



Marine Fisheries
Commonwealth of Massachusetts



From Fishing Capacity to Diversity; Changing Fishery Management Priorities in the US New England Groundfish Fishery

Eric Thunberg, NOAA Fisheries, Office of Science and Technology

Steven Correia, Massachusetts Division of Marine Fisheries

Outline

❖ Introduction

- Management priority timeline

❖ Measures of Fleet Diversity

- Richness
- Shannon Index
- Evenness

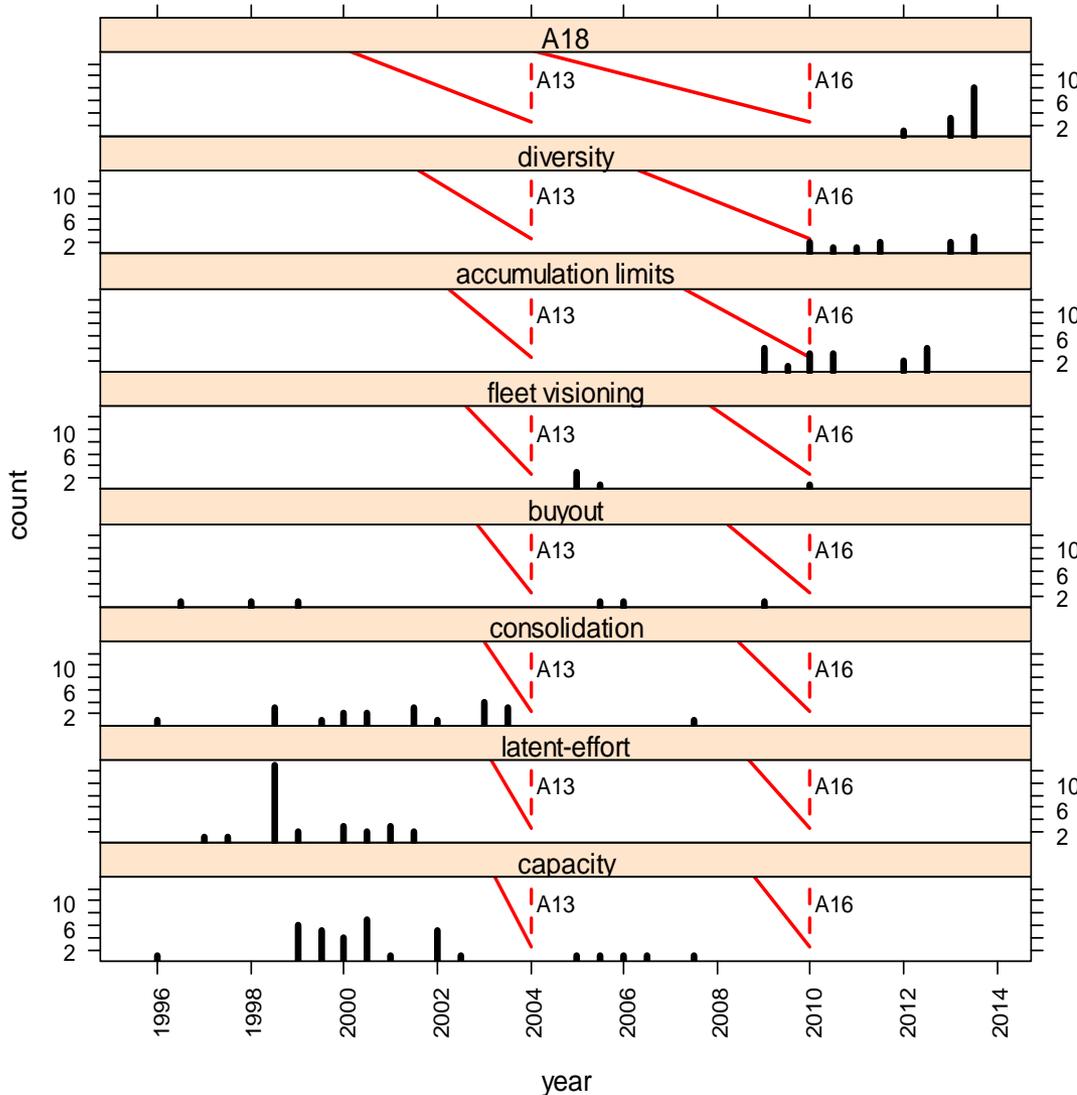
❖ Data and Methods

❖ Results

❖ Conclusions

Management Priorities Over Time

Count of topics in Federal Register summaries



- ❖ Federal Register meeting summaries proxy for topic importance
- ❖ Issues related to capacity dominated from 1996 to 2004
- ❖ Issues related to diversity begin to crop up in 2005 with more frequency from 2009 to Present

