

# Marine Mammal Mortality Estimates

By

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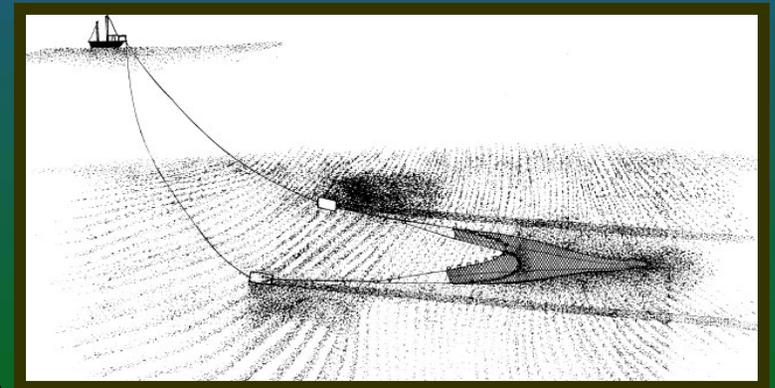
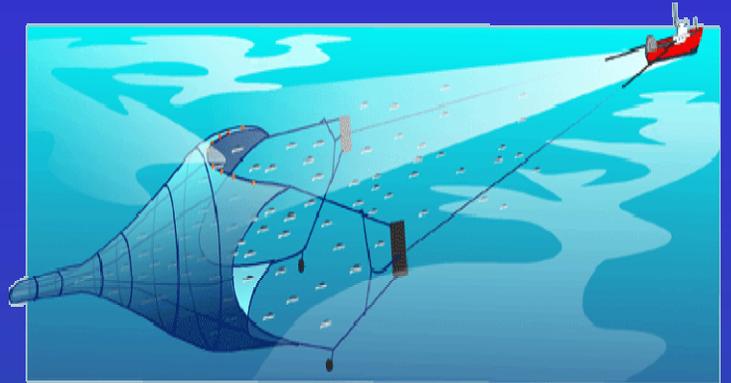
# Overview

- **Debi**

- Overview of bycatch estimation method: 2000-04
- Specifics for mid-water trawl estimates

- **Marjorie**

- Specifics for bottom trawl estimates
- Takes from 2005 and 2006



# PBR and bycatch estimate (CV) average for 2000 - 2004



Species	Strategic ?	PBR	Total Bycatch	NE Bottom	NE Midwat	MidAtl Bottom	MidAtl Midwat	JV and TALFF
Common D.	No	1000	101 (0.12)	33 (0.19)	0	68 (0.15)	0	0
Pilot W. spp	No	249	113 (0.24)	10 (0.23)	9.4 (0.55)	12 (0.22)	0.8 (0.74)	11
White-sided D.	No	379	197 (0.09)	130 (0.09)	1.1 (0.58)	25 (0.10)	15 (0.38)	2
Harbor P.	No	747	473 (0.17)	0	0	0	0	0
Minke W.	?	31	2.8+	1+	0	0	0	0

# Steps in estimation method

- I. Estimate bycatch rate and its level of variance [coefficient of variation (CV)]

$$\text{bycatch rate} = \frac{\text{number of dead animals}}{\text{unit of fishing effort}}$$

Observer data used in this step

# Steps in estimation method

## II. Expand bycatch rate to entire fishery

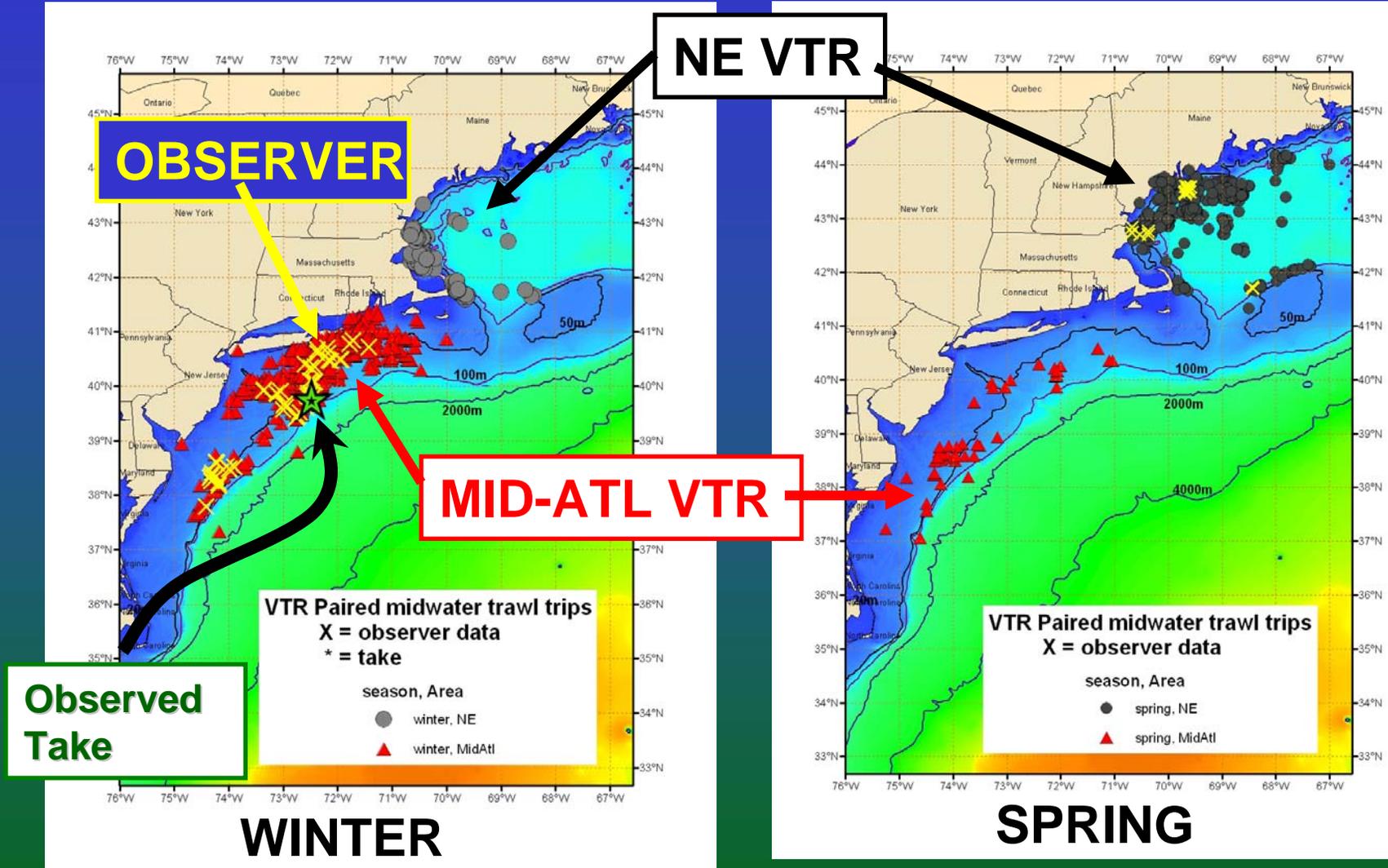
Total bycatch estimate

= bycatch rate \* total effort

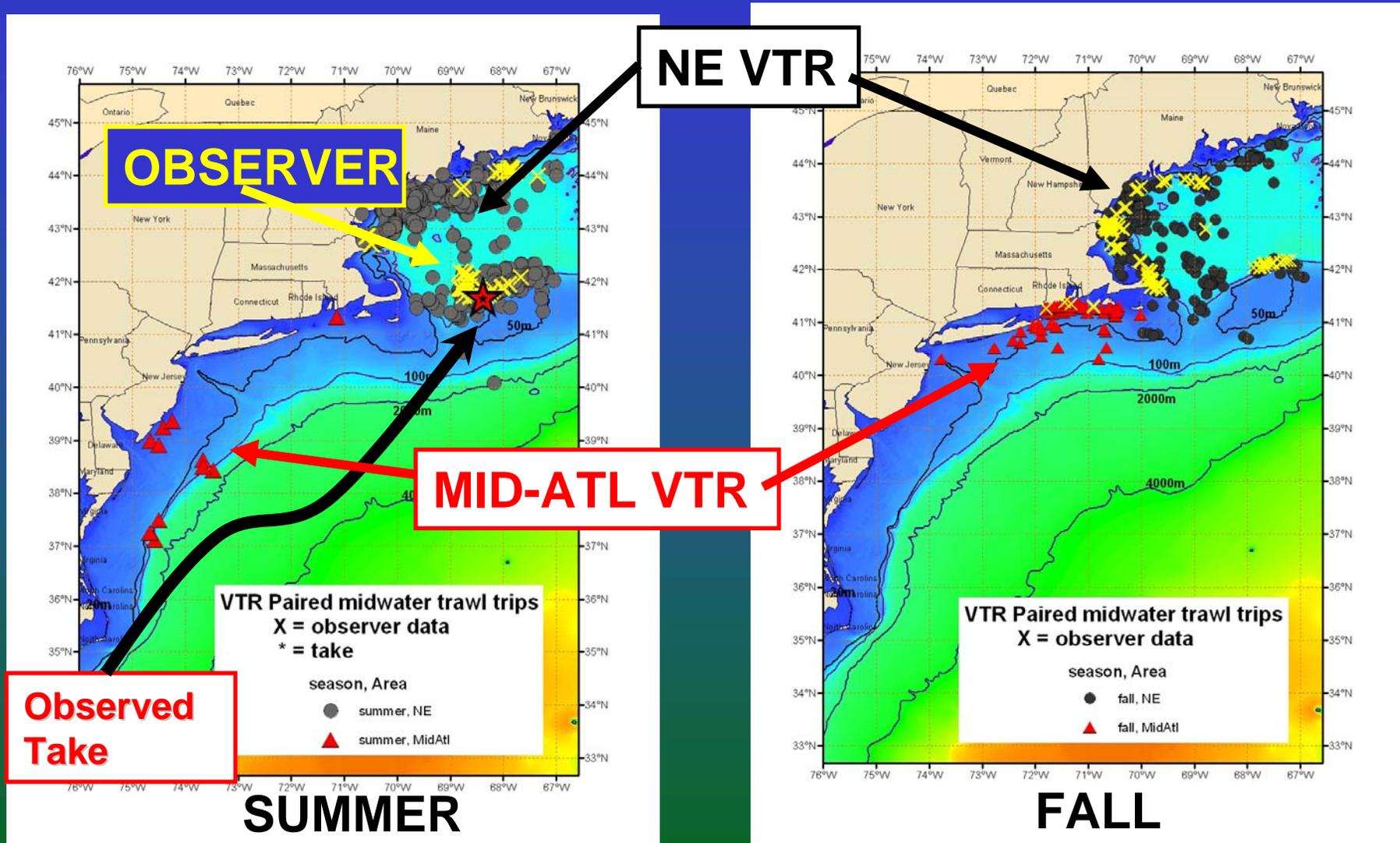
=  $\frac{\text{number of dead animals}}{\text{days fished}} * \text{total days fished}$

Vessel Trip Report (VTR) data used for total effort

# Midwater pair trawl VTR & observer data



# Midwater pair trawl VTR & observer data



# I. Estimate Bycatch Rate Strategy

- Goal is to divide the fishing hauls into groups (stratum) that have similar bycatch rates
- Use regression model to define strata, where strata could be:
  - **Spatial/temporal**  
(north vs south, season)
  - **Environmental**  
(bottom depth or slope, SST)
  - **Gear characteristics**  
(mesh size, main species)

# Steps in analysis

## I. Estimate bycatch rate using regression model

1. Determine appropriate subset of data
2. Define bycatch rate
3. Define potential predictor variables
4. Choose best model
5. Predict bycatch rate

