Gillnet Harbor Porpoise Bycatch Estimates and Factors influencing Bycatch

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Objective of Presentation

1) Provide a brief summary of the observed harbor porpoise takes

2) Show the extent to which NEFOP (observer) data is representative of the entire fishery

3) Explain calculation of bycatch estimates

4) Describe bycatch modeling exercise, and factors influencing bycatch

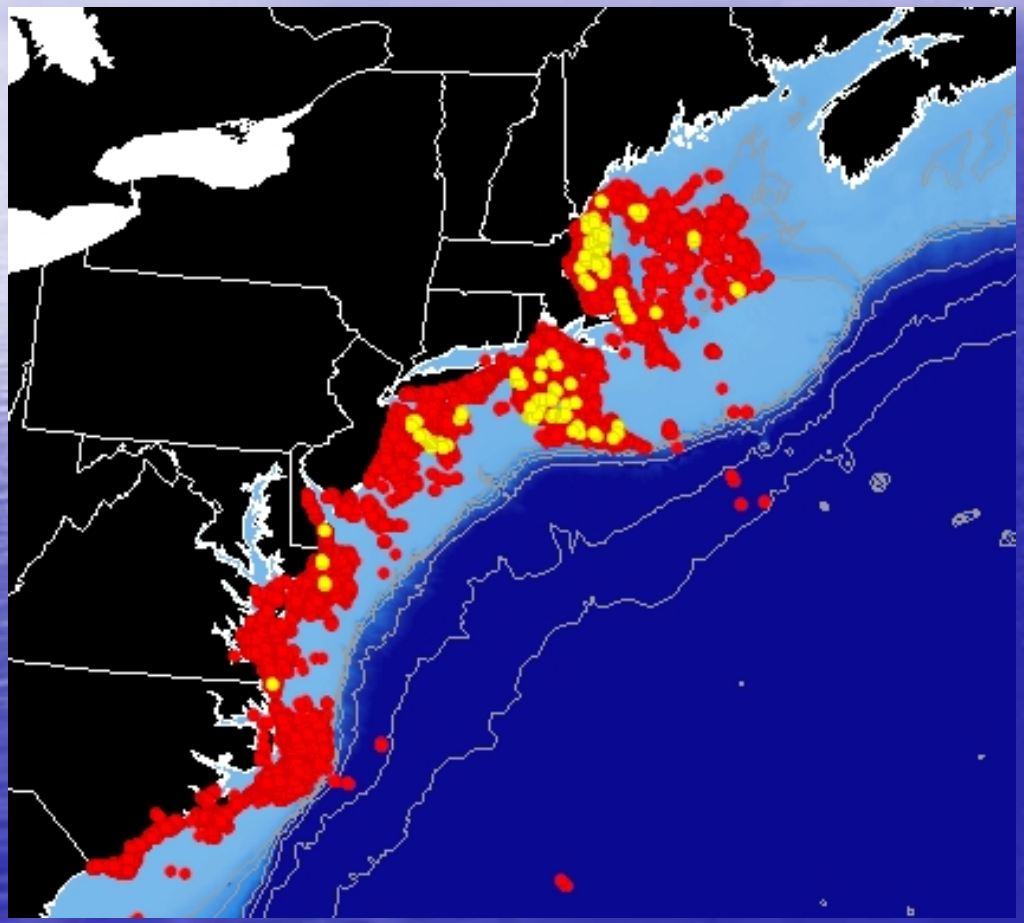
Part 1

Brief Summary of Bycatch

Summary of 1999-2006 Observed Gillnet Hauls and Harbor Porpoise Take

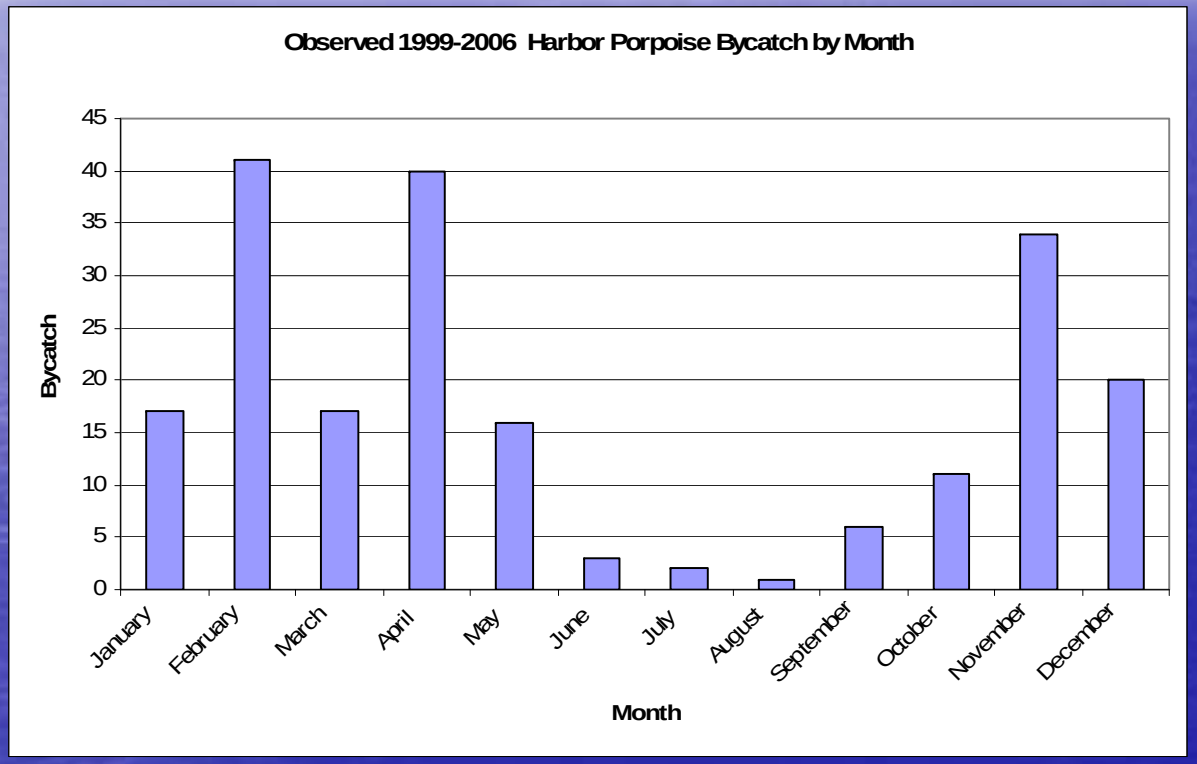
- A total of 42,519 gillnet hauls and 208 harbor porpoise takes were observed
- Of 208 observed harbor porpoise takes, 157 hauls had 1 take, 16 hauls had 2 takes, 5 hauls had 3 takes, and 1 haul had 4 takes
- 99.51% of hauls had no takes, for an overall harbor porpoise bycatch rate per haul of 0.0048
- The overall bycatch rate per metric ton fish landed was 0.025 (208/8266.851 total metric tons observed landed)

1999-2006 Observed Hauls and Observed Harbor Porpoise Take



- Observed Hauls in Red
- Observer Harbor Porpoise Takes in Yellow
- Most bycatch from Hudson Canyon area (off NJ) and further north and east