Fleet Diversity

- ❖ FMP Objective to Maintain a Diverse Fleet
 - Gear type, vessel size, locations, levels of participation
- ❖ Fleet Visioning
 - Gear type, vessel size, location
- ❖ Amendment 18
 - Gear type, vessel size, location, ownership patterns, level of participation through permit banks
- ❖ Primarily framed in terms of presence or absence
 - Lends itself to biodiversity measures

General Diversity (Hill 1973)

$${}^qD \equiv \left(\sum_{i=1}^N p_i^q \right)^{1/(1-q)}$$

- “Diversity Order” determined by q
- Weight put on less abundant vis à vis more abundant species
- For $q > 0$ and < 1 greater weight on less abundant
- For $q > 1$ greater weight on more abundant
- For $q = 0$; Richness
- For $q = 1$; Shannon Index
- For $q = 2$; Simpson’s Index

Effective Diversity and Evenness

- ❖ Effective diversity; the number of vessel types that would be present if all types were equally abundant
 - Shannon; ${}^1D = e^{SH}$
 - Simpson; ${}^2D = 1/S$
 - For any population with equal abundance;
 - $e^{SH} = 1/S = \text{Richness}$
- ❖ Evenness; The degree to which all vessel types are of equal abundance
 - Gini Coefficient

Data and Methods

❖ Vessel Types (368 possible vessel types)

- Gear – hook, longline, gillnet, trawl
- Vessel size - < 30, 30 to < 50, 50 to < 75, >= 75
- Port Group – 23 sub-regions

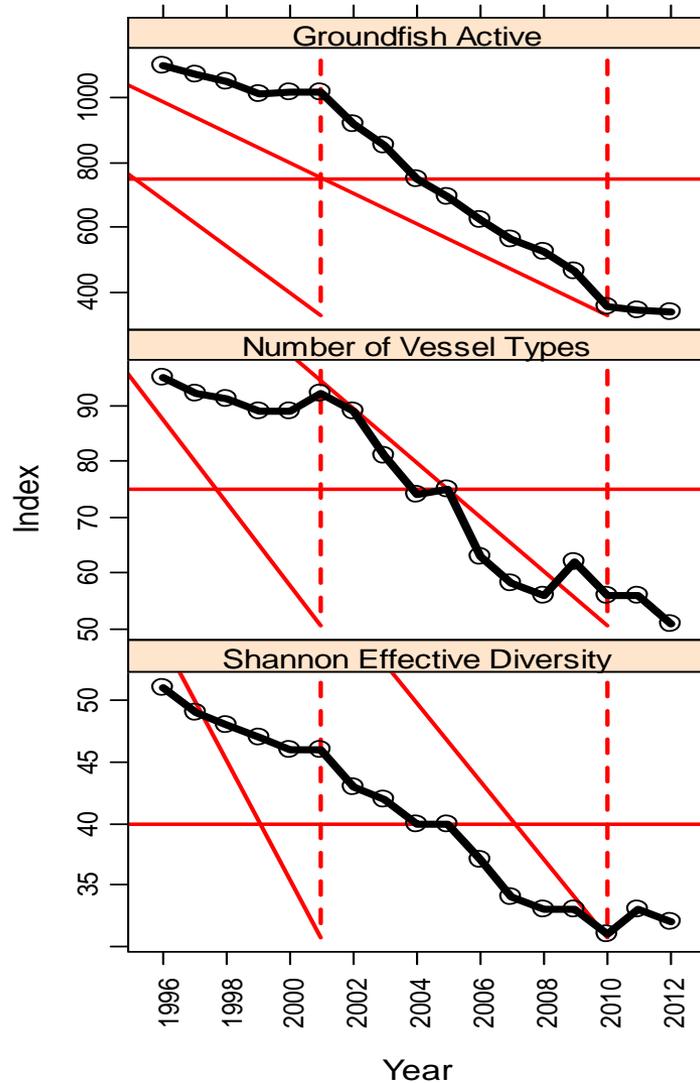
❖ Preponderance of groundfish landings used to assign vessel types; 1996-2012