# Takes in observed mid-water trawl 1993-2004

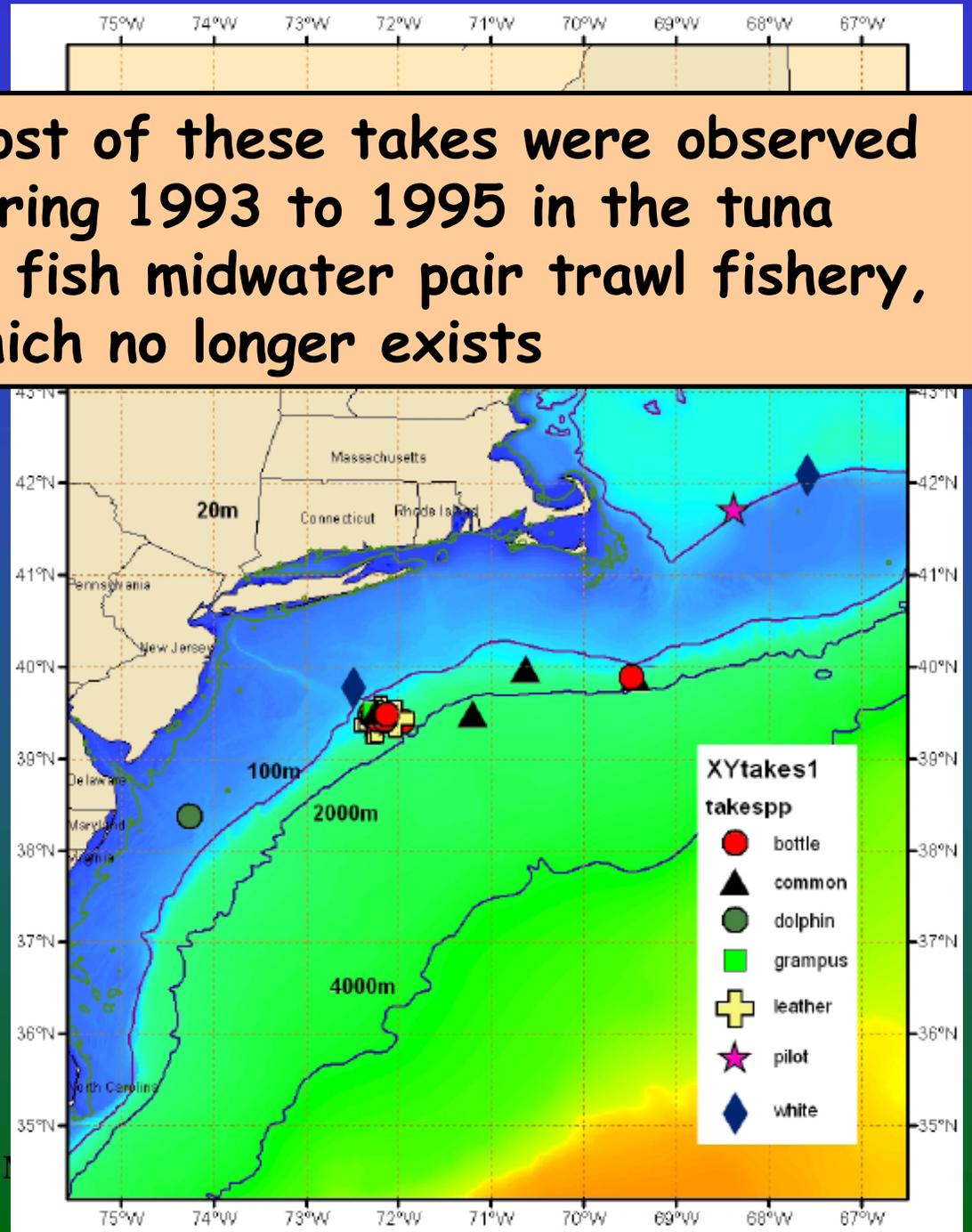
*paired:*

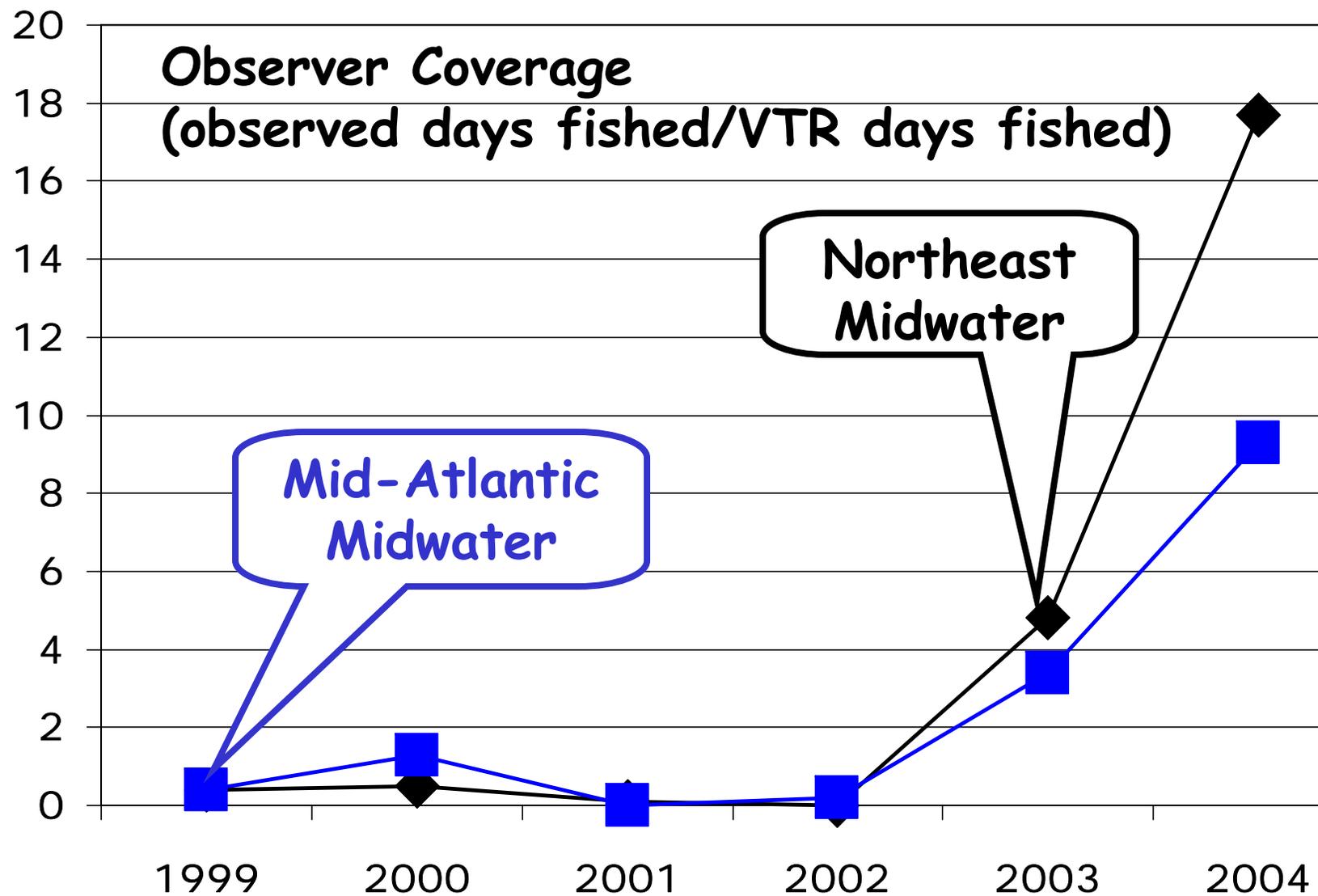
- 5 leatherback T.
- 29 bottlenose D.
- 9 common D.
- 20 pilot W.
- 2 Risso's D.
- 1 white-sided D.

*Single:*

- 1 white-sided D.
- 1 unknown D.

Most of these takes were observed during 1993 to 1995 in the tuna or fish midwater pair trawl fishery, which no longer exists

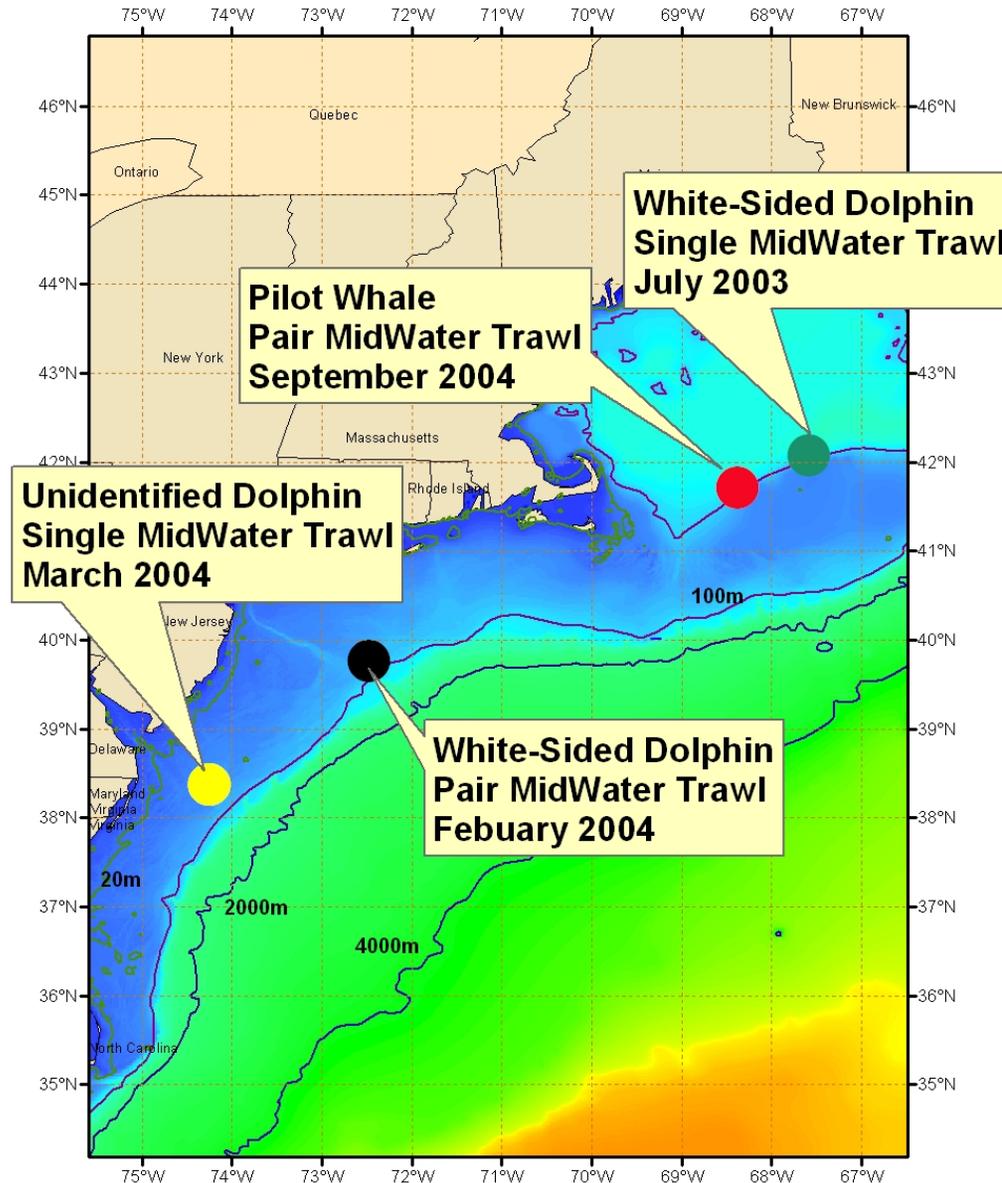




## Mid water trawl during 2003 and 2004

Target species	Number of observed trips			Cetacean takes	Number of trips in VTR			%Observer coverage	
	NE	MidAtl	Total		NE	MidAtl	Total	NE	MidAtl
Finfish	3	0	3	0	67	64	131	4.5	0.0
Herring	121	4	125	2 <sup>1</sup>	1575	287	1862	7.7	1.4
Mackerel	0	18	18	2 <sup>2</sup>	4	452	456	0	4.0
Squids	0	12	12	0	0	5	5	0	??
<b>TOTAL</b>	124	34	158	4	1646	808	2454	7.5	4.2

