab, rock gunnel, Atlantic tomcod, skates, scup

Clustering Dendrogram - by Year



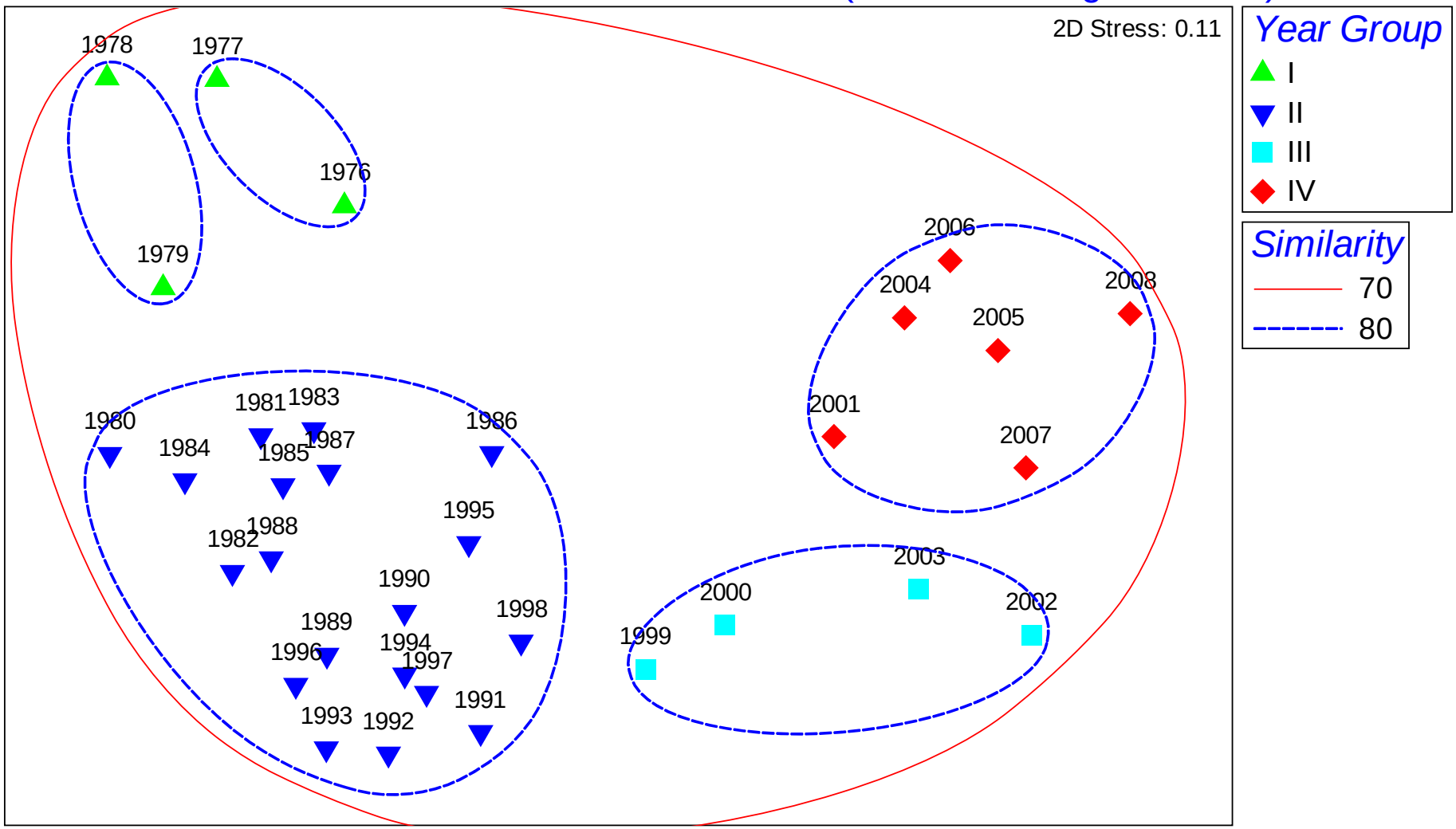
Annual Groupings - Similarities

- Each of the four major clusters had an average similarity of 80-85%
- 23 to 29 taxa accounted for ~90% of the average similarity within each grouping
- 8 to 10 taxa accounted for ~50%
- 3 to 4 taxa made up ~25%