1999-2006 Observed Hauls and Observed Harbor Porpoise Take



Limited bycatch in the summer, majority from Nov.- April

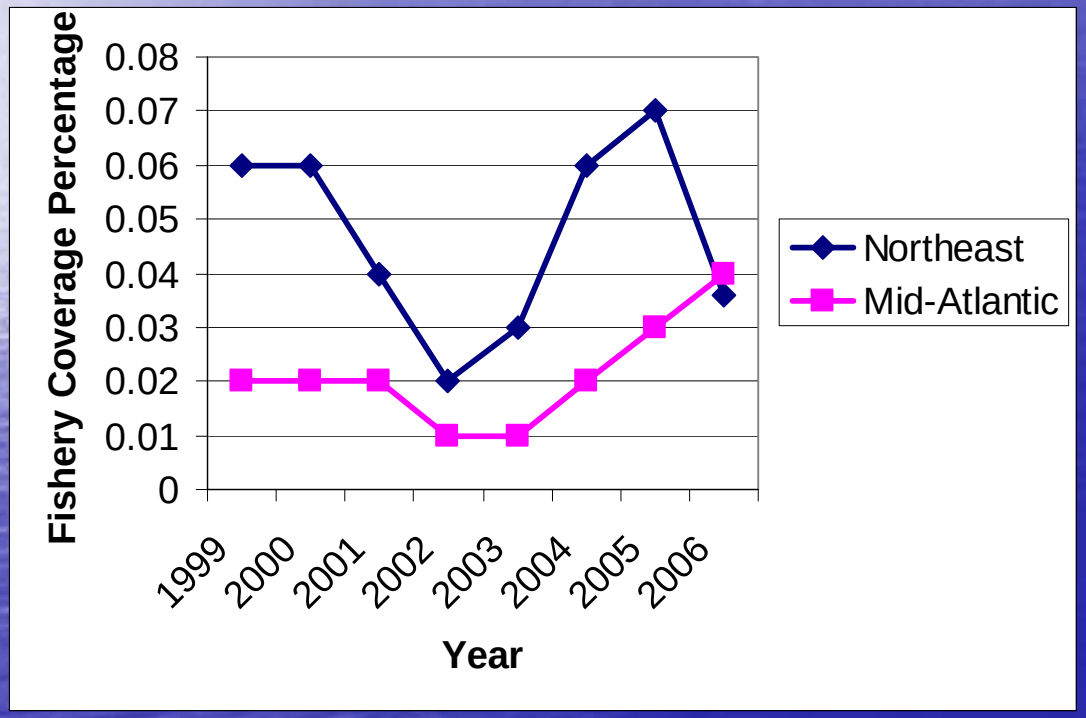
Part 2

Observer Data - Representative of the Fishery as a Whole

Data used to calculate estimates

- Observer data is the primary data source used to estimate harbor porpoise bycatch
- Observed bycatch, gear parameters, environmental factors, time and area information, all come from Observer data
- Observer data used to calculate bycatch rate, and Vessel Trip Report (VTR) and Dealer data used to expand bycatch rate into an estimate for the entire fishery

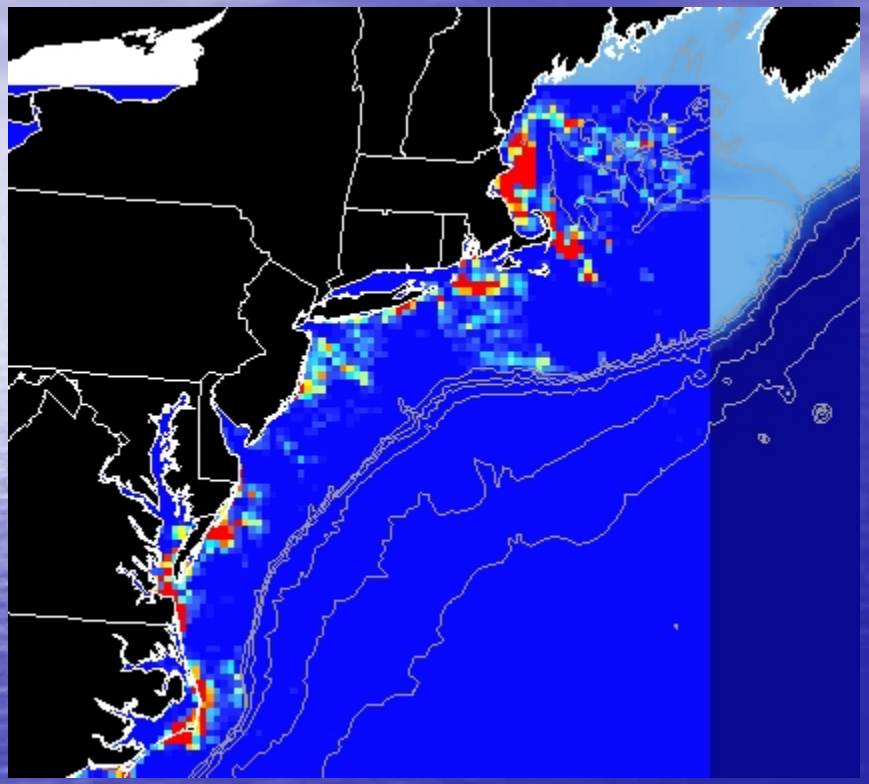
Northeast and Mid-Atlantic 1999-2006 Observer Coverage Levels



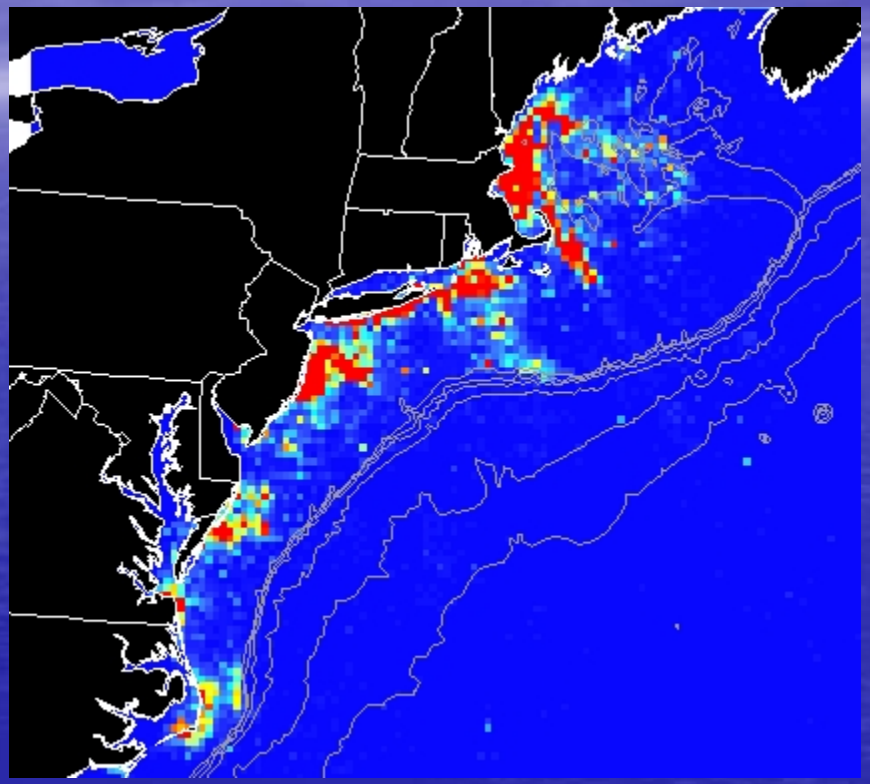
- The Northeast coverage level was consistently higher than the Mid-Atlantic until 2006.
- The mean annual Northeast observer coverage level during 1999-2006 was over twice that of the Mid-Atlantic (4.7 vs. 2.1).

Percent Coverage based on landings (metric tons)

Spatial Distribution of Observer Sampling vs. VTR Effort



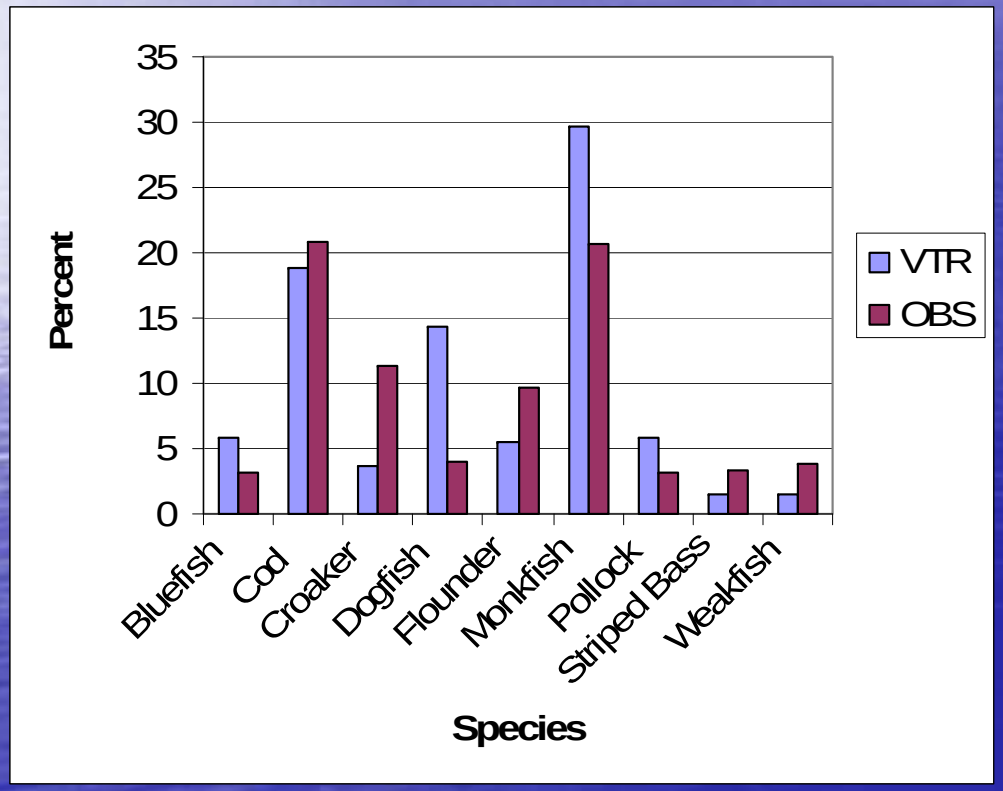
Gillnet Observer Data Haul Density, 1999-2006