# Observed takes in midwater trawls during 2003 & 2004



## 2. Define bycatch rate

$$= \frac{\text{number of dead animals}}{\text{amount of effort}}$$

### Mid-water trawl

- All cetaceans

### Bottom trawl

- Each species separately

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Unit of effort = Days fished =  
time trawl net was in the water,  
expressed as part of a day

### 3. Define potential predictor variables

Predictor variables are observer data variables that are used to find gear characteristics/fishing practices that are correlated with cetacean bycatch

#### MID-WATER EXAMPLE

##### SPACE

- NE vs MidAtl
- State landed
- Statistical Area

##### TIME

- Month
- Season
- Year

##### FISHING PRACTICES

- Tow speed
- Target species
- Pair vs single

##### ENVIRONMENTAL

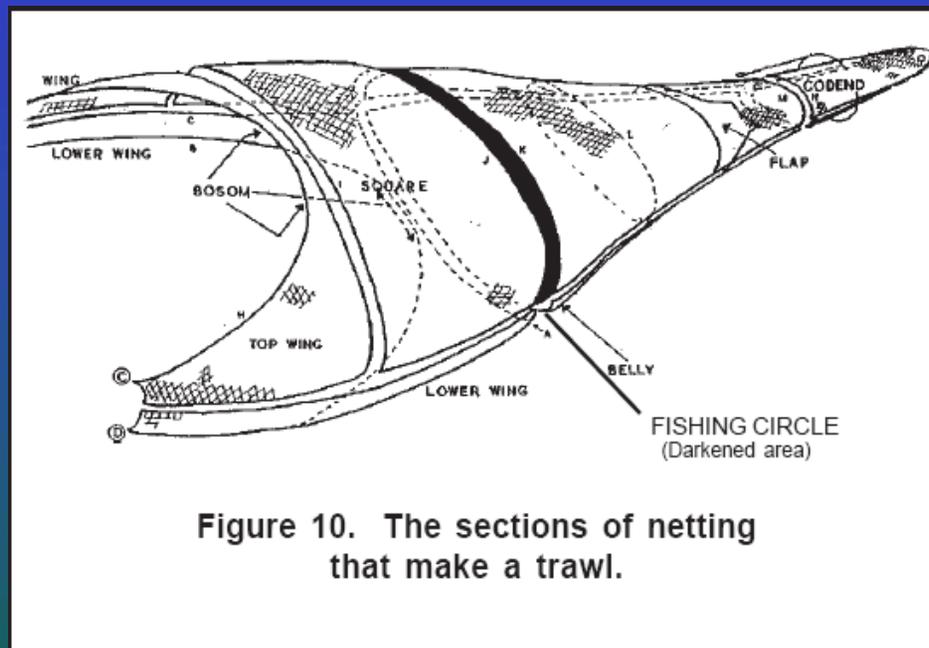
- Bottom slope
- Bottom depth
- Sea surface temp
- Wind speed

### 3. Define potential predictor variables

## MID-WATER EXAMPLE

### GEAR CHARACTERISTICS

- Net design
- Wireout
- Kite panels used
- Net material
- Codend material
- Codend liner used?
- Codend strengthen used?
- Codend chaffing lines used?



## 4. Choose best logistic model

$$\text{logit}(p_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \log(\text{effort}) + \beta_0 + f_1x_1 + f_2x_2 + K + f_ix_i$$

- $p$  = probability of a take
- $f$  = linear or non-linear parameter value
- $X$  = potential predictor variable

## 4. Choose best logistic model

### MID-WATER EXAMPLE

$$\text{logit}(p_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \log(\text{effort}) + \beta_0 + f_1x_1 + f_2x_2 + K + f_ix_i$$

#### Cetacean model for mid-water trawl

- Probability of a take (p) was a binomial distribution (0 or 1)
- Used linear (GLM) and non-linear (GAM) model to describe relationship between the probability of a take and a predictor variable
- Used corrected Akaike Information Criteria (AICc) to choose best model
- Used stepwise selection methods
- Results
  - Bottom slope ( $<0.5^\circ$ ,  $\geq 0.5^\circ$ )
  - Main species (herring, mackerel)

## Mid-water trawl fisheries

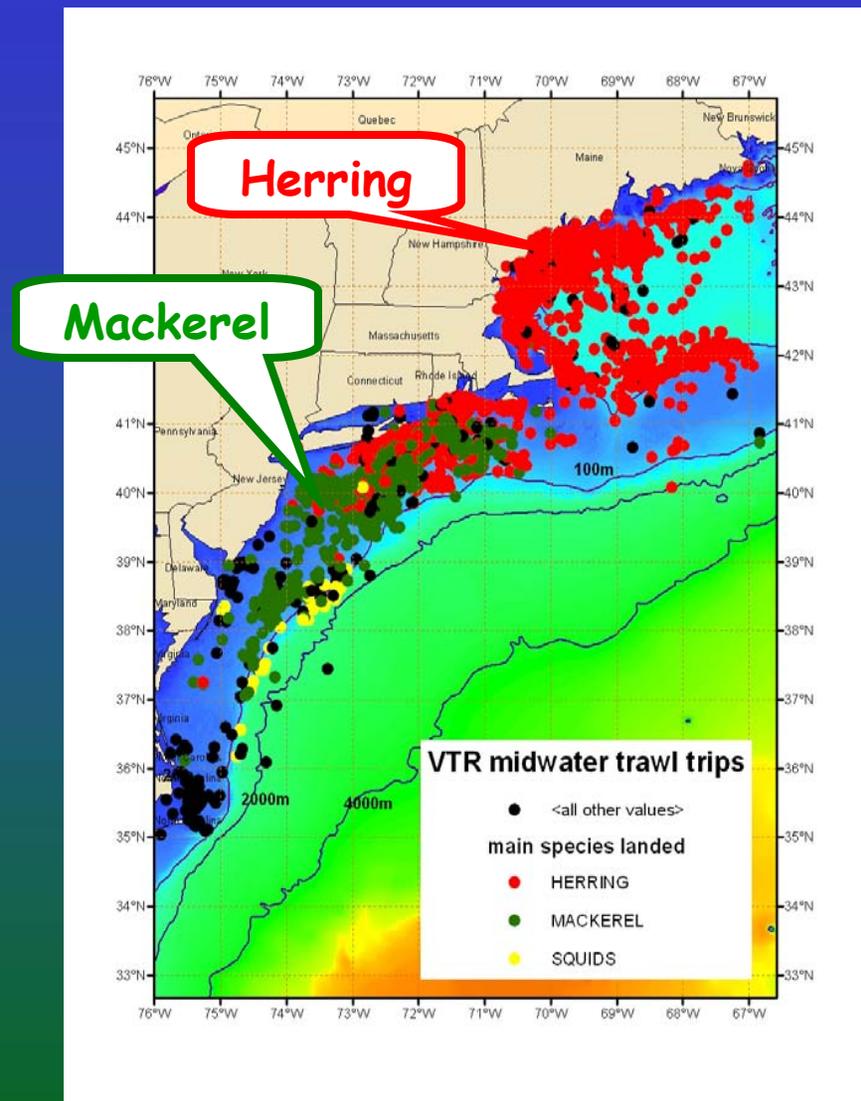
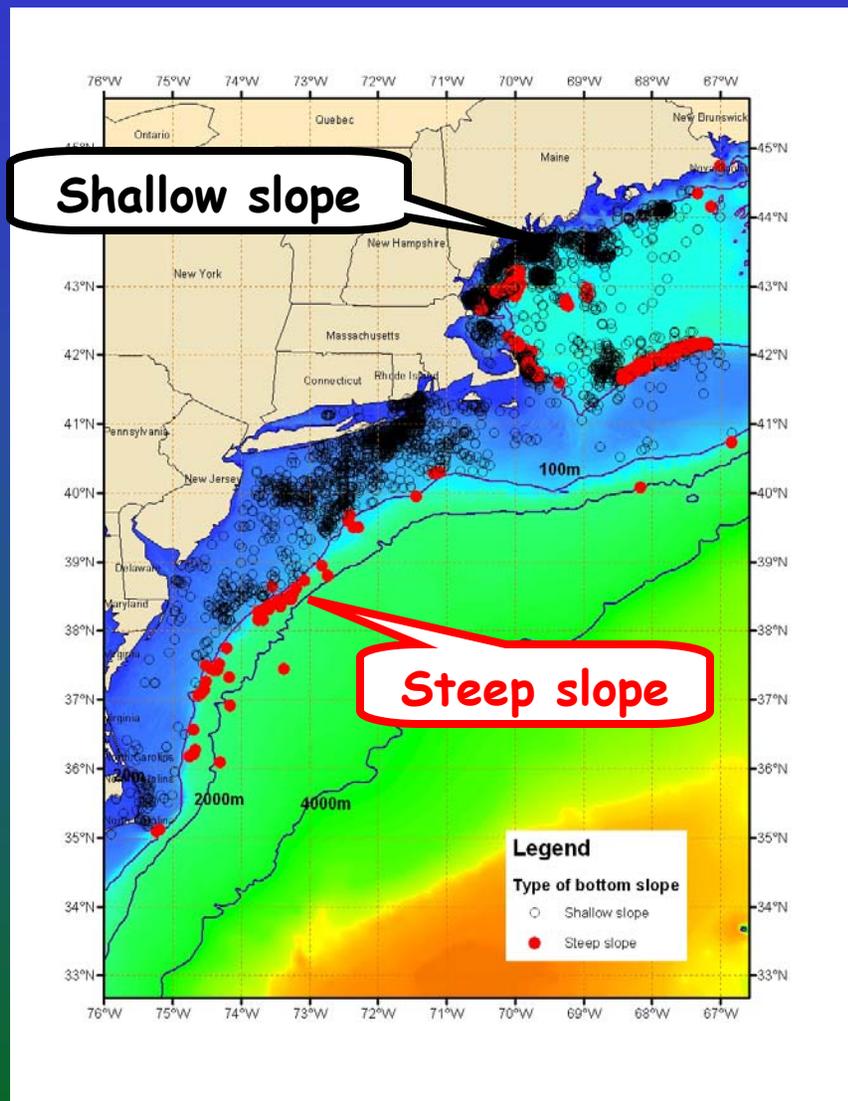
**Bycatch rates (animals/day fished) & CV**