Accounting for 50% of similarity	1976-79	1981-98	1999-2000, 2002-03	2001, 2004-08
Green crab	X	X	X	X
Winter flounder	X	X	X	X
Spider crabs	X	X	X	X
Lady crab	X	X	X	
Silversides	X	X	X	X
Grubby	X	X	X	
Atl. rock crab	X	X		
Bay scallop	X			
Windowpane	X	X		
Summer flounder		X	X	X
Scup			X	X
Tautog			X	X
Northern pipefish		X		
Striped searobin			X	
Horseshoe crab	X			
Cunner				X

2D MDS Plot – by Year

Niantic River Fish & Macroinvertebrates (1976-77 through 2008-09)



Dissimilarities Between Adjacent Annual Groupings

- Average dissimilarity was 22-26%
- 13 to 16 taxa accounted for ~50% of inter-group differences
- Of note, some of more abundant taxa (winter flounder, spider and lady crabs, and silversides) were not informative
- Exception was green crab, which was in low abundance during late 1970s, but then greatly increased (Group I vs. II difference)

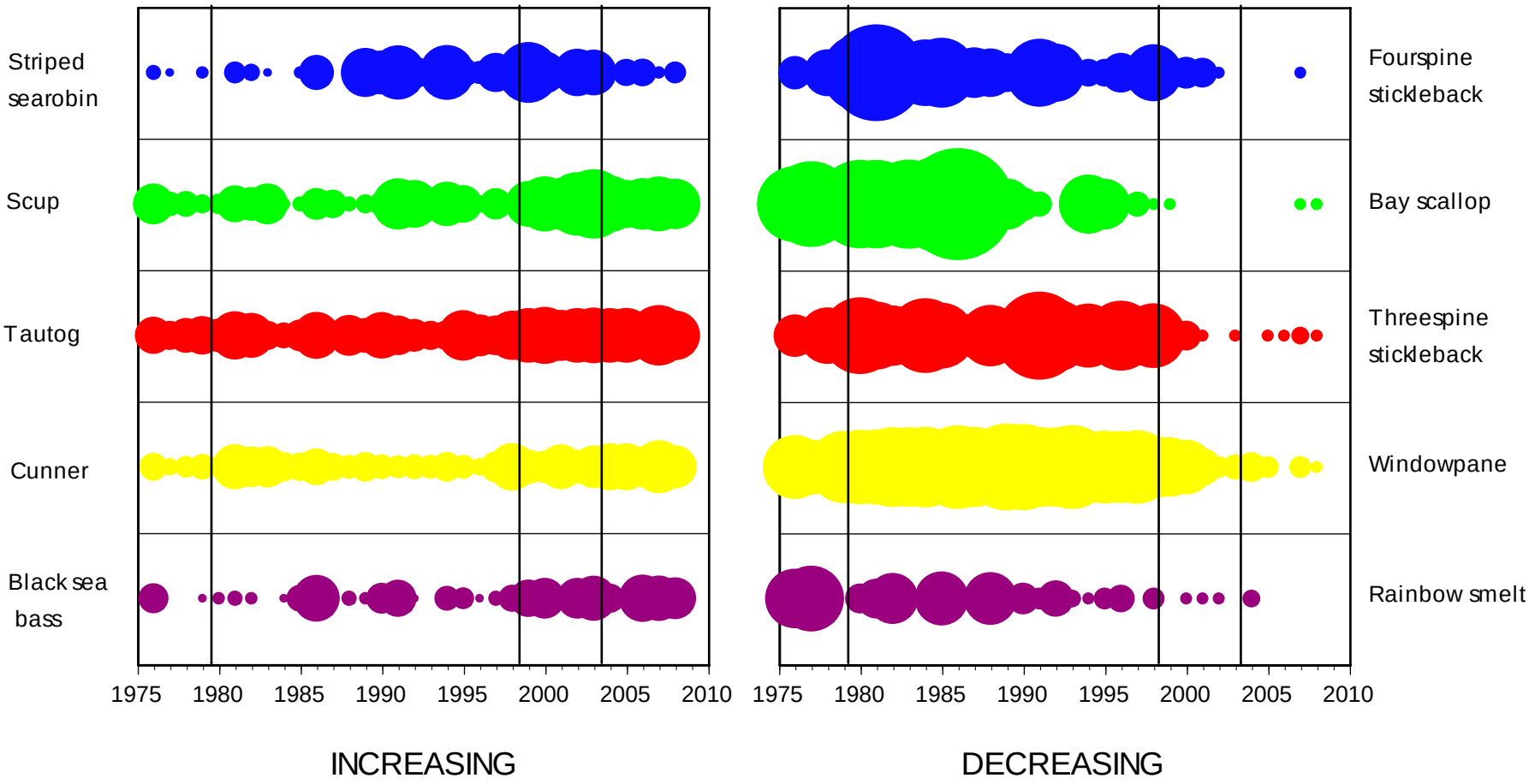
Species differences	I vs II		II vs III		III vs IV
Green crab	+	Spotted hake	+	Striped searobin	-
Northern pipefish	+	Tautog	+	Smallmouth flounder	-
Rock gunnel	+	Black sea bass	+	Spotted hake	-
Grubby	+	Atlantic menhaden	+	Atlantic menhaden	-
Summer flounder	+	Windowpane	-	American lobster	-
		Scup	+		