Vessel Trip Report (VTR) Trip Density, 1999-2006

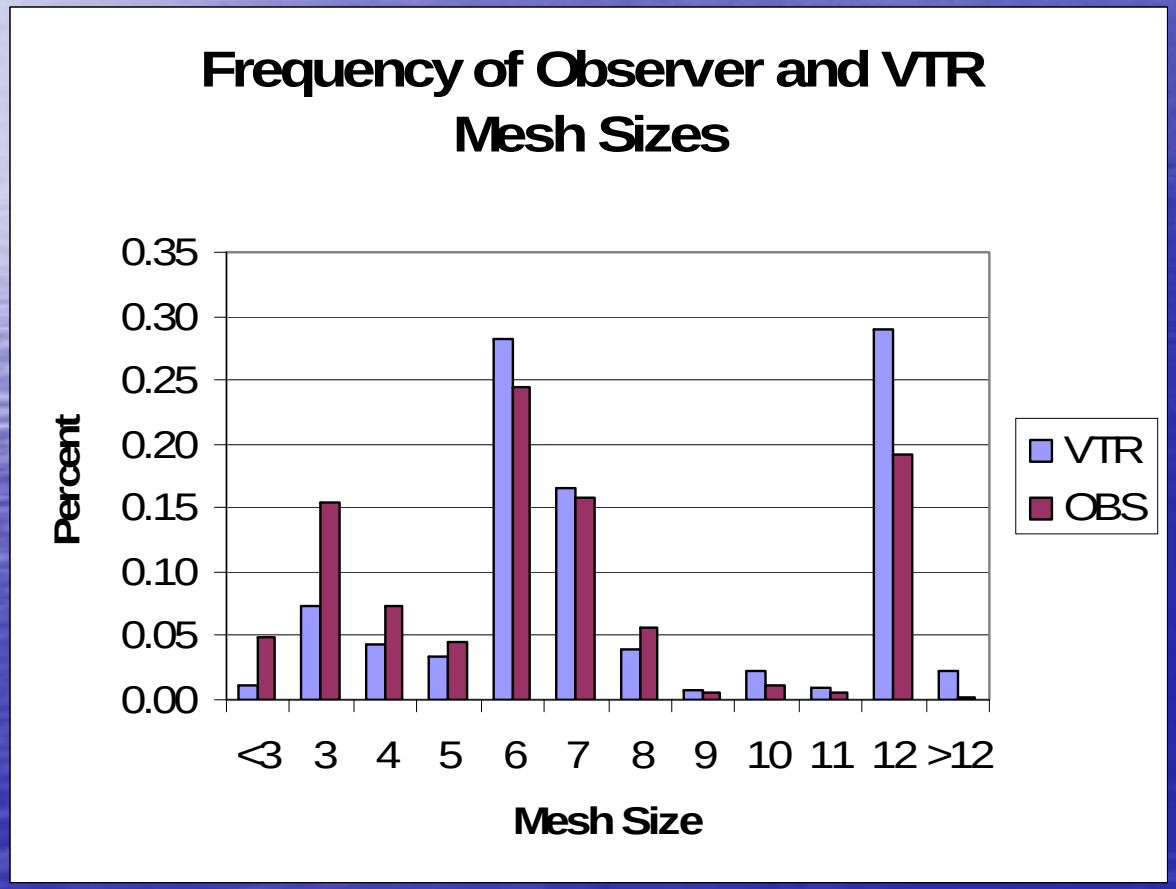
Warm colors (reds) indicate areas of higher fishing density (more effort), cool colors (blues) signify areas of lower fishing density (less effort)

VTR Main Species Caught on a Trip vs. Observed Hauls Target Species



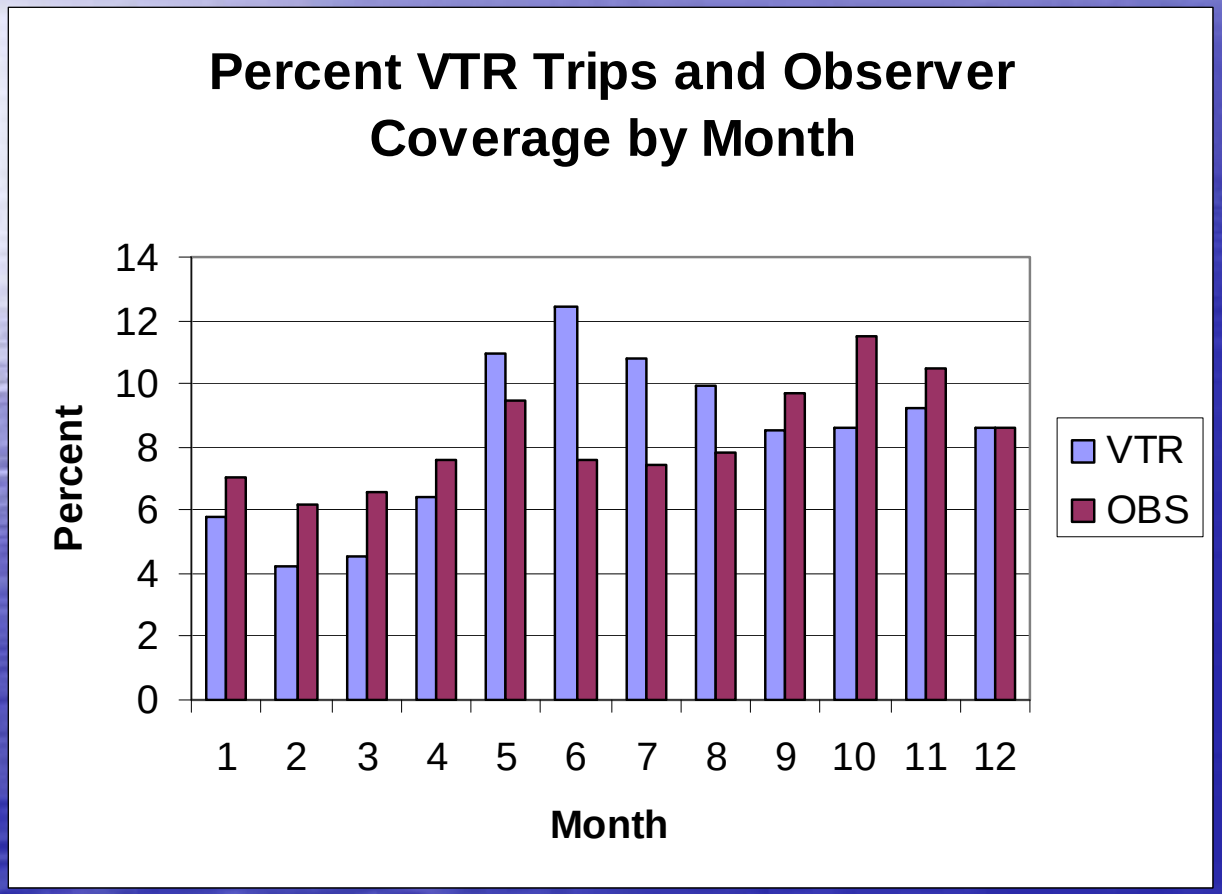
- For each VTR trip, the species with the largest amount of landings in lbs was designated the “main species” for that trip
- This VTR Main species is compared to the captain’s stated primary target species on observed hauls
- This is not a direct “apples to apples” comparison, but it does give an indication of the representativeness of the observer data sampling

Comparison of 1999-2006 Gillnet Observer and VTR Mesh Size



- Mesh size summary of all 1999-2006 observed hauls and VTR trips
- Though there are differences, the observed data does appear to reflect effort in the fishery as a whole

Monthly VTR and Observer Effort (Gillnet 1999-2006)



- The pattern of observer effort is similar to effort in the overall fishery.
- Although, effort in the fishery is highest during the late spring and summer months, while observer effort is highest in the fall.
- Observer effort was optimized for times when harbor porpoise bycatch could be observed, resulting in less coverage during the summer months and more in the fall and winter.