Observed days fished

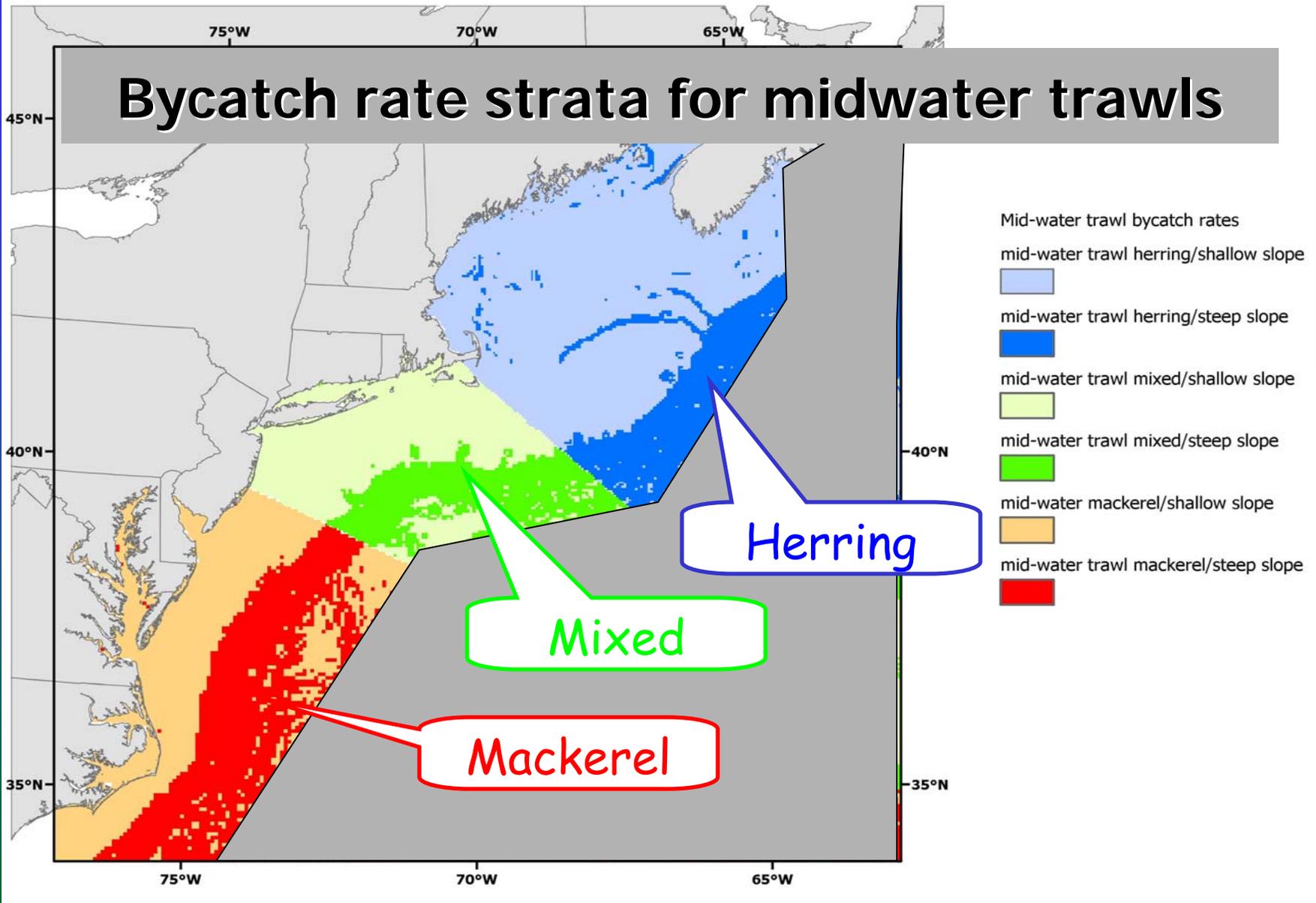
total days fished from VTR during 2003 and 2004

Bottom slope	Target Herring	Species Mackerel
Shallow ( $< 0.5^\circ$ )	<b>0 (0.54)</b> 36.7 224.9, 180.2	<b>0.339 (0.69)</b> 6.1 58.0, 73.1
Steep ( $\geq 0.5^\circ$ )	<b>0.305 (0.71)</b> 6.9 47.7, 24.9	<b>0 (NA)</b> 0 6.4, 2.9

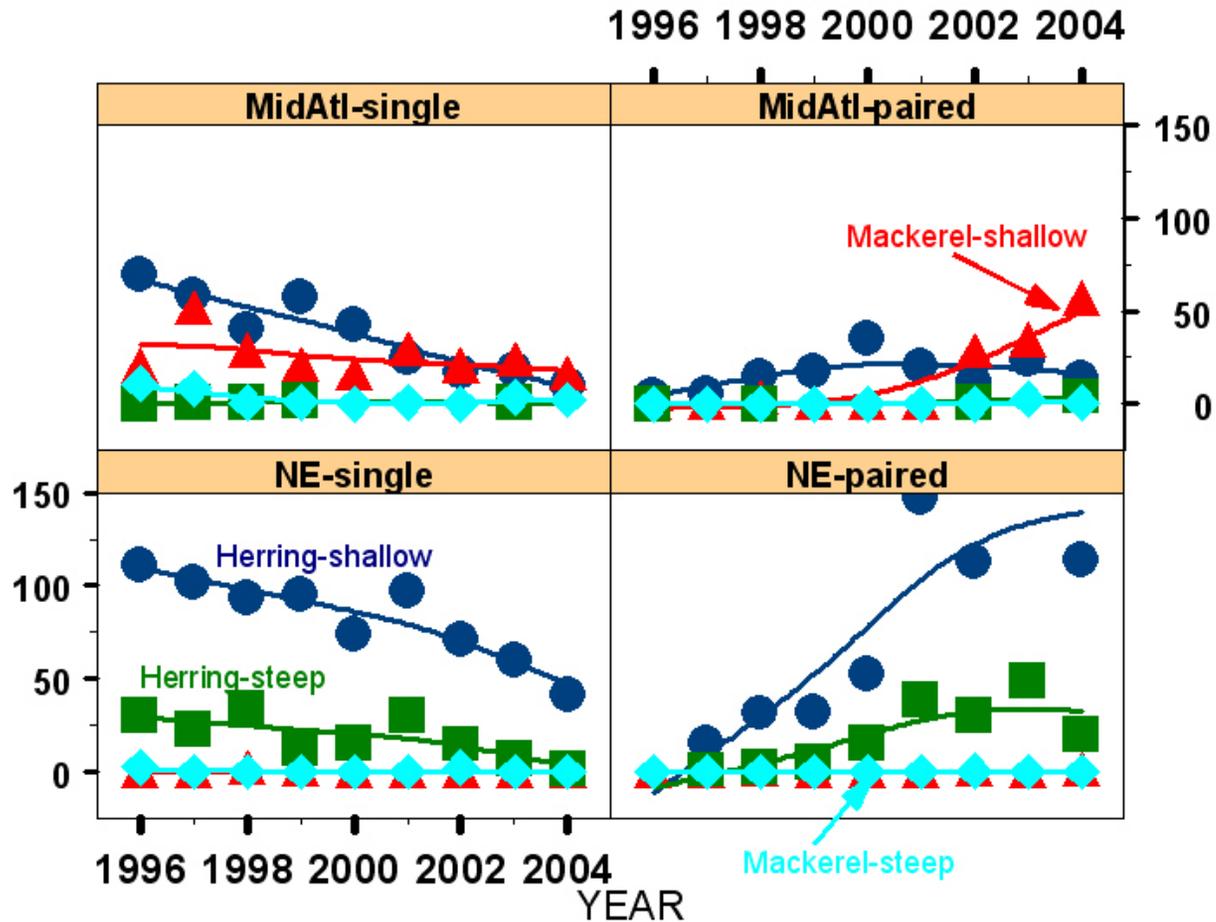
# Bycatch rate strata for mid-water trawls



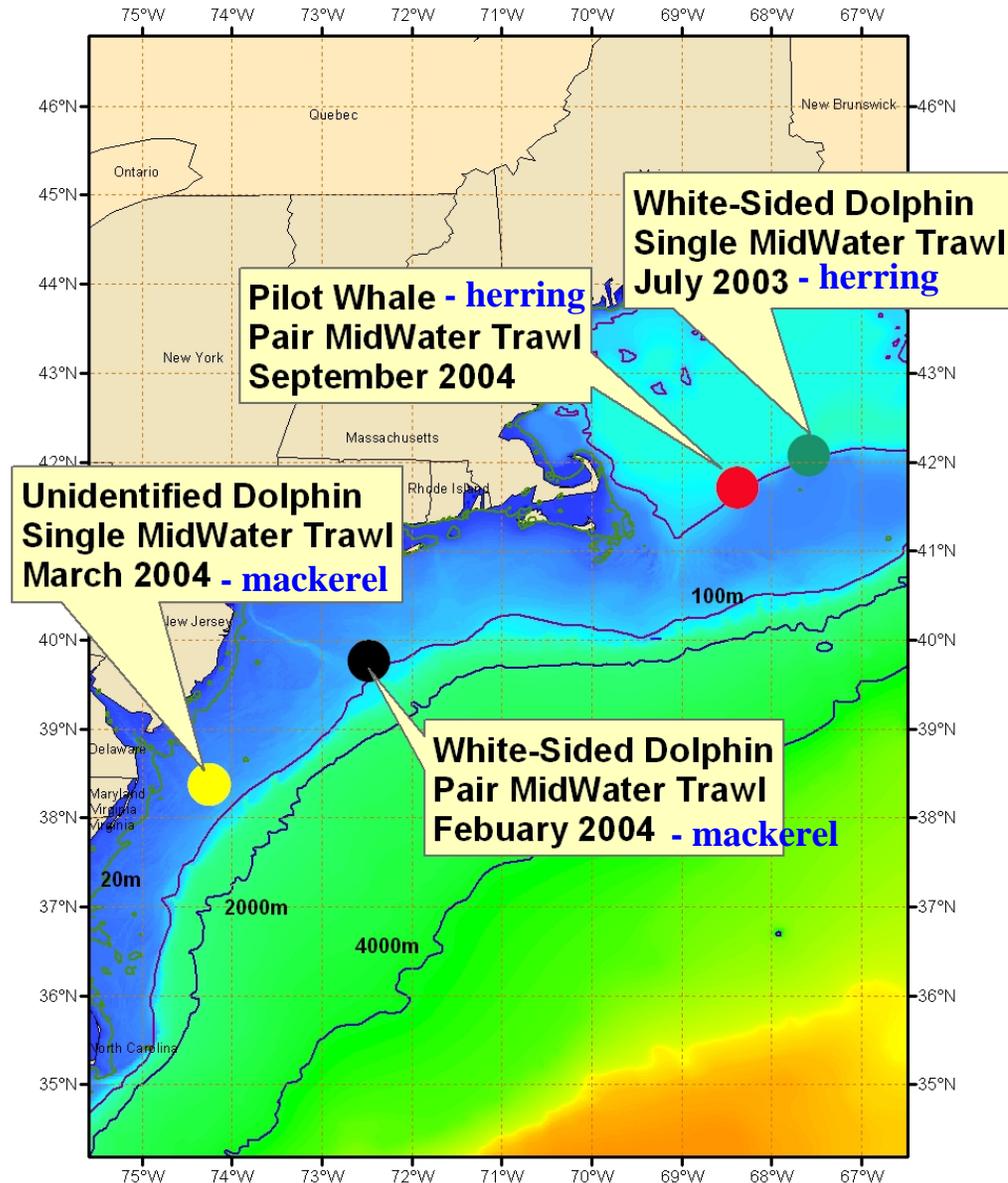
# Bycatch rate strata for midwater trawls



# Patterns of fishing effort



# Observed takes in midwater trawls during 2003 & 2004



# Bycatch estimate by species

Area	Geartype	Year	Days Fished	white-sided		Unidentified dolphin		Pilot whale	
				Estimate	CV	Estimate	CV	Estimate	CV
NE	single	2003	56.12	1.7	0.74				
NE	single	2004	42.23	0.3	0.74				
<b>NE</b>	<b>single</b>	<b>AVG</b>	<b>49.18</b>	<b>1.00</b>	<b>0.64</b>				
NE	pair	2003	178.96	0.0	0.53			12.7	0.73
NE	pair	2004	134.82	0.2	0.53			6.0	0.73
<b>NE</b>	<b>pair</b>	<b>AVG</b>	<b>156.89</b>	<b>0.10</b>	<b>0.17</b>			<b>9.35</b>	<b>0.55</b>
MidAtl	single	2003	43.39	0.2	0.73	8.0	0.53		
MidAtl	single	2004	28.75	0.0	0.73	5.4	0.53		
<b>MidAtl</b>	<b>single</b>	<b>AVG</b>	<b>36.07</b>	<b>0.10</b>	<b>0.73</b>	<b>6.7</b>	<b>0.38</b>		
MidAtl	pair	2003	57.59	11.6	0.53			0.0	0.73
MidAtl	pair	2004	85.80	19.1	0.53			1.6	0.73
<b>MidAtl</b>	<b>pair</b>	<b>AVG</b>	<b>71.70</b>	<b>15.35</b>	<b>0.39</b>			<b>0.80</b>	<b>0.73</b>