❖ Vessel trip report data

❖ Total of 132 vessel types “existed” in at least 1 year

Results – Diversity Measures

Trends in three indices



❖ From 1996 to 2012

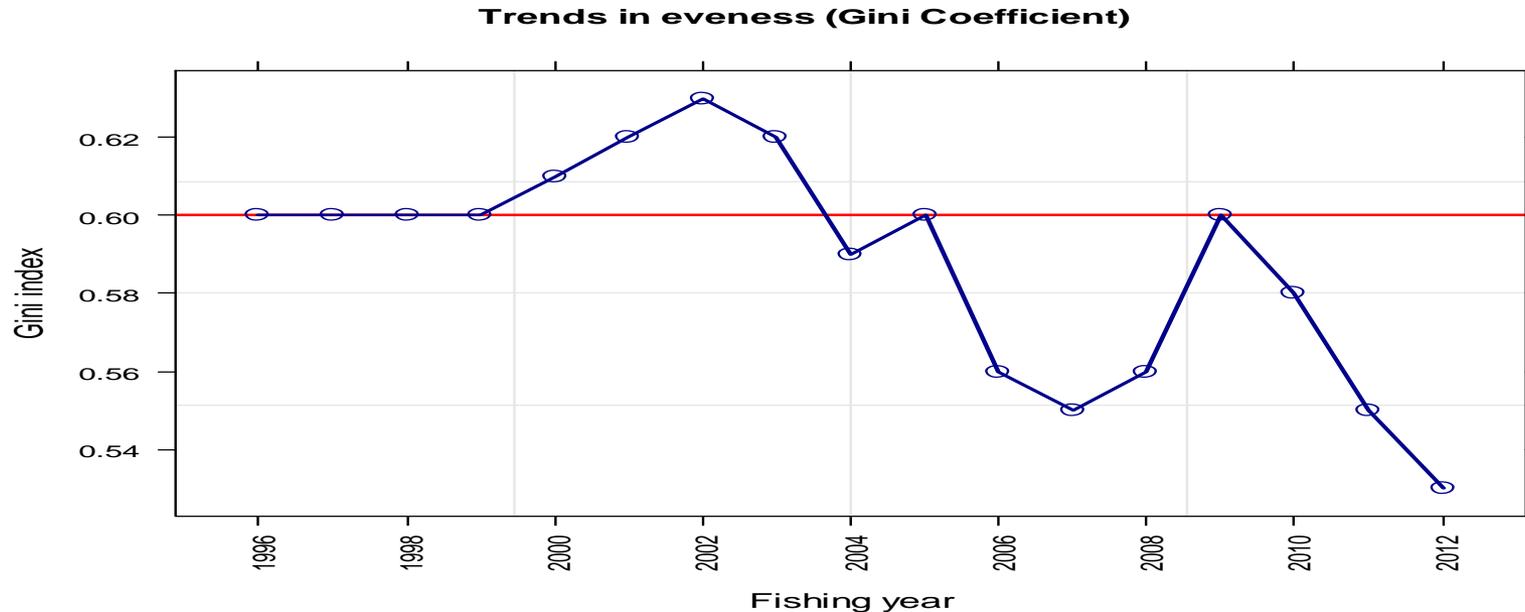
- -69% in active vessels (1,098 to 337)
- -46% in richness (95 to 51)
- -37% in effective diversity (51 to 32)

❖ Times series break in 2001; prior to 2001 fleet size, richness, and effective diversity change at similar rates -0.6% to -1.7%