Part 3

Overview of Bycatch Calculation

Bycatch Estimation – The Basics

Bycatch Estimate =
Observed Bycatch Rate*Total Fishery Effort

Observed Bycatch rate =

$$\frac{\text{\# of incidental takes observed}}{\text{fishery effort observed}}$$

Total Fishery Effort =
Metric tons of fish landed

(All of the above is divided up and summed by time, area, and pinger use)

Bycatch Estimation – Stratification

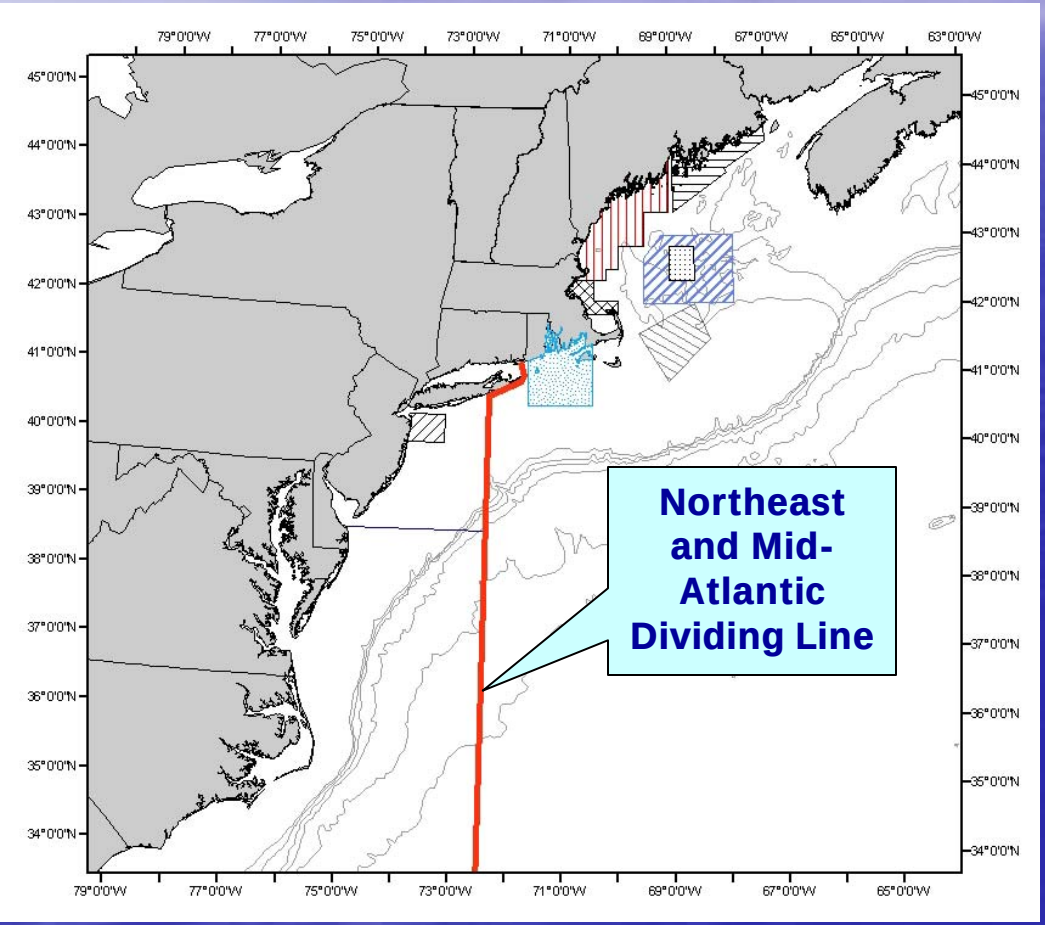
Northeast Estimates

Estimates are calculated separately by season, port group, and closure times and areas

Mid-Atlantic Estimates

- Estimates have been historically calculated by state, month, and year
- Because of increased observed bycatch in 2005 and 2006, estimates were calculated by state, season, and year

Bycatch Estimation – Stratification



- Prior to the 2005 estimates, dividing the Northeast and Mid-Atlantic was by state, separated at CT and RI
- 2005 estimates included CT in the Northeast
- The current estimates (2006) divide the Northeast and Mid-Atlantic spatially, to matches with the List of Fisheries definition

Bycatch Estimation – Stratification

Northeast Estimates Stratification

Northeast Port-Area Groups

Northern Maine, Southern Maine, New Hampshire, North of Boston, South of Boston, South of Cape Cod, East of Cape Cod, and Offshore

Northeast Closure Groups

Offshore, Cashes Ledge, Midcoast, Mass Bay, Cape Cod Bay, South Cape, and Great South Channel

Seasons

Fall (Sep-Dec), Winter (January – May), Summer (Jun-Aug)

Bycatch Estimation – Example

Winter 2006	Observed Hauls	Observed Tons	Prorated Dealer Tons	Observed Bycatch	Bycatch Rate	Estimated Bycatch
South of Boston	96	11.45	437.41	1	0.087	38

Bycatch rate = observed bycatch / observed tons

(0.087 = 1 / 11.45)

Bycatch estimate = bycatch rate * metric tons of effort

(38.05 = 0.087 * 437.41)

For areas with pingers, a weighted bycatch rate is calculated based on what percentage of hauls had pingers on their nets

Bycatch Estimation Example

- **Estimates by area and season are then summed for a total bycatch estimate**

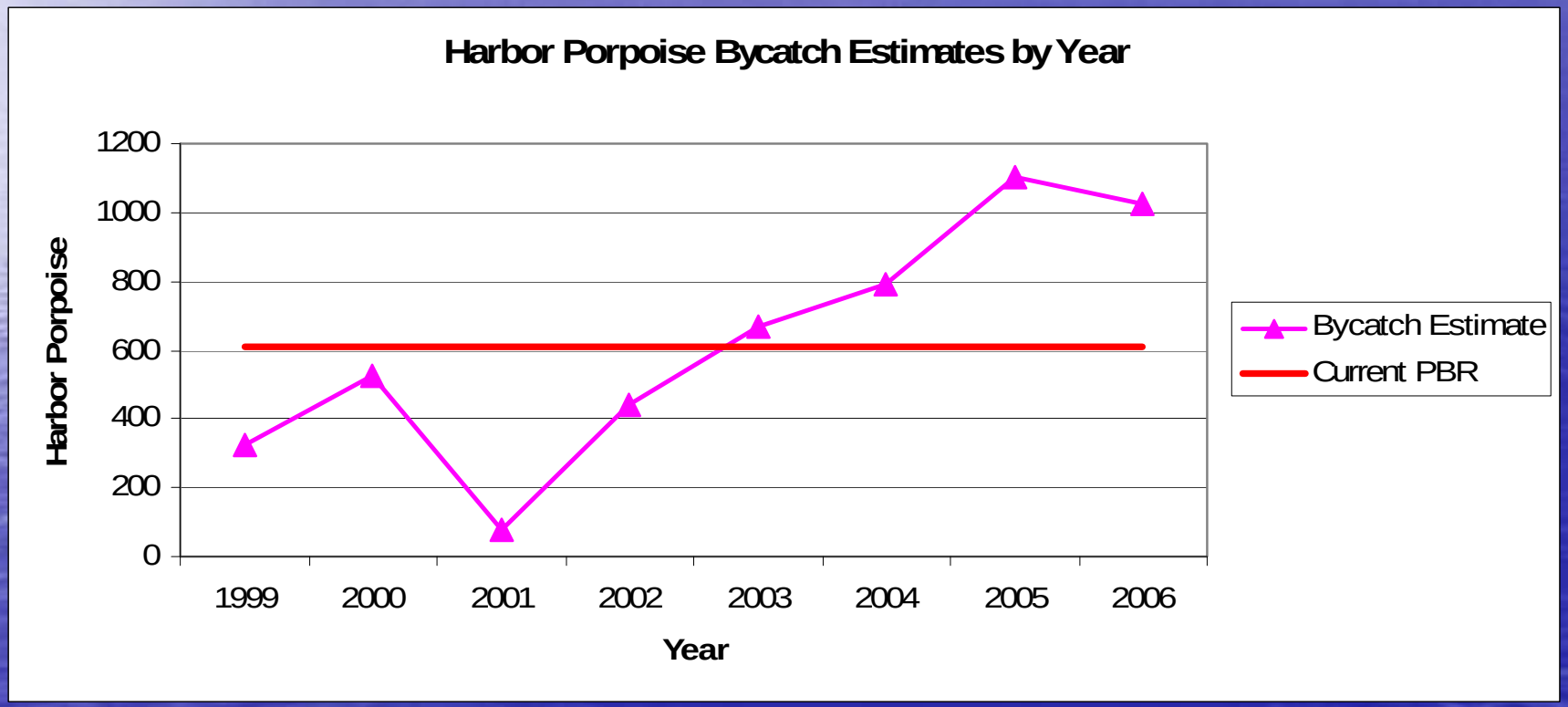
- **Mid-Atlantic is done the same way, except state is substituted for port group-closure areas, and pingers do not play a role**