# Bycatch estimate by species

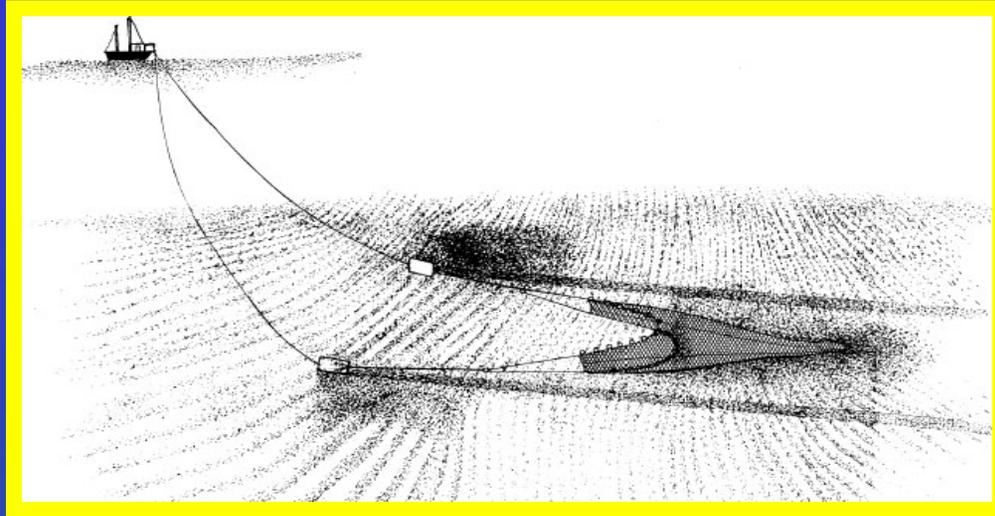
Area	Geartype	Year	Days Fished	white-sided		Unidentified dolphin		Pilot whale	
				Estimate	CV	Estimate	CV	Estimate	CV
NE	single+pair	2003	235.08	1.7	0.74			12.7	0.73
NE	single+pair	2004	177.05	0.5	0.49			6.0	0.73
NE	single+ pair	AVG	206.07	1.10	0.58			9.35	0.55
MidAtl	single+pair	2003	100.98	11.8	0.52	8.0	0.53	0.0	0.74
MidAtl	single+pair	2004	114.55	19.1	0.53	5.4	0.53	1.6	0.74
MidAtl	single+ pair	AVG	107.77	15.45	0.38	6.70	0.38	0.80	0.74
NE+MidAtl	single+pair	2003	336.06	13.5	0.46	8.0	0.53	12.7	0.73
NE+MidAtl	single+pair	2004	291.60	19.6	0.52	5.4	0.53	7.6	0.60
NE+MidAtl	single+ pair	AVG	313.83	16.55	0.36	6.70	0.38	10.15	0.51

# PBR and bycatch estimate (CV) average for 2000 - 2004

Species	Strategic ?	PBR	Total Bycatch	NE Bottom	NE Midwat	MidAtl Bottom	MidAtl Midwat	JV and TALFF
Common D.	No	1000	101 (0.12)	33 (0.19)	0	68 (0.15)	0	0
Pilot W. spp	No	249	113 (0.24)	10 (0.23)	9.4 (0.55)	12 (0.22)	0.8 (0.74)	11
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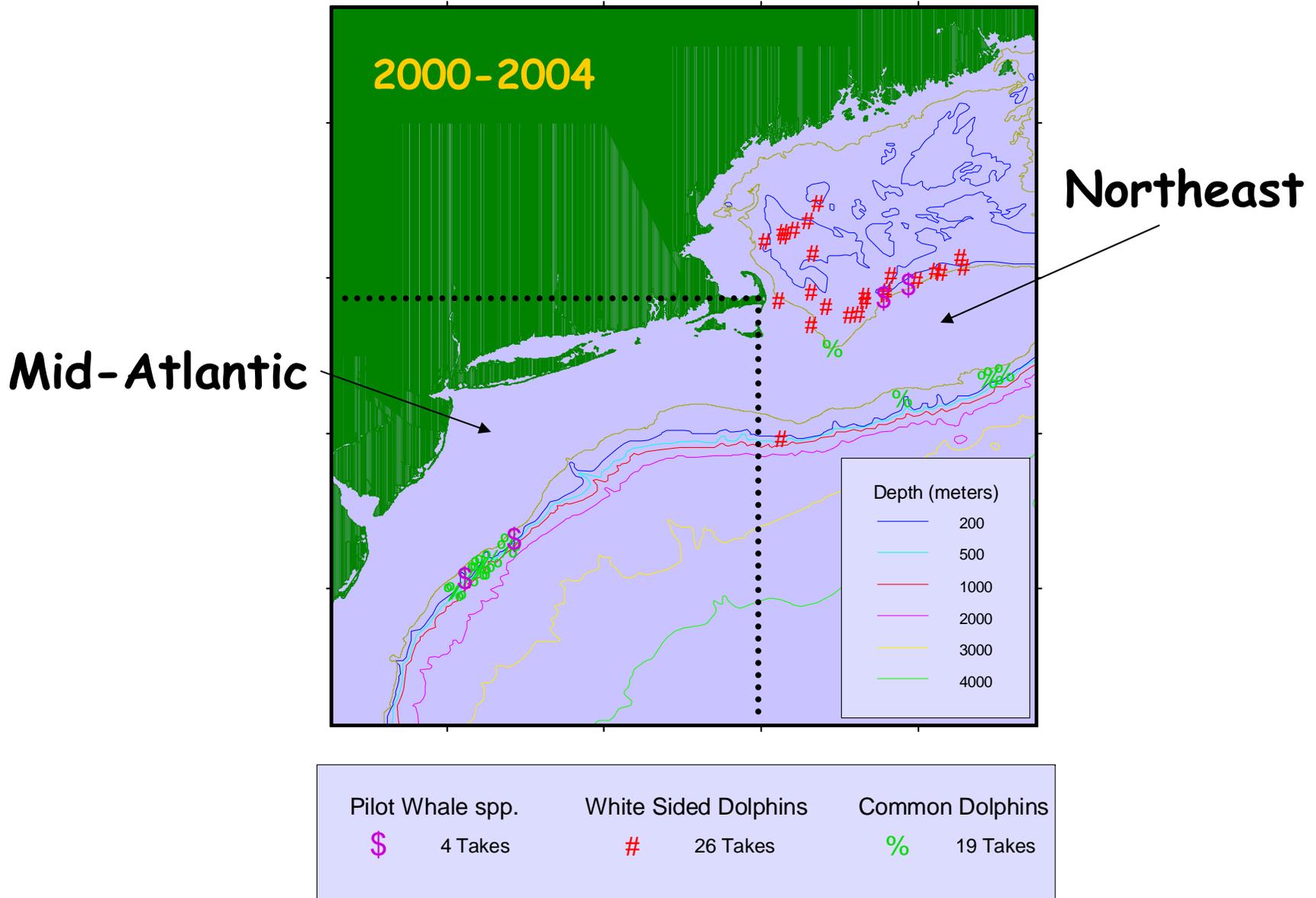
## But ...

Since there were only four (4) observed takes in the mid-water trawl fisheries and in just two years of observer data, these bycatch estimates should be considered preliminary. They will be re-estimated when the 2005 (and maybe 2006) observer data are also added into the regression model.



**Now Marjorie Rossman  
will explain the  
bottom trawl bycatch estimates  
of cetaceans**

# Observed Marine Mammal Takes in Bottom Trawl



# Mammal Bycatch in Bottom Trawl

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- **Overview**
  - Factors investigated
  - Significant factors (strata) selected for predicting mammal bycatch rates
    - Pilot Whale Strata
    - White-sided Dolphin Strata
    - Common Dolphins Strata
  - Stratified bycatch rates, effort, coverage, and mortality by species

# BOTTOM TRAWL

## Observed Characteristics Investigated for Correlation with Cetacean Bycatch

### SPACE

- State landed
- Statistical area
- Latitude/Longitude

### TIME

- Year
- Month

### Fishing Practices

- Haul duration
- Target fish species

### Environment/Habitat

- Sea Surface Temp
- Bottom Depth
- Bottom Slope

### Vessel

- Length
- Gross Tons
- Horse Power

### Gear

- Foot rope length

# BOTTOM TRAWL

## What Characteristics Fit the Data Best For Predicting Mammal Bycatch Rates ?

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- **Pilot Whales**

- Vessel Horse Power
  - Small < 1,265 HP
  - Large  $\geq$  1,265 HP
- Bottom Slope
  - Shallow  $\leq 3.9^\circ$
  - Steep  $> 3.9^\circ$

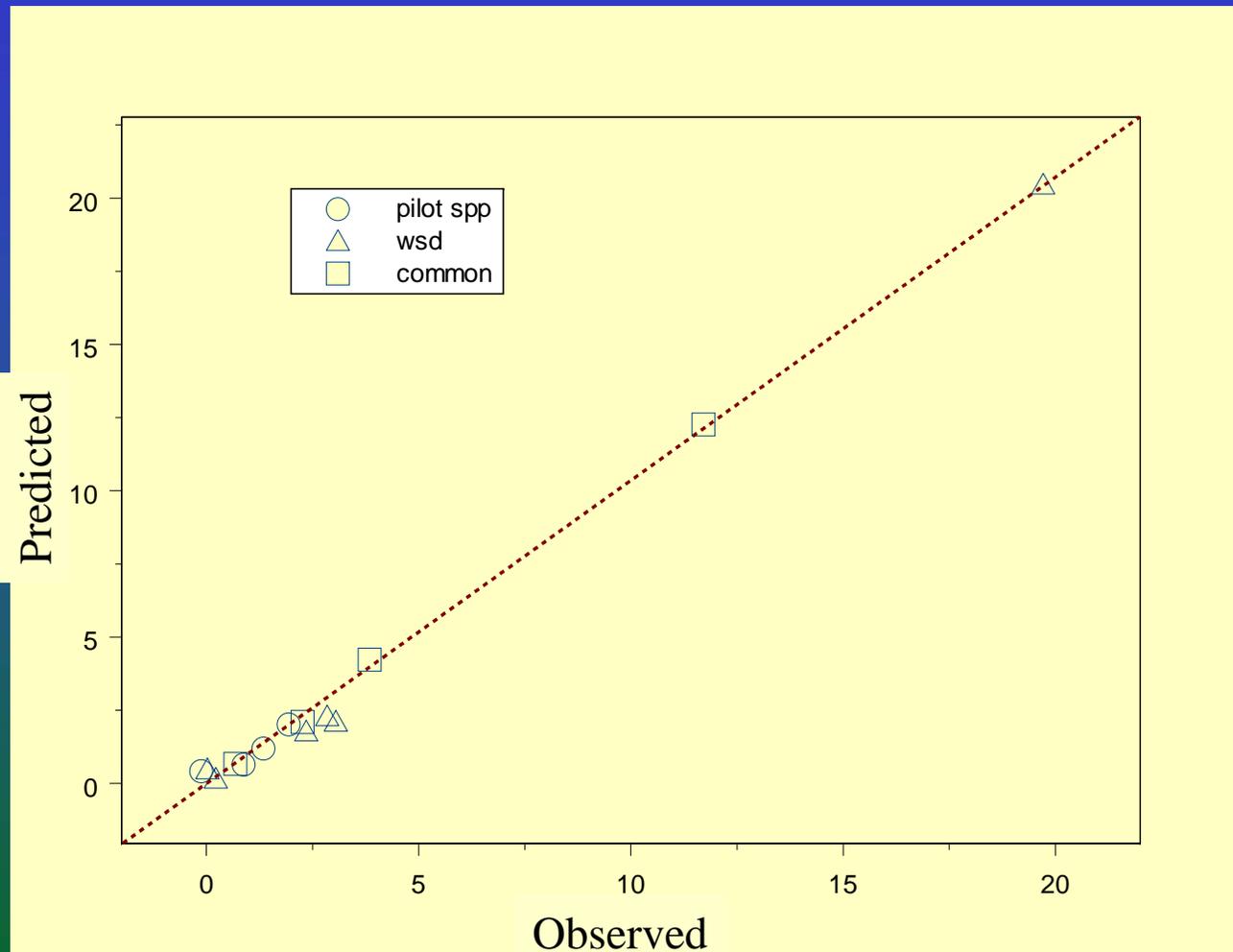
- **White-sided Dolphins**

- Sea Surface Temp.
  - Low <  $7.39^\circ$
  - High  $\geq 7.39^\circ$
- Bottom Depth
  - Shallow < 109.95 meters
  - 109.95  $\geq$  Mid < 270.43
  - Deep  $\geq 270.43$  meters