+ indicates an increase and – a decrease

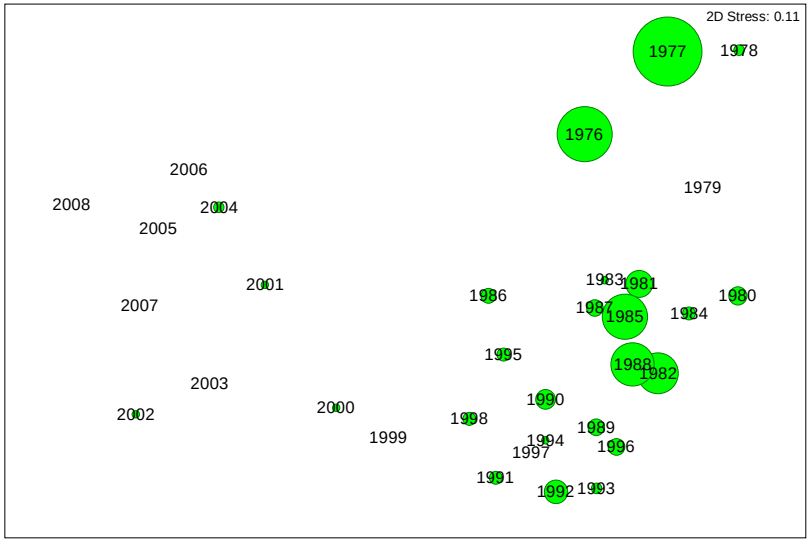
Annual Groupings - Dissimilarities

- Over the 33 years, we saw moderate to large decreases in bay scallop, winter flounder, three- and fourspine sticklebacks, windowpane, rainbow smelt, lady crab, Atlantic rock crab, American lobster, and oyster toadfish
- Had increases in black sea bass, Atlantic menhaden, spotted hake, tautog, cunner, and scup
- 2008-09 decrease in fish abundance in the river bears further scrutiny