Belden D and C. Orphanides. Estimates of Cetacean and Pinniped Bycatch in the 2006 Northeast Sink Gillnet and Mid-Atlantic Coastal Gillnet Fisheries

2006 Winter (Jan-May)	Observed Takes	Bycatch Rate (Take/MTon)	Estimated Takes	C.V. (%)	95% C.I.
Port Group-Area Strata					
Northern Maine	0	0.000	0		
Southern Maine	0	0.000	0		
New Hampshire	0	0.000	0		
North of Boston	3[b]	0.111[c]	50	71%	3-124
South of Boston	1[b]	0.087	38	99%	1-128
South Of Cape Cod[d]	13[b]	0.188	265	48%	52-561
East Of Cape Cod	0	0.000	0		
Offshore	0	0.000	0		
Closure Strata					
Offshore Closure	0	0.000	0		
Cashes Ledge Closure	0	0.000	0		
Midcoast Closure	0	0.000	0		
Mass Bay Closure	0	0.000	0		
Cape Cod Bay Closure	0	0.000	0		
South Cape Closure[d]	5[b]	0.095[c]	67	80%	5-188
Great S. Channel Closure	0	0.000	0		
Subtotal	22		420	36%	168-740
Summer (Jun-Aug)	**Observed Takes**	**Bycatch Rate (Take/MTon)**	**Estimated Takes**	**C.V. (%)**	**95% C.I.**
Port Group-Area Strata					
Northern Maine	0	0.000	0		
Southern Maine	0	0.000	0		
New Hampshire	1[b]	0.092	37	108%	1-134
North of Boston	0	0.000	0		
South of Boston	0	0.000	0		
South Of Cape Cod[d]	0	0.000	0		
East Of Cape Cod	0	0.000	0		
Offshore	0	0.000	0		
Closure Strata					
Northeast Closure	0	0.000	0		
Great S. Channel Closure	0	0.000	0		
Subtotal	1		37	108%	1-134
Fall (Sep-Dec)	**Observed Takes**	**Bycatch Rate (Take/MTon)**	**Estimated Takes**	**C.V. (%)**	**95% C.I.**
Port Group-Area Strata					
Northern Maine	0	0.000	0		
Southern Maine	0	0.000	0		
New Hampshire	0	0.000	0		
North of Boston	1[b]	0.081[c]	31	104%	1-110
South of Boston	0	0.000	0		
South Of Cape Cod[d]	0	0.000	0		
East Of Cape Cod	0	0.000	0		
Offshore	0	0.000	0		
Closure Strata					
Northeast Closure	0	0.000	0		
Offshore Closure	0	0.000	0		
Midcoast Closure	2[a]	0.035[c]	26	71%	2-69
Mass Bay Closure	0	0.000	0		
South Cape Closure[d]	0	0.000	0		
Subtotal	3		57	66%	1-143
2006 Total	26		514	31%	236-863

[a] Observed take from haul equipped with pingers.
[b] Observed take from haul not equipped with pingers.
[c] A weighted bycatch rate (observed hauls with and without pingers were used to calculate a weighted bycatch rate)
[d] Totals for South of Cape Cod port group and closure stratum includes effort from Connecticut and New York trips that fished east of 72º30'W.

1999-2006 Harbor Porpoise Bycatch Estimates and PBR



Part 4

Bycatch Modeling and Factors Influencing Bycatch

Bycatch Modeling - Overview

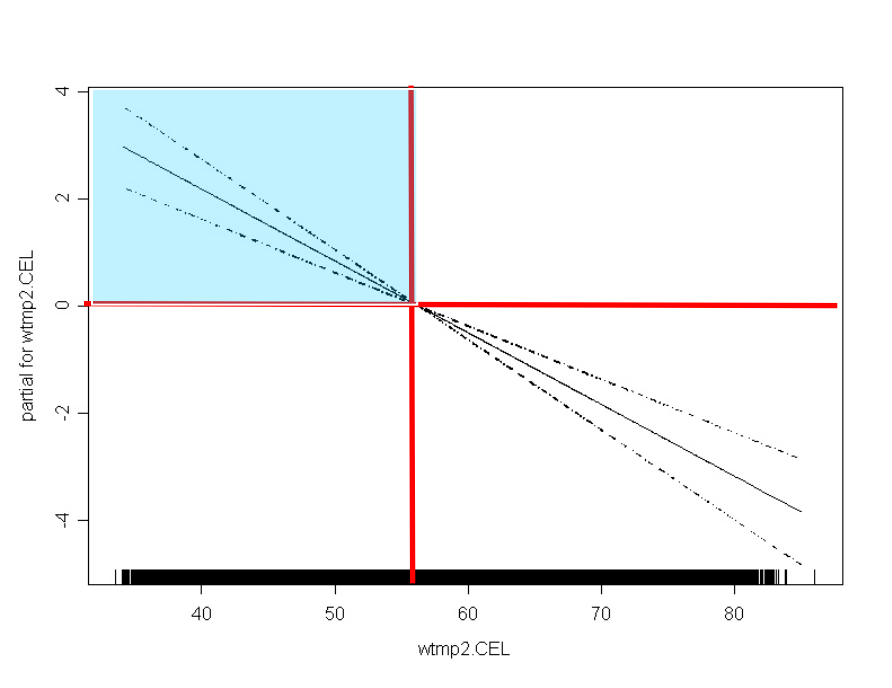
- Observer data was used to model harbor porpoise gillnet bycatch to better understand reasons for bycatch
- Generalized Linear Models (GLM), Generalized Additive Models (GAM), and classifications trees were used to assess impact on bycatch
- Found suite of variables that best predict bycatch together, and others that had significant relationships with bycatch

Bycatch Modeling – Model Selection

- A model was developed to find the variables that best predicted observed bycatch
- The Model was created using a GAM with a forward stepwise process
- Landings were used as the unit of effort and the suite of variables that best predicted observed bycatch included water temperature, depth, mesh, closures, and year

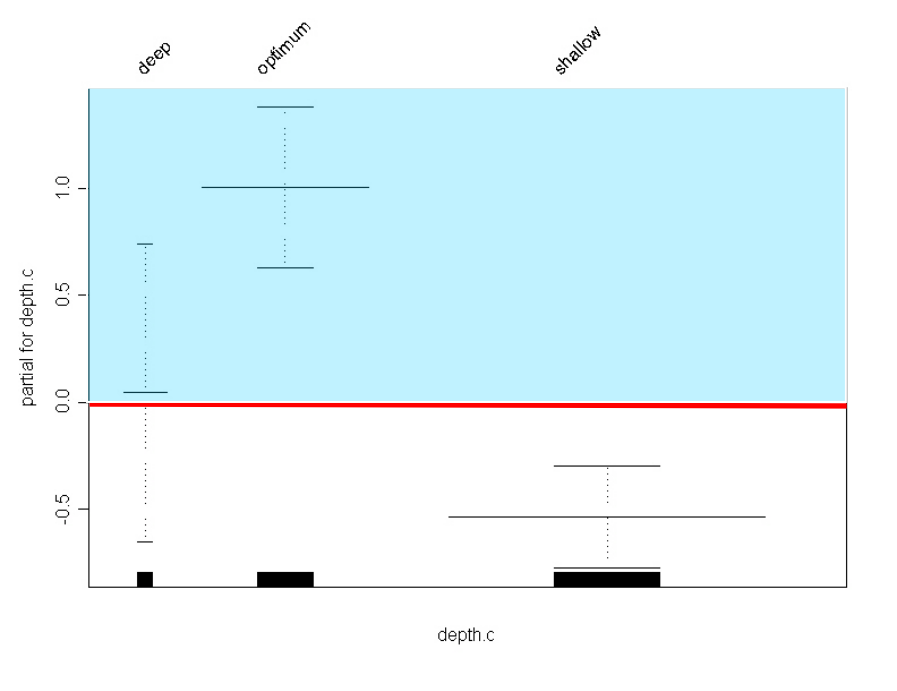
```
model <- glm(take~offset(log(fshkept/2204.62262 + 0.001))
                    + wtmp2 + depth.c + mesh.c + closure.all.c2 + year.c2,
                    family=quasi(link=log, var=mu),
                    data=wdf.9906.obsv.4cv, na.action=na.exclude,
                    control=gam.control(maxit=50))
```