- **Common Dolphins**

- Statistical Area
  - 525 (SGB), 622 (MAN), 627 (MAS), remaining (OTH)

# How good do the models fit the raw observed data?

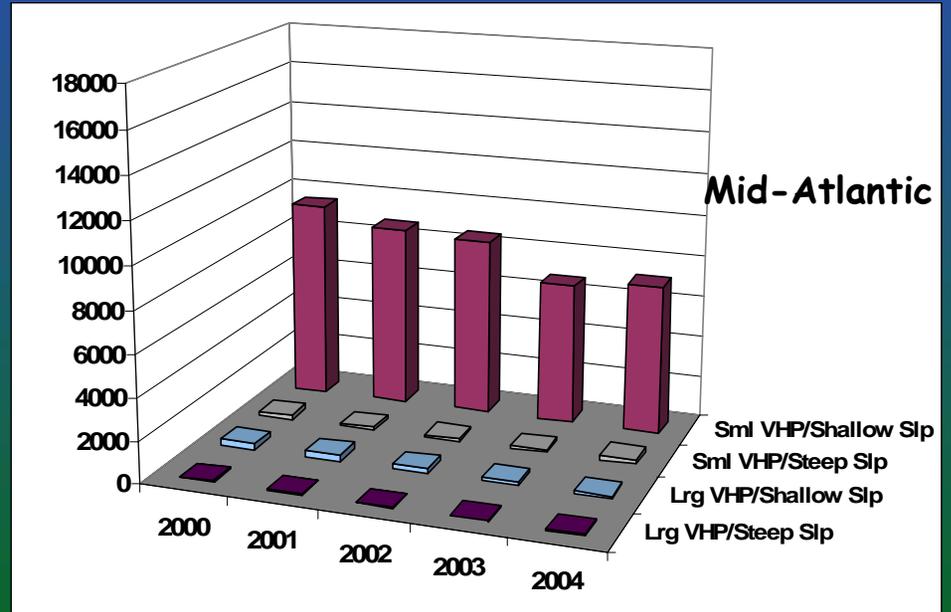
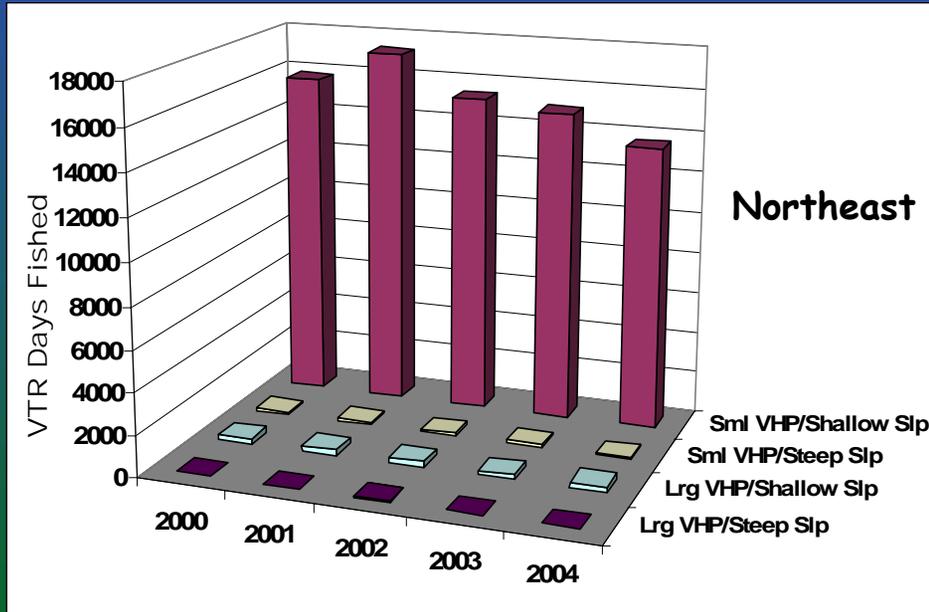
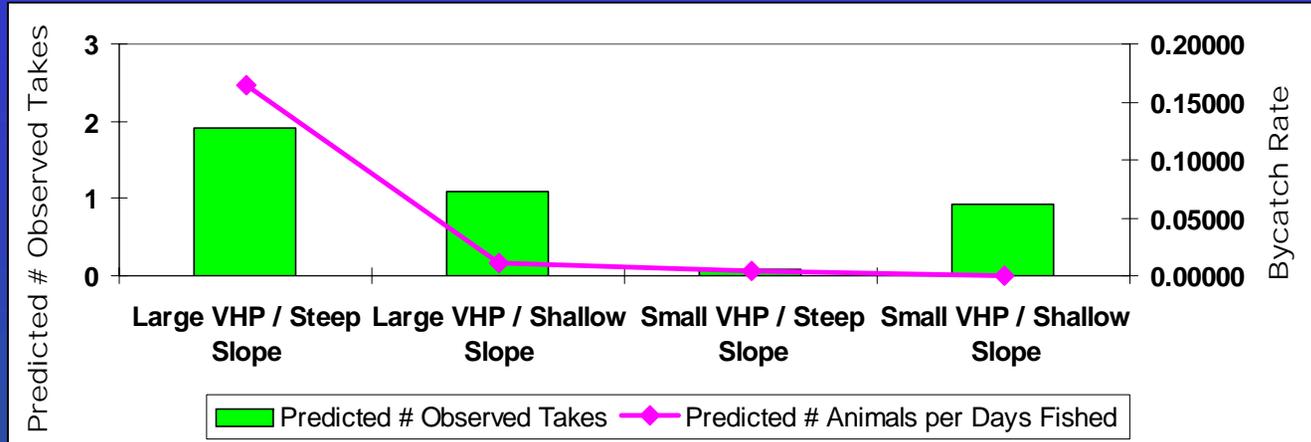


# Bottom Trawl

## Pilot Whale Bycatch

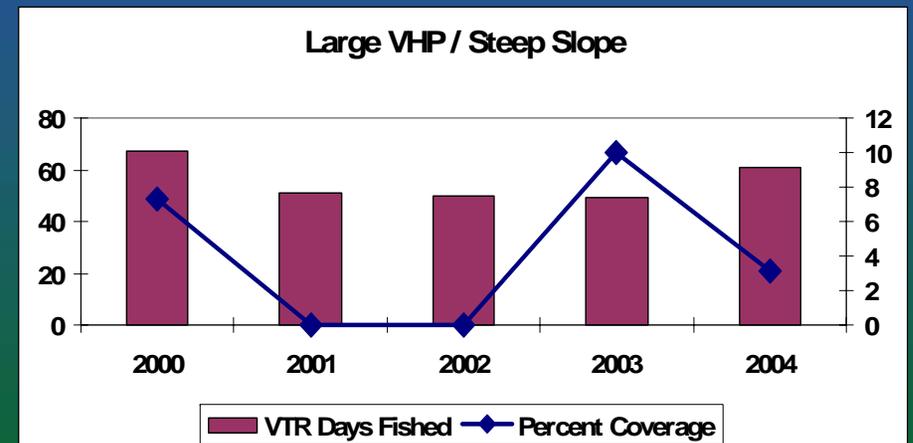
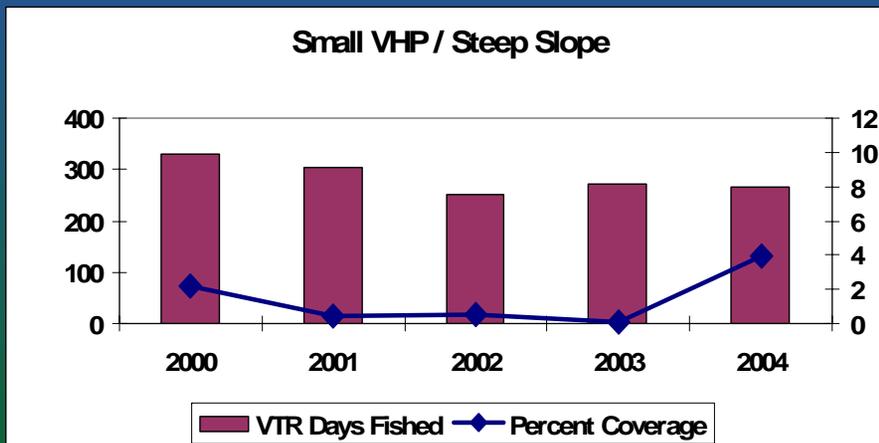
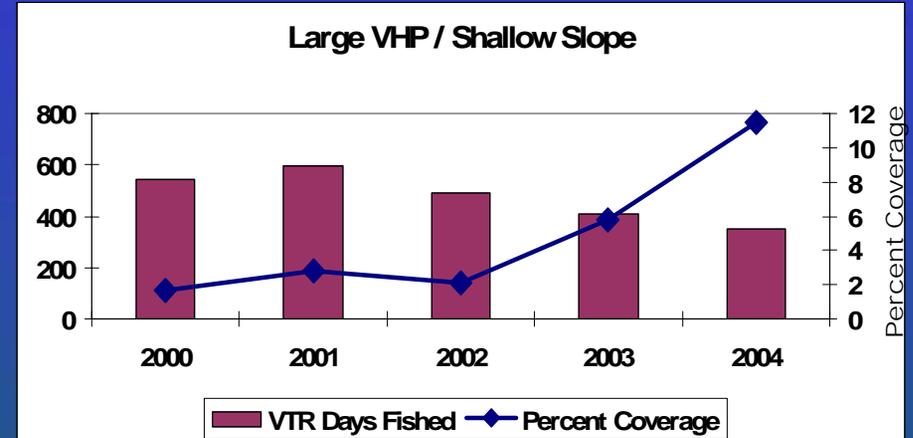
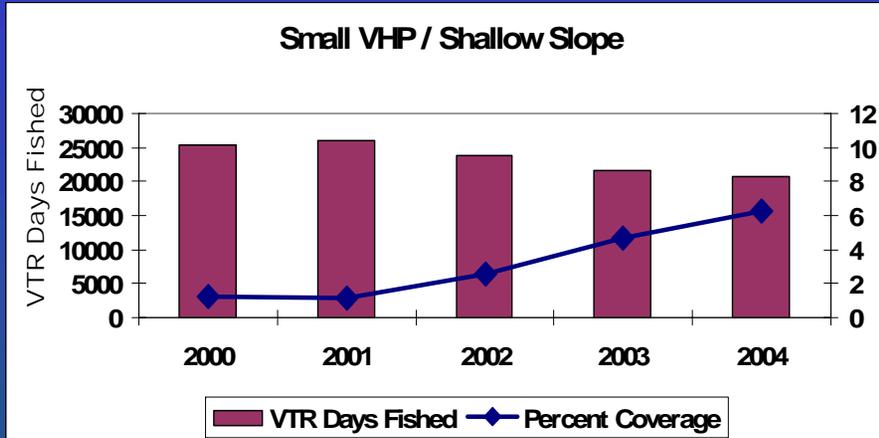
# BOTTOM TRAWL