❖ 2002-2010 fleet size down at an average annual rate of 11%, richness down 5%

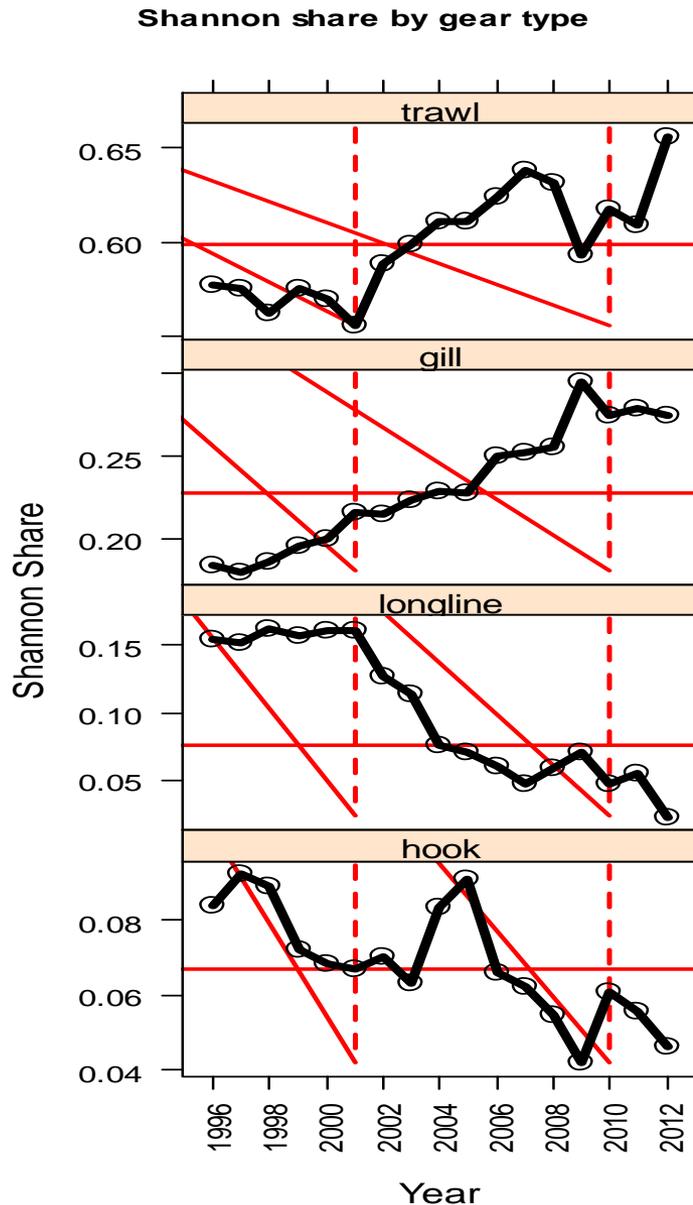
❖ Effective diversity down 2002-2008 by 5% per year, but stable since 2008 (31 to 34)

Evenness (Gini Coefficient)



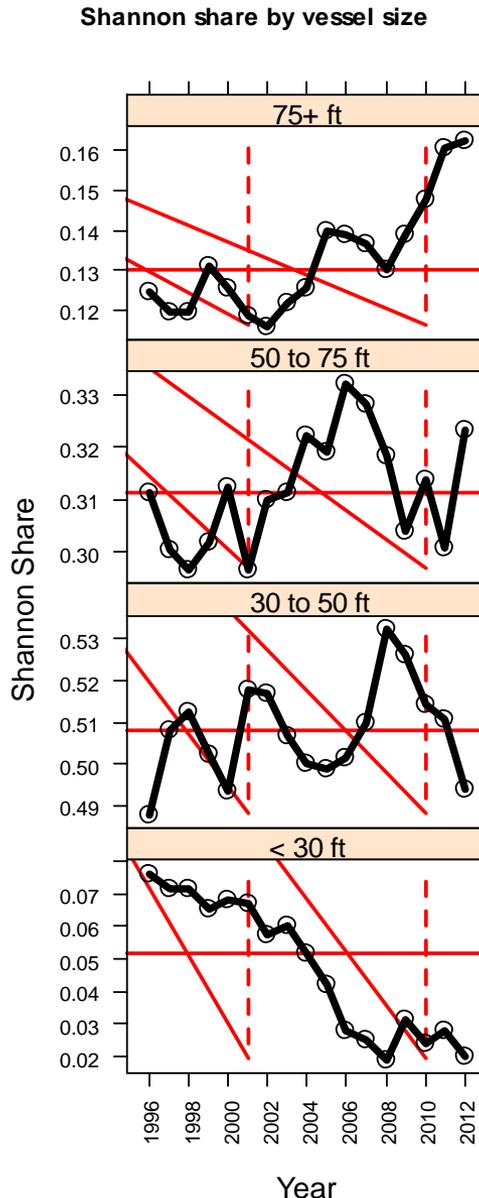
- ❖ Average annual percent change -1.7% since 2002
- ❖ Abundance among vessel types has become more even since 2002.