Bycatch Modeling – Variable Plots

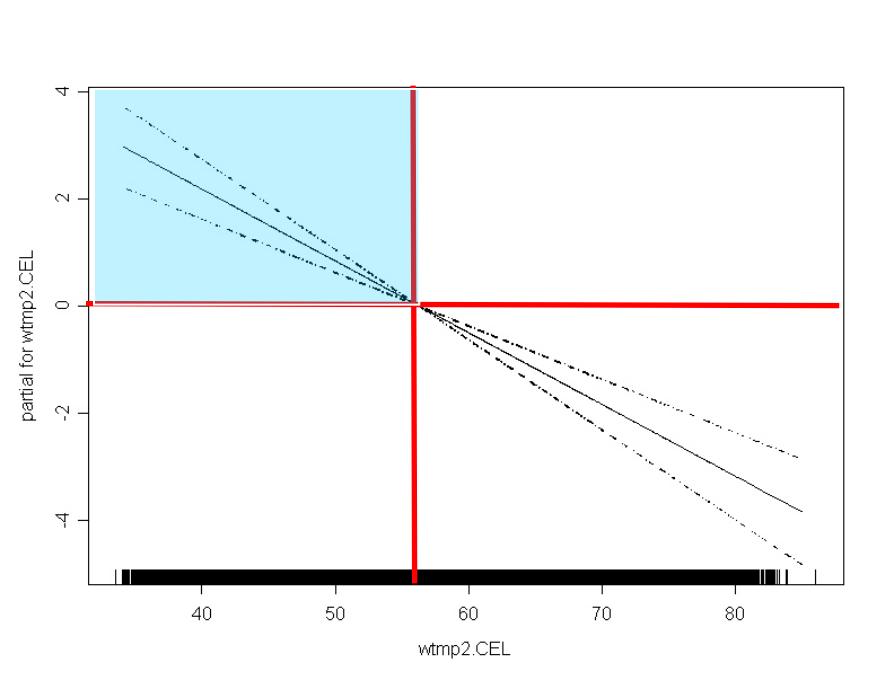


Water Temperature (F)

Areas above zero on the y-axis have an above average chance of harbor porpoise bycatch and the chance increases the further a point gets from zero



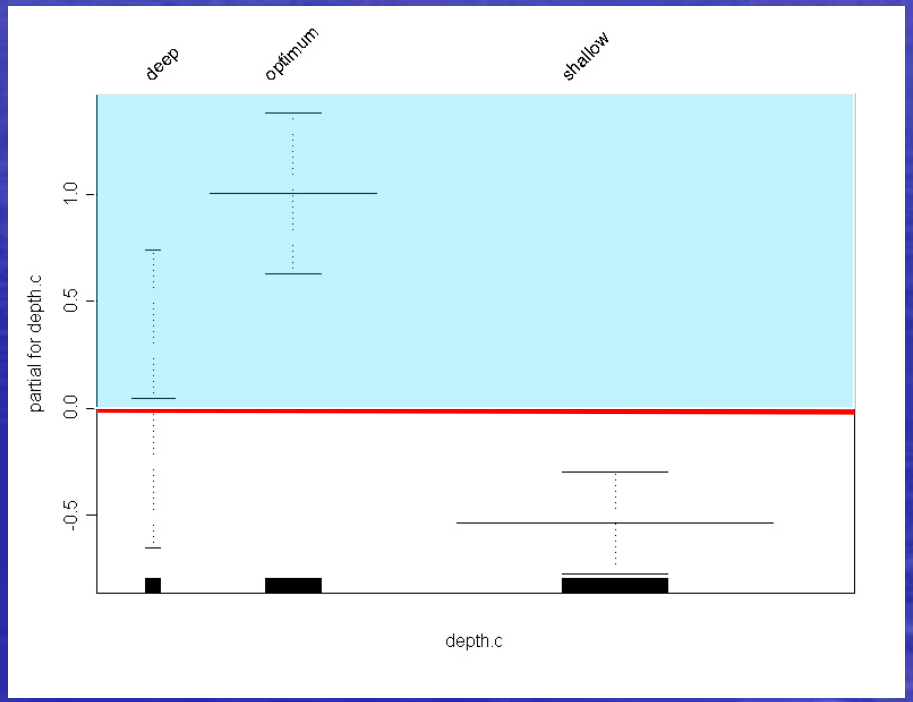
Bottom Depth Categories



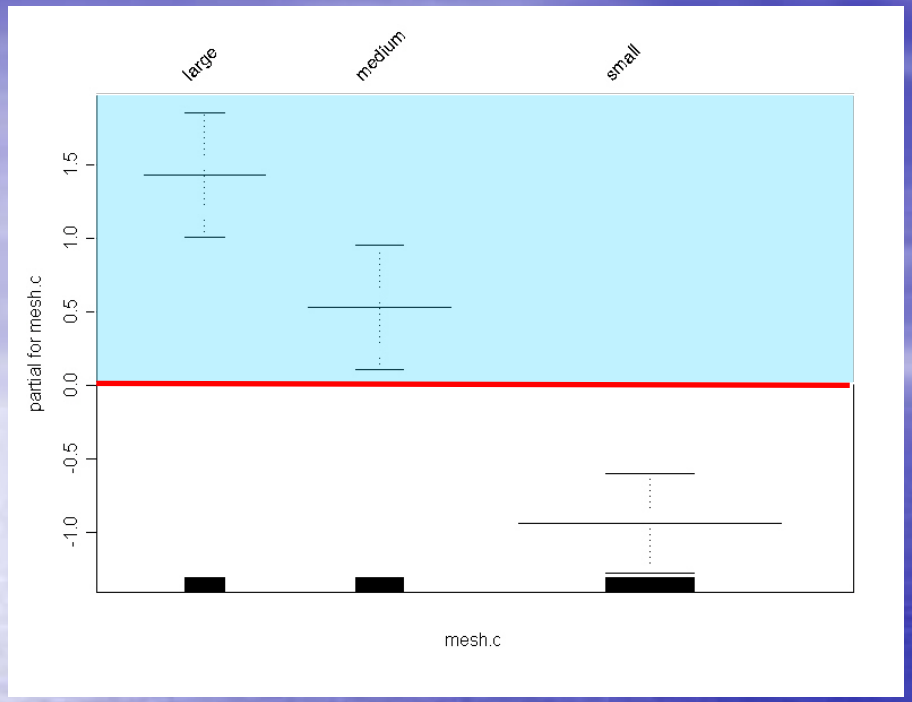
Water Temperature (F)

- Chance of bycatch increases with colder water and is greater than average when colder than than ~56° F

- The three depth categories are split at 50 and 110 meters
- Chance of bycatch is greatest when between 50 and 110 meters bottom depth (164 - 360 ft, or 27 - 60 fathoms)