## Pilot Whale Bycatch Rates and Total Effort by Stratum



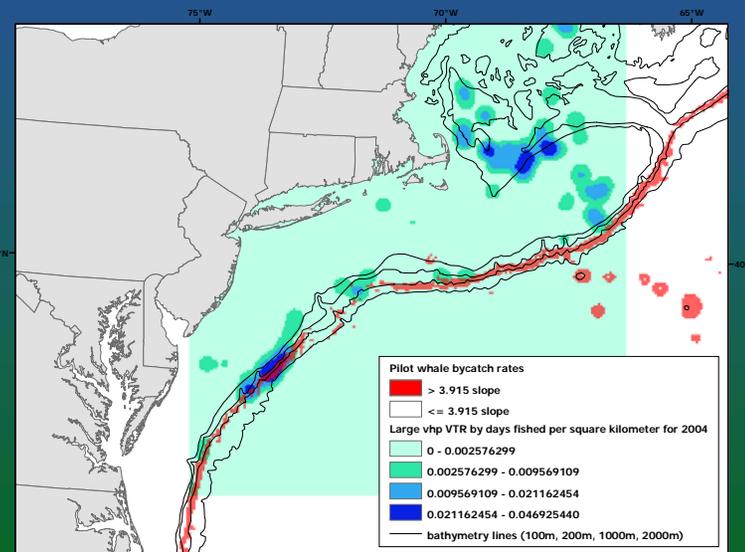
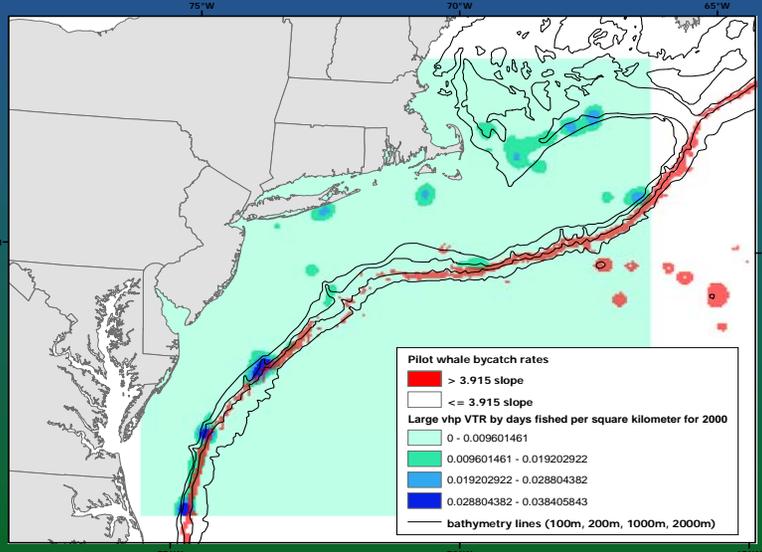
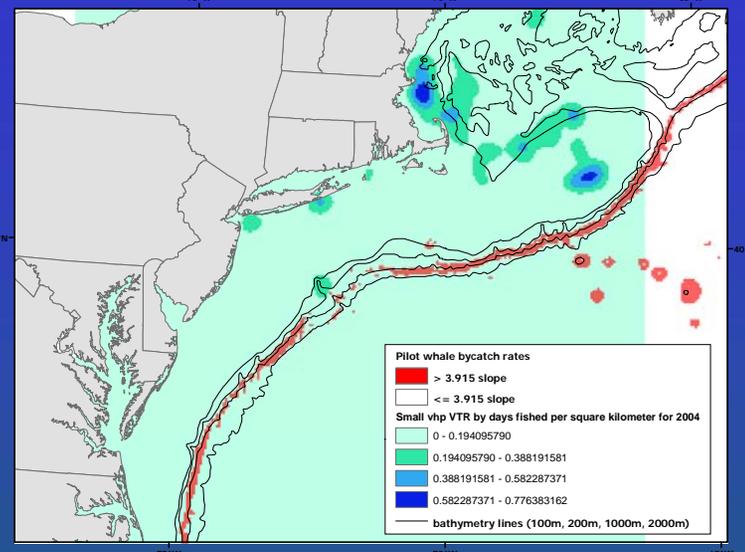
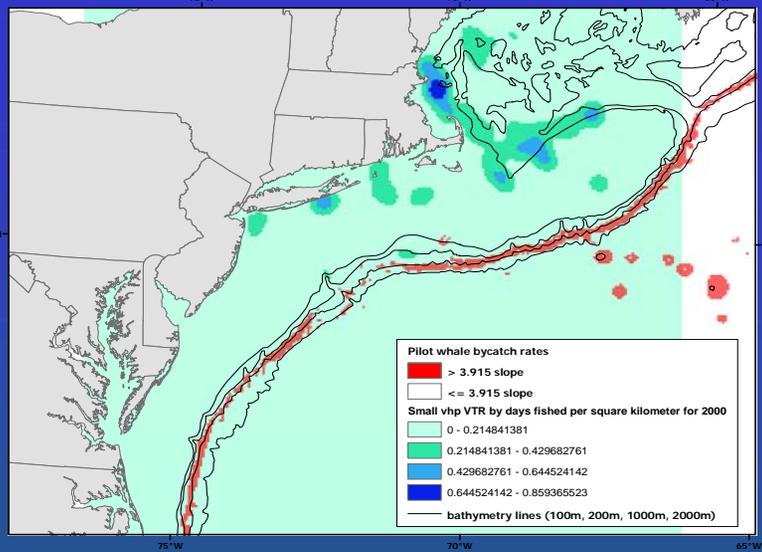
# Bottom Trawl

## Annual Observer Coverage in Pilot Whale Strata



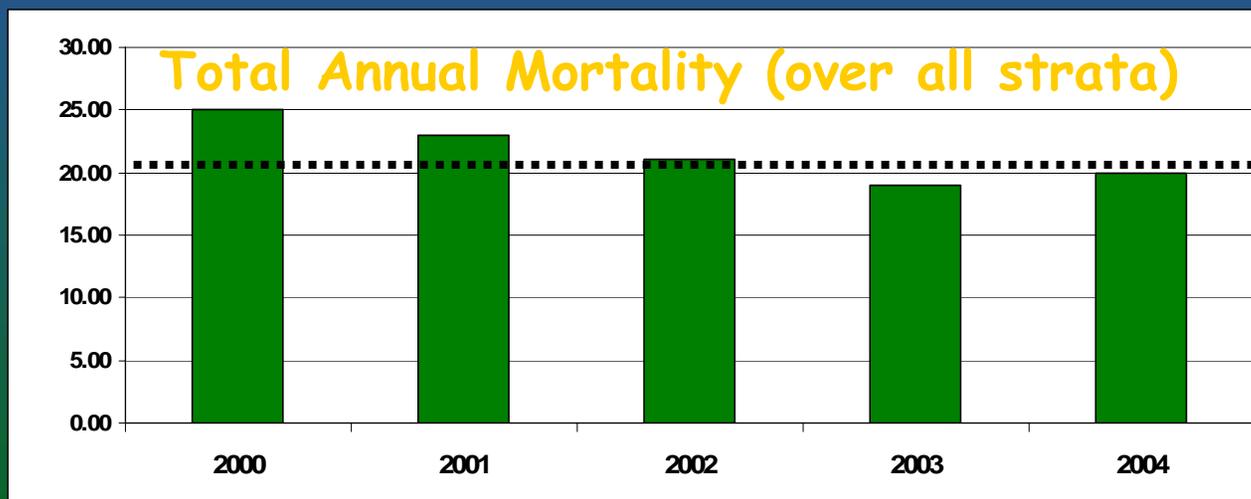
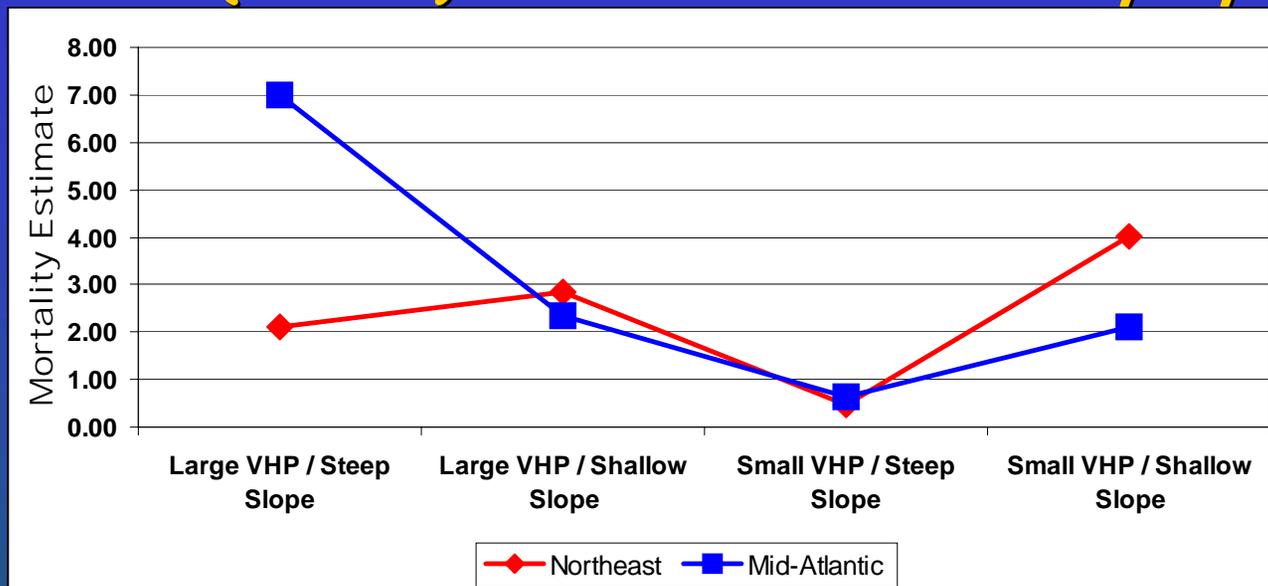
# BOTTOM TRAWL