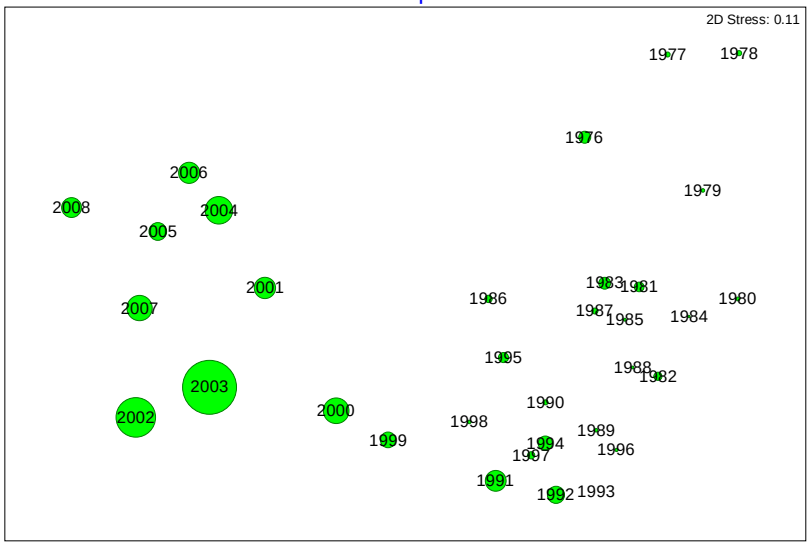
ANNUAL $\log_e(X + 1)$ ABUNDANCES



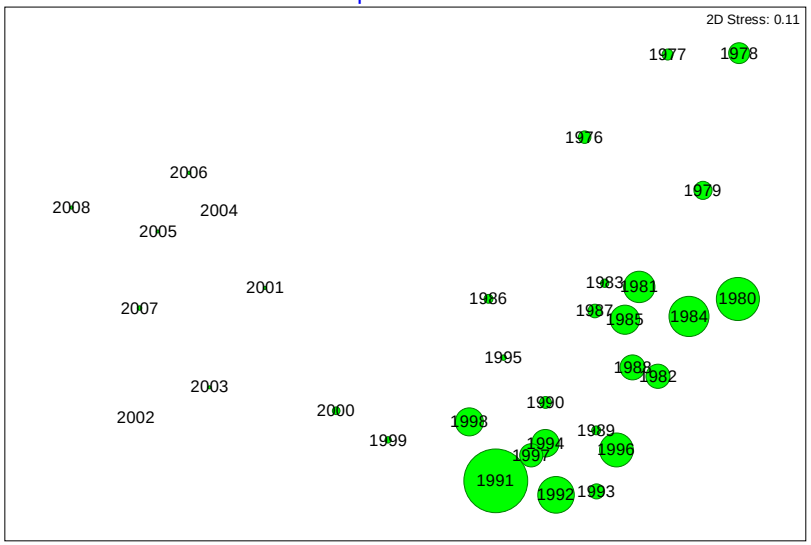
Rainbow smelt



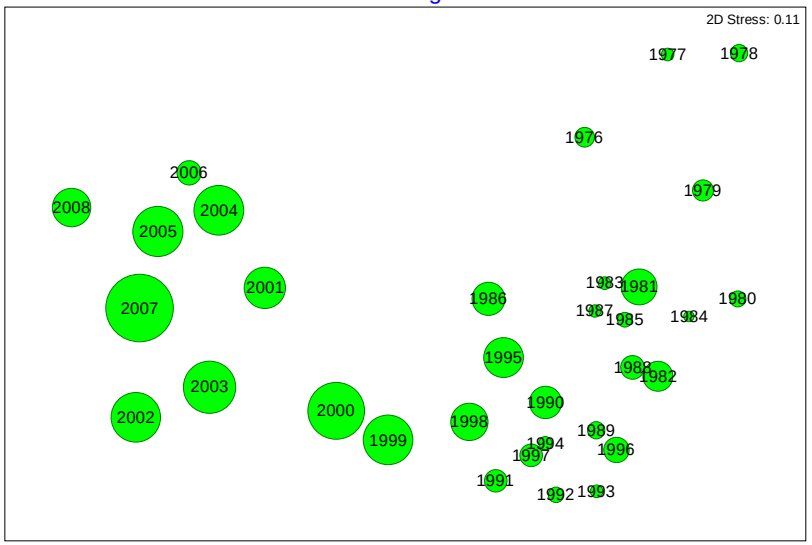
Scup



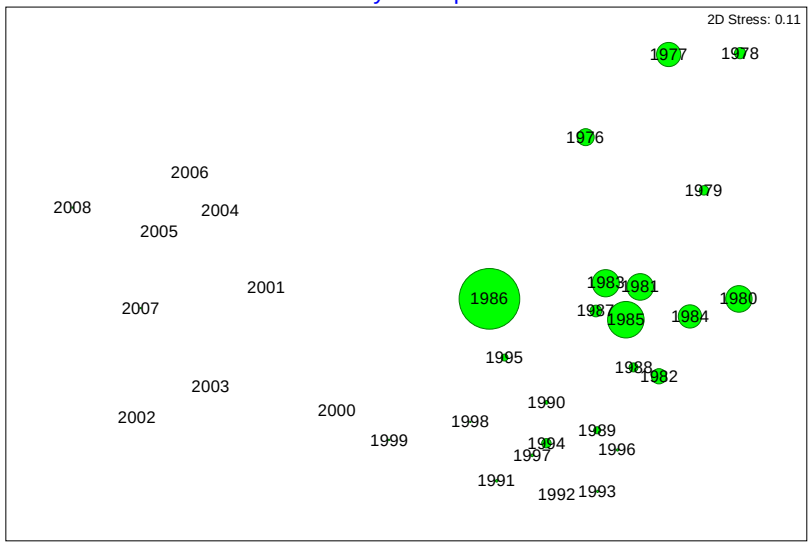
Threespine stickleback



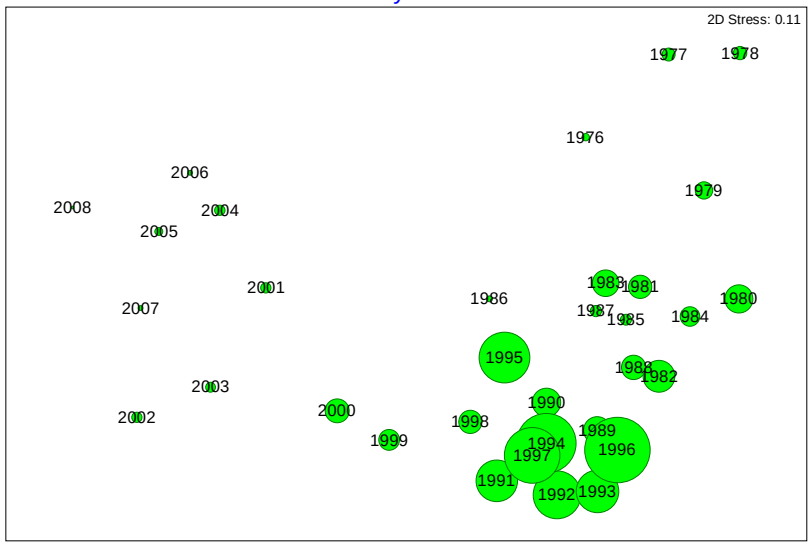
Tautog



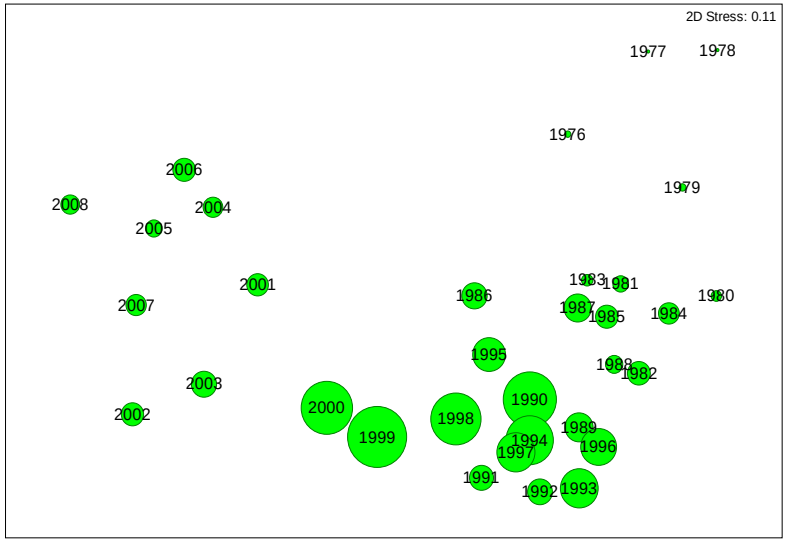
Bay scallop



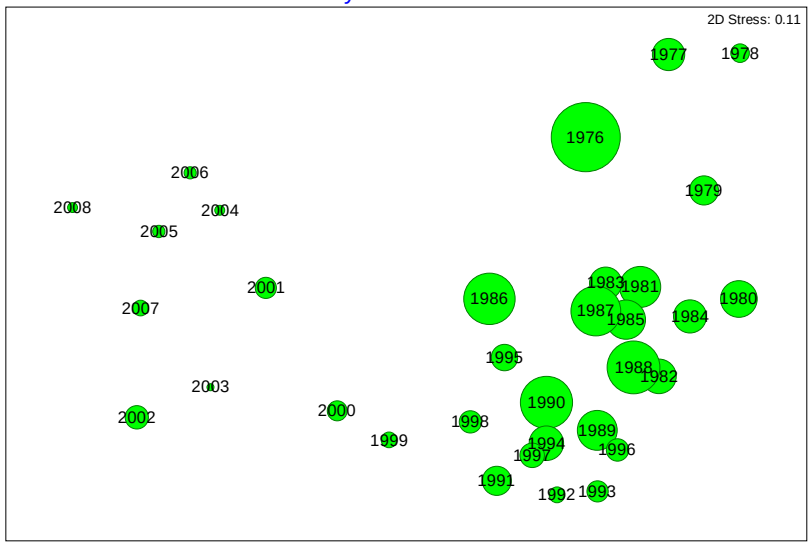
Lady crab



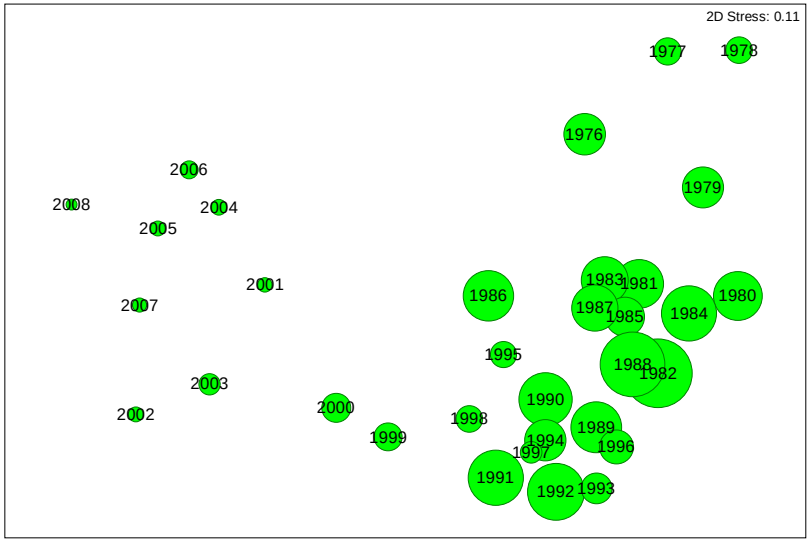
Green crab