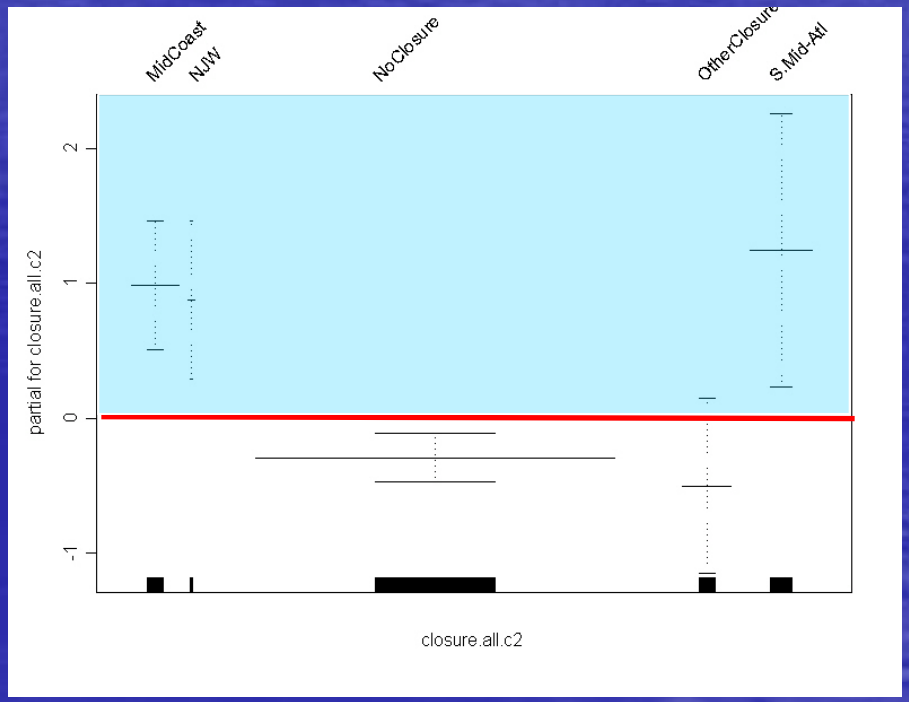
Bottom Depth Categories



Mesh Size Categories

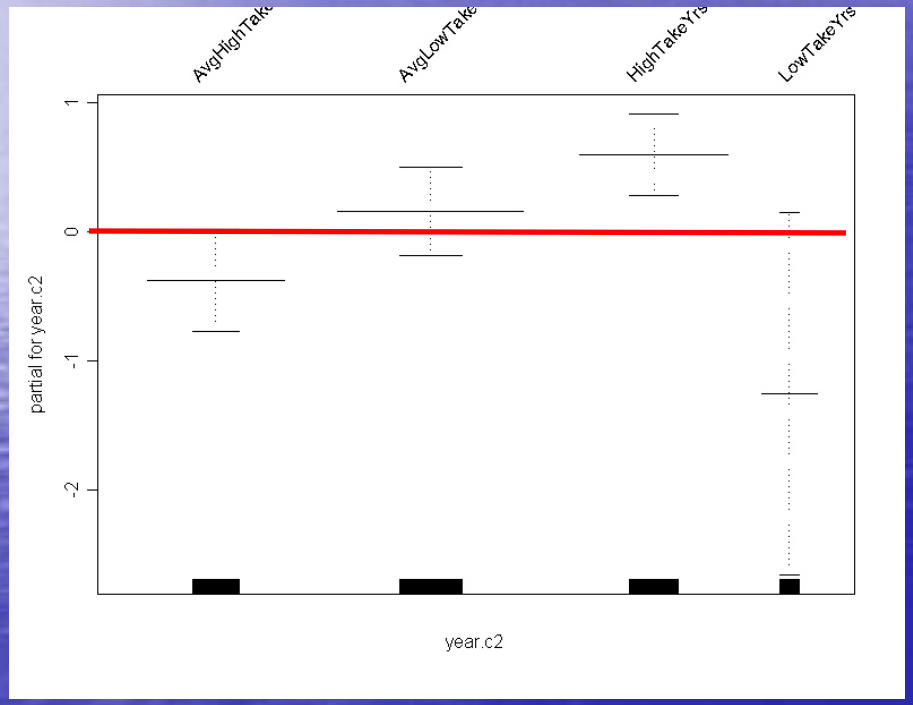
- Chance of bycatch increases with larger mesh. Mesh sizes are split at 6.535 and 9.15 inches

- Midcoast and NJ waters have high chances of bycatch, other closures combined, and areas with no closures have less than average chance of bycatch
- The high Southern Mid-Atlantic value is likely compensating for a lack of good predictor variables for this area in the rest of the model



Closures

Bycatch Modeling – Model Plots



Year categories

- **LowTakeYrs:**
- **2001**
- **HighTakeYrs: 2005, 2006**
- **AvgLowTakeYrs: 2002, 2004**
- **AvgLowTakeYrs: 1999, 2000, 2003**

Bycatch Modeling – Variable Plots

- Additional variables were also found to have a significant relationship with bycatch
- Among the variables not found in the model, the most significant included: port, soak duration, season, state, month, and statistical area.
- These variables point to the importance of time and area as factors in bycatch
- Additional variables can be seen on the following slide

Bycatch Modeling – Variables Tested and Significant

FISHING CHARACTERISTICS

- Pingers*
- Number of Nets*
- String Length*
- Net Length
- Mesh Size*
- # of Vertical Meshes*
- Twinesize*
- Net Material
- Hang ratio
- # Strands
- Floats Used
- # of Floats Used
- Tie Downs Used*
- Tied Down Length
- Space Used*
- # Spaces*

FISHING CHARACTERISTICS

- Soak Duration*
- Drop line used
- Anchor used*
- Net color*
- Set Method*
- Gear type*
- Target Species*

ENVIRONMENT

- Water Temperature*
- Water Temp Anomaly
- Depth*
- Bottom Slope
- Wind Speed
- Wind Direction
- Wave Height
- Surface Chlorophyll

TIME

- Month*
- Quarter*
- Season*
- Day of Year*
- Days Absent

LOCATION

- State*
- Ten Minute Square*
- Statistical Area*
- Latitude*
- Longitude*
- Port/Port group*
- Region