## VTR Effort Density in Pilot Whale Strata



# Bottom Trawl

## Mean Annual (00-04) Pilot Whale Mortality by Strata



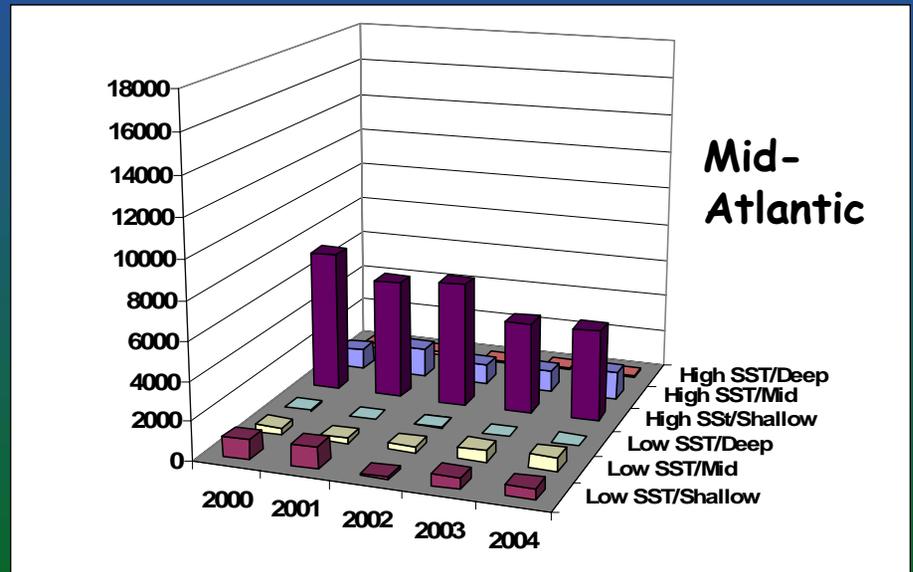
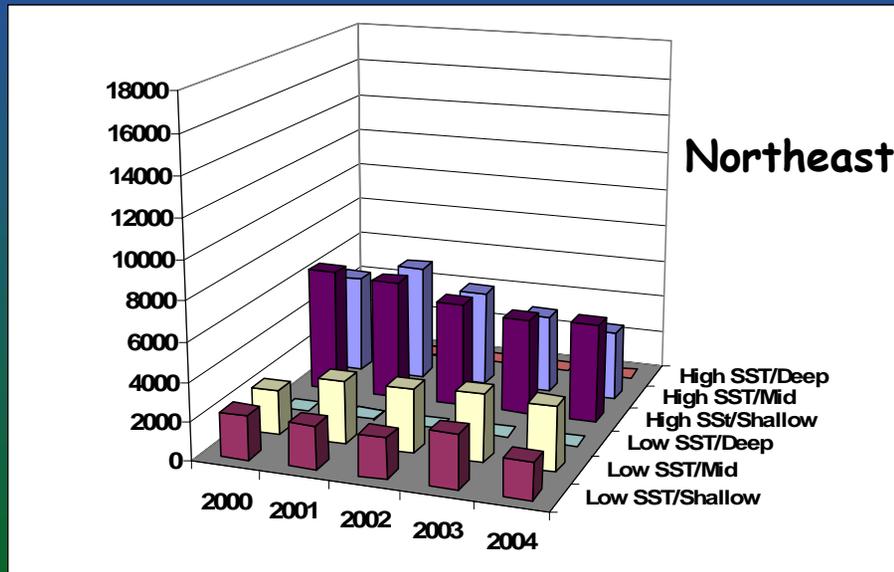
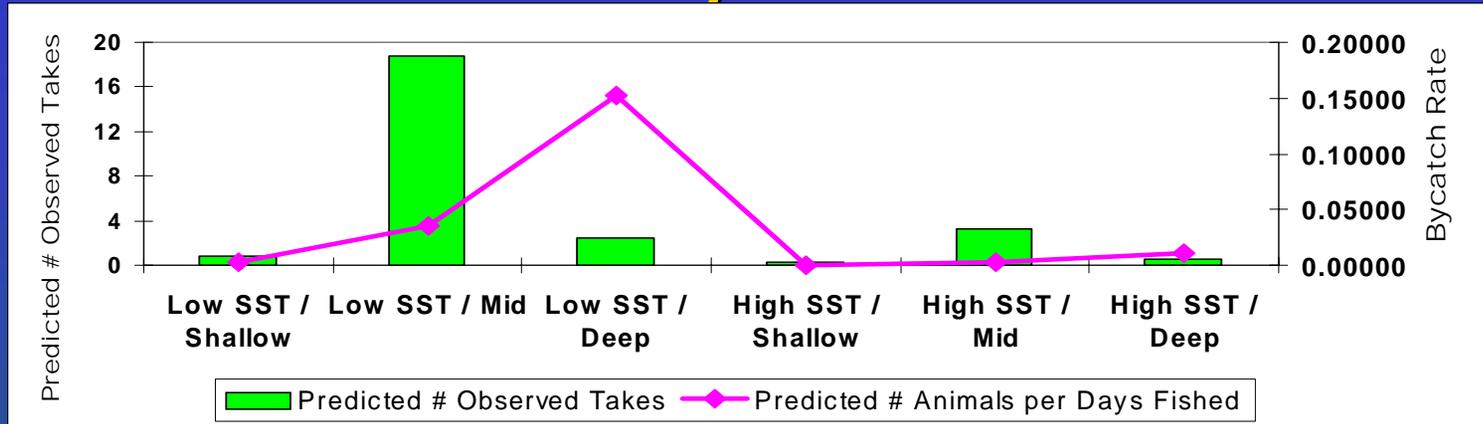
Mean=22

# Bottom Trawl

## White-sided Dolphin Bycatch

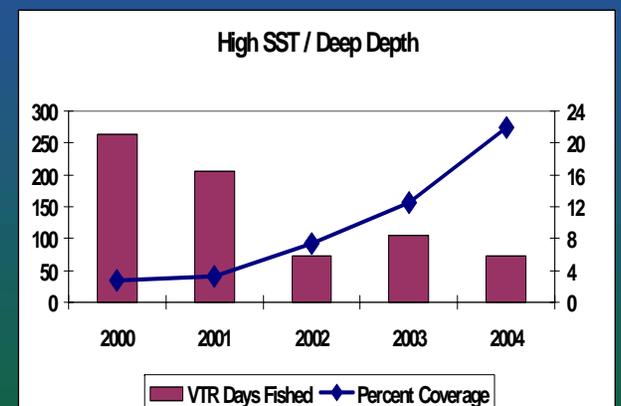
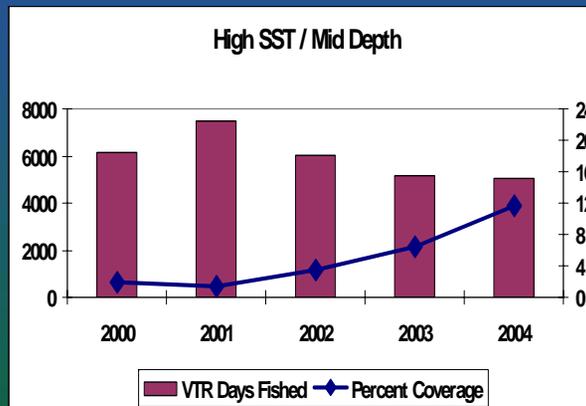
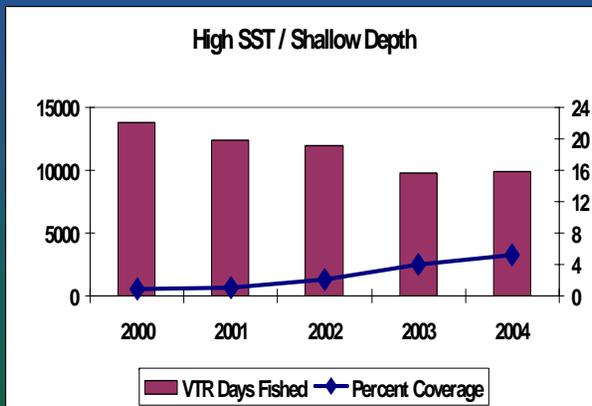
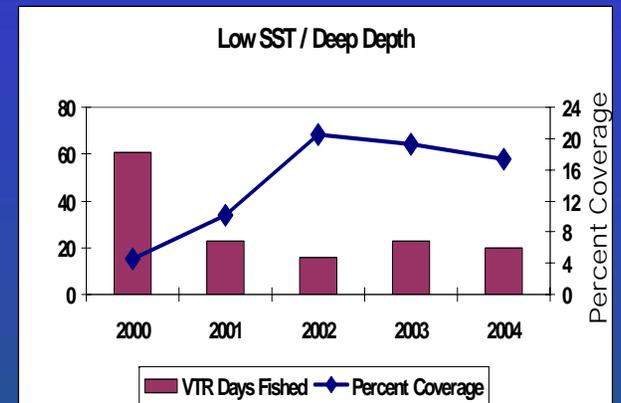
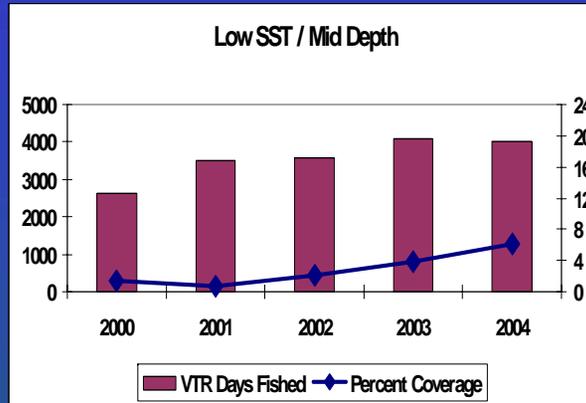
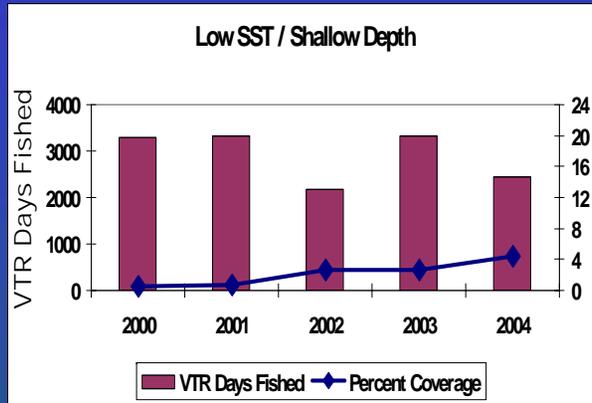
# BOTTOM TRAWL

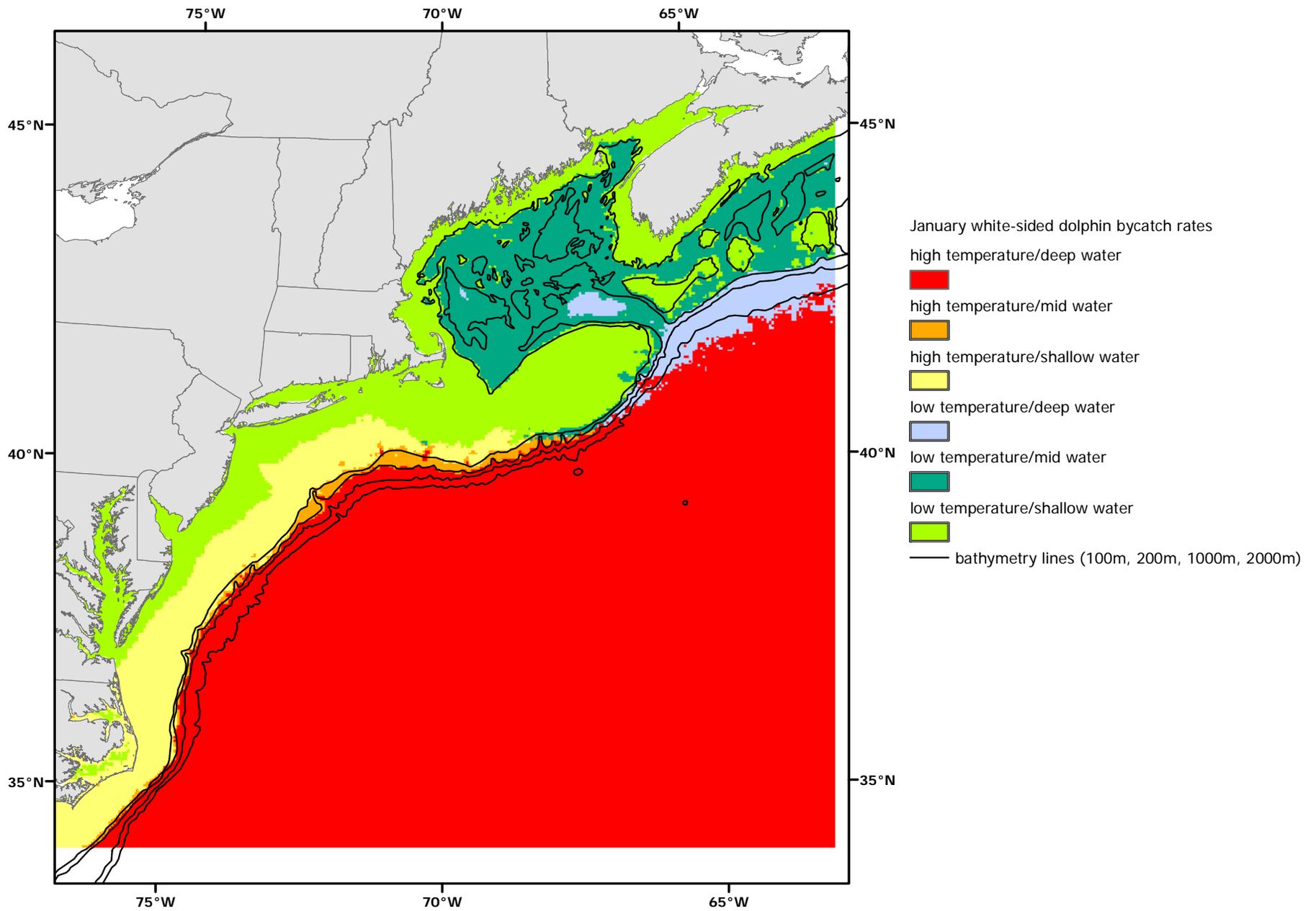
## White-sided Dolphin Bycatch Rates and Total Effort by Stratum