Gear Effects on Shannon Index



- ❖ Time series median trawl 60%, gillnet 23%, longline 8%, hook 7%
- ❖ Time series break in 2001 – increase in trawl, drop in longline
- ❖ Consistent upward trend in gillnet and trawl, downward trend in longline and hook

Vessel Size Effects on Shannon Index

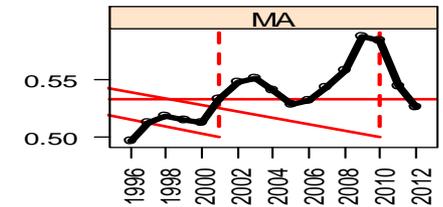
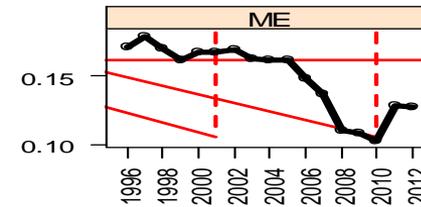
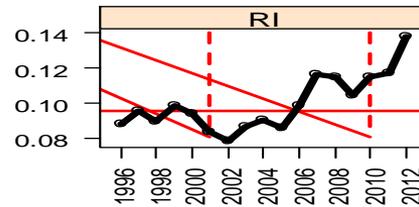
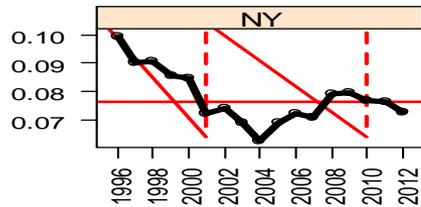


- ❖ Time series median <30 (5%), 30 to 50 (51%), 50 to 75 (31%), >75 (13%)
- ❖ Size classes 30 to 50 and 50 to 75 vary around median
- ❖ -10% average annual change in small vessel share (1996-2008)
- ❖ 3% average annual change in large vessel share (2002-2012)

Port Group State Effects on Shannon Index

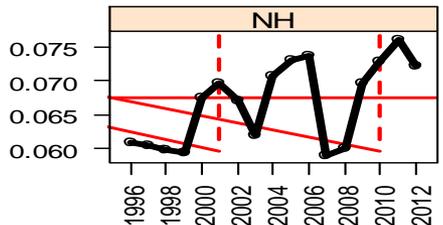
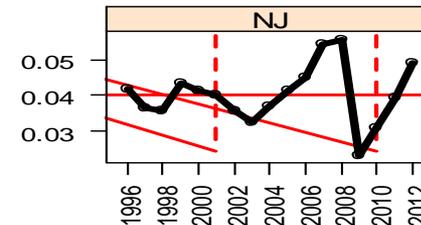
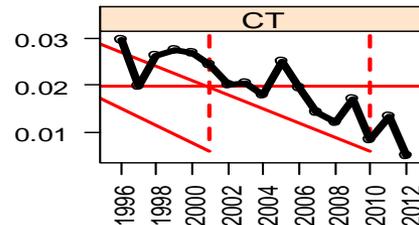
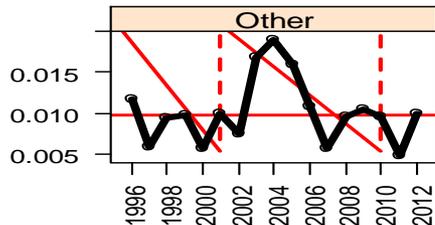
- ❖ MA 53% of index, increase 1% per year through 2009 down 2010-2012
- ❖ ME 16% of index 1996-2005, down 8% per year 2006-2010, serial “extinction” of key vessel types.
- ❖ RI 10% of index, 2003-2012 increasing at average annual rate of 6%

Shannon share by state



Year

Shannon share by state



Year

Shannon Share

Shannon Share

Conclusions

❖ Diversity indicators show downward trend

- Effective diversity stable since 2008
- More even distribution of relative abundance

❖ Evidence of shifts among vessel types

- ↑ share for trawl and gillnet gears
- ↑ share for larger vessels, ↓ share of small vessels
- Massachusetts more than 50% of Shannon index
- ↓ share in Maine port groups
- ↑ share in Rhode Island port groups

Conclusions (continued)

- ❖ 40 of 132 vessel types present in all 17 years
 - These 40 vessel types accounted for 85% of Shannon index, 93% of groundfish landings, and 89% of fleet size
- ❖ 46 vessel types present in 5 or fewer years
 - Extirpation or artifact of decision rules?
 - Loss of a rare vessel type reduces diversity
 - Loss of abundant vessel type increases diversity
- ❖ Evaluate rules for assigning vessel type
 - Low frequency of “switch” due to vessel size
 - About 25% due to gear
 - Over 60% of change in vessel type due to port group