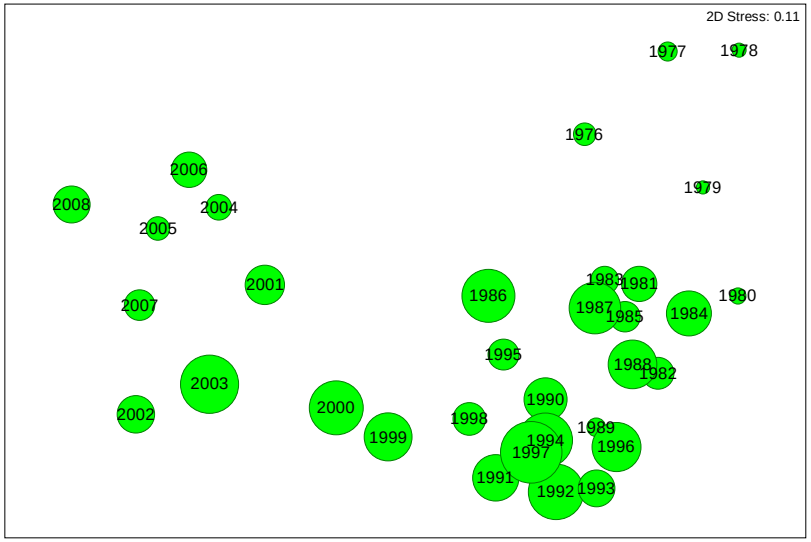
Oyster toadfish



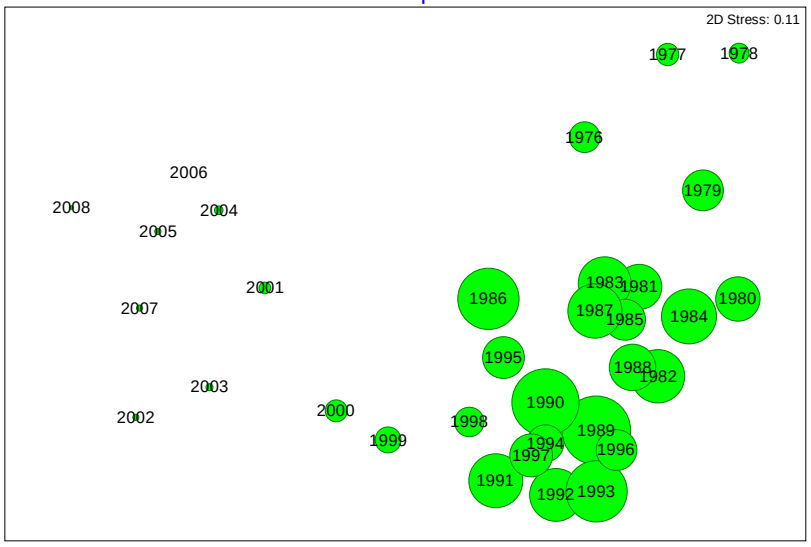
Winter flounder



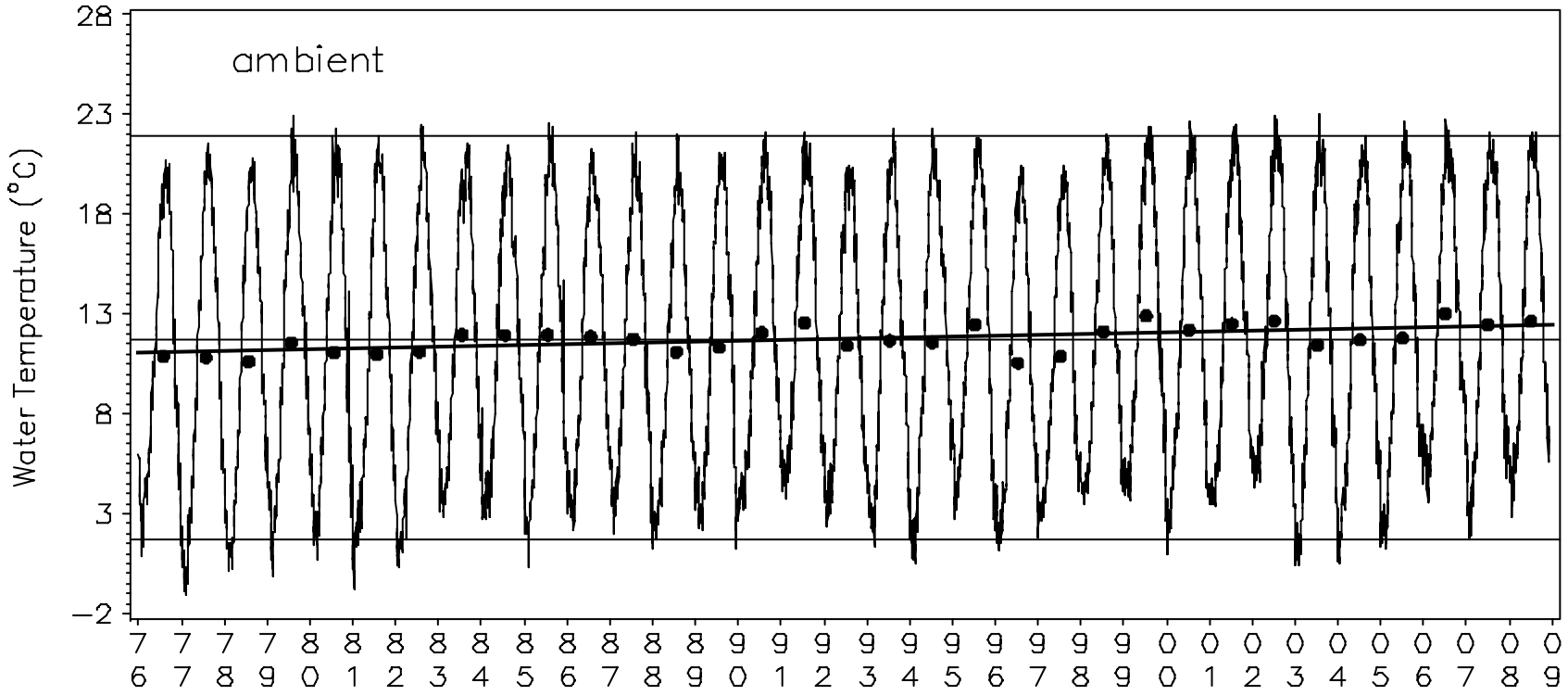
Summer flounder



Windowpane



Daily Mean Seawater Temperature – MPS Intakes



Slope = 0.042°C/year; p=0.0002**; 1.4°C increase over 33 years

Conclusions - Millstone Study

- No negative trends found in taxa or abundance that would indicate community stress
- Differences in assemblages and abundances appear related to species preferences and long-term changes to the environment
- Most changes have occurred over entire Southern New England: winter flounder (-) or larger regions: American eel (-), bay anchovy (-), Atlantic menhaden (+)
- Some changes probably reflect a long-term increase in average ambient water temperature that resulted in range extensions (clearnose skate, spotted hake, black sea bass) or contractions (lumpfish)

Conclusions - Millstone Study

- Some increases (tautog, summer flounder) resulted from changes in fishery management reducing F
- Some increases may be related to increased seaweed loading (= excess nutrients?) in river (more habitat for settling YOY tautog and cunner)
- Some decreases are probably related to loss of critical habitat (rainbow smelt: spawning streams; bay scallop and sticklebacks: eelgrass decline?)
- Some decreases due to enhanced inter-specific interactions (river herrings: striped bass and green crab: Asian shore crab?)

Conclusions - Millstone Study

- Scup-black sea bass-spotted hake assemblage is currently dominant in local waters and cool-water fishes (e.g., winter flounder) are in decline
- Current dominant species similar to groupings of others - commonly characterized as “southern, warm”
- An ichthyofaunal change has occurred, probably associated with warming ambient water temperatures and localized habitat changes


Questions?