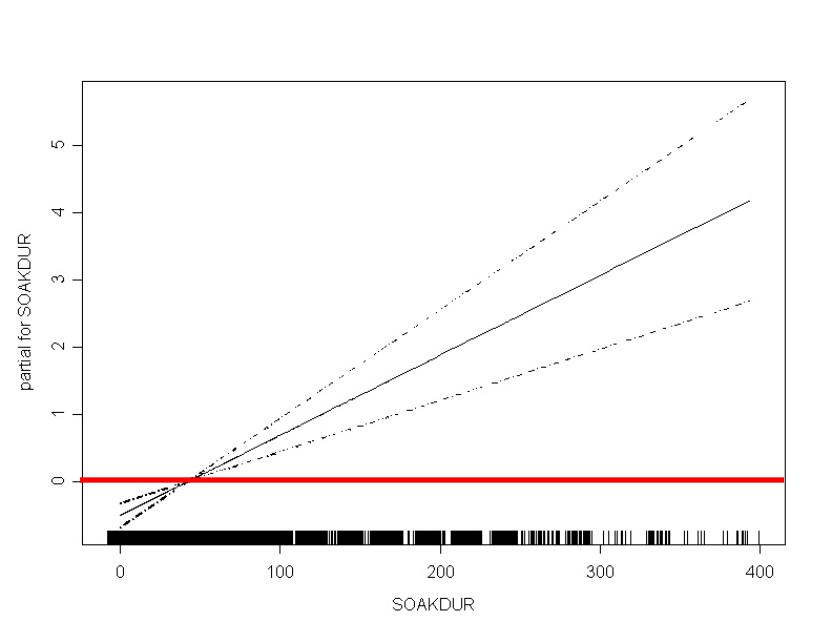
OTHER

- Vessel Length*
- Vessel Gross Tons
- Type of Observed Trip*

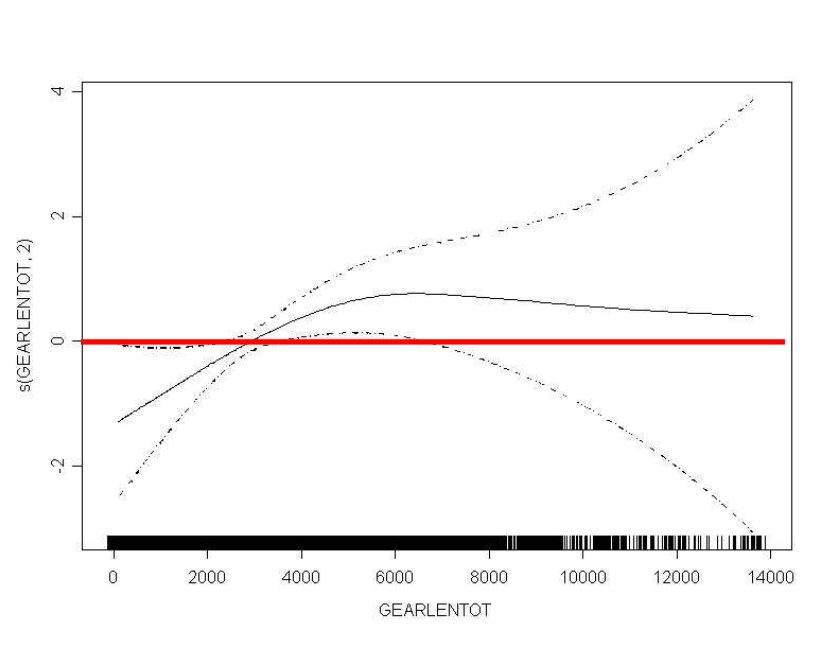
* Indicates significant relationship

Bycatch Modeling – Variable Plots

Fishing Characteristics



Soak Duration

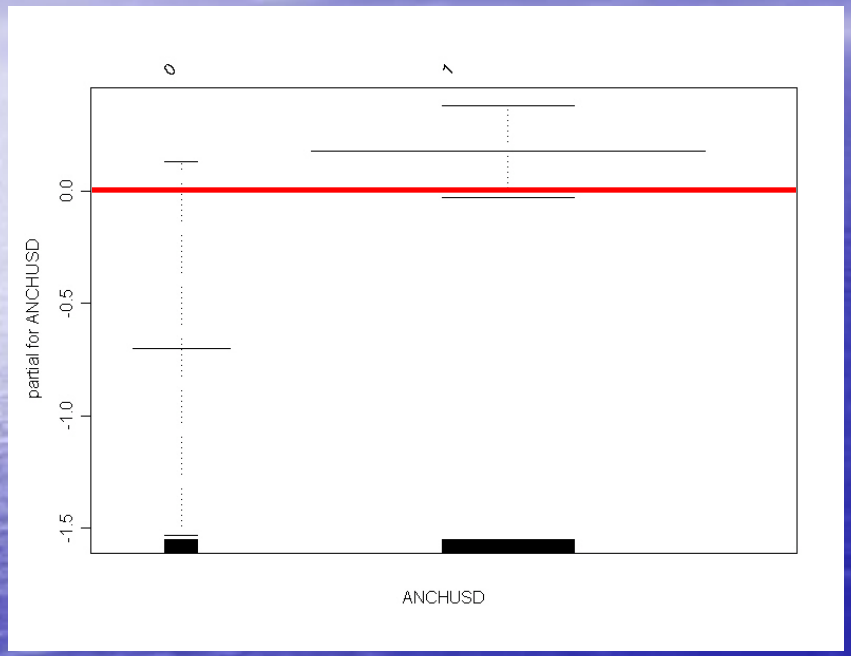


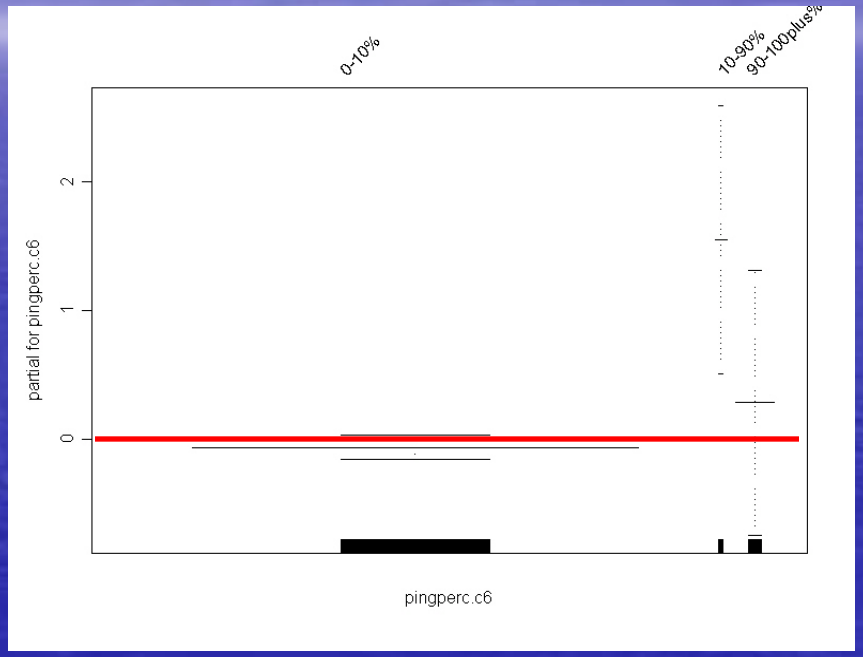
String Length

- Chance of bycatch increases with increased soak time and string length

Bycatch Modeling – Variable Plots

Fishing Characteristics





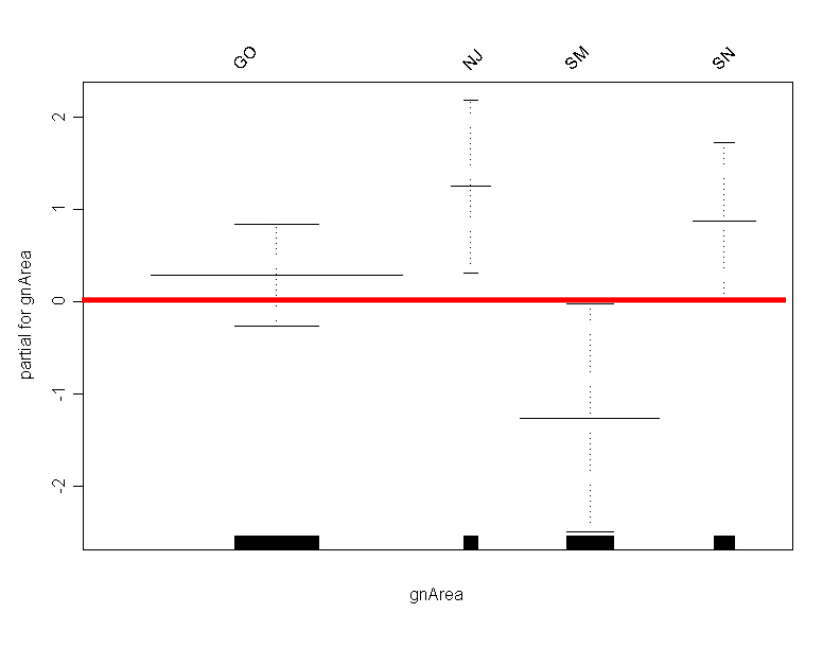
Anchors Used (0=No, 1=Yes)

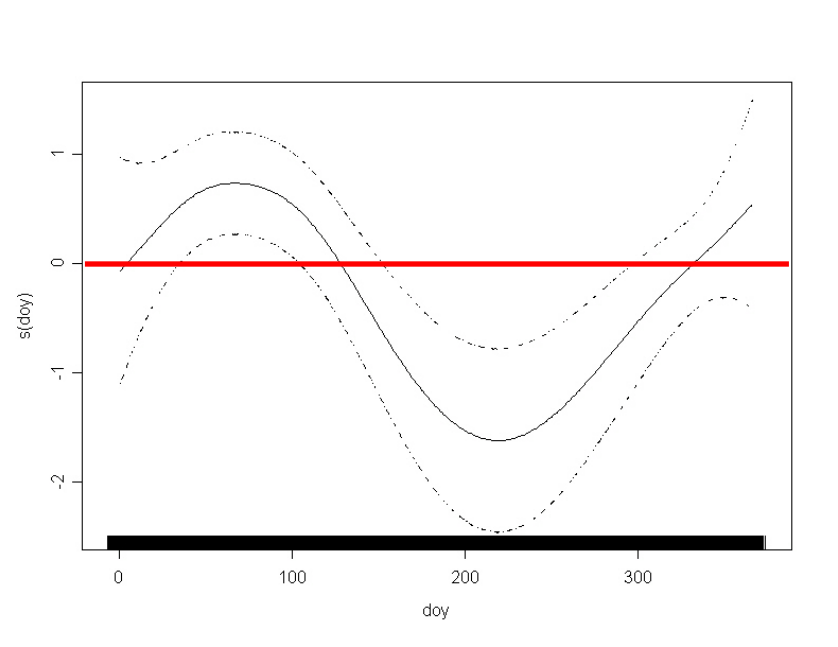
Pinger Compliance

- Many gear parameters had a relationship with bycatch, including using anchors and pingers. Interpretation of gear variables can be difficult because they may be closely tied to other factors such as time and area

Bycatch Modeling – Variable Plots

Time and Area





Region

Day of Year

- Bycatch is heavily influenced by time and area

(GO= Gulf of Maine, NJ = New Jersey, SM = Southern Mid Atlantic, SN = South of New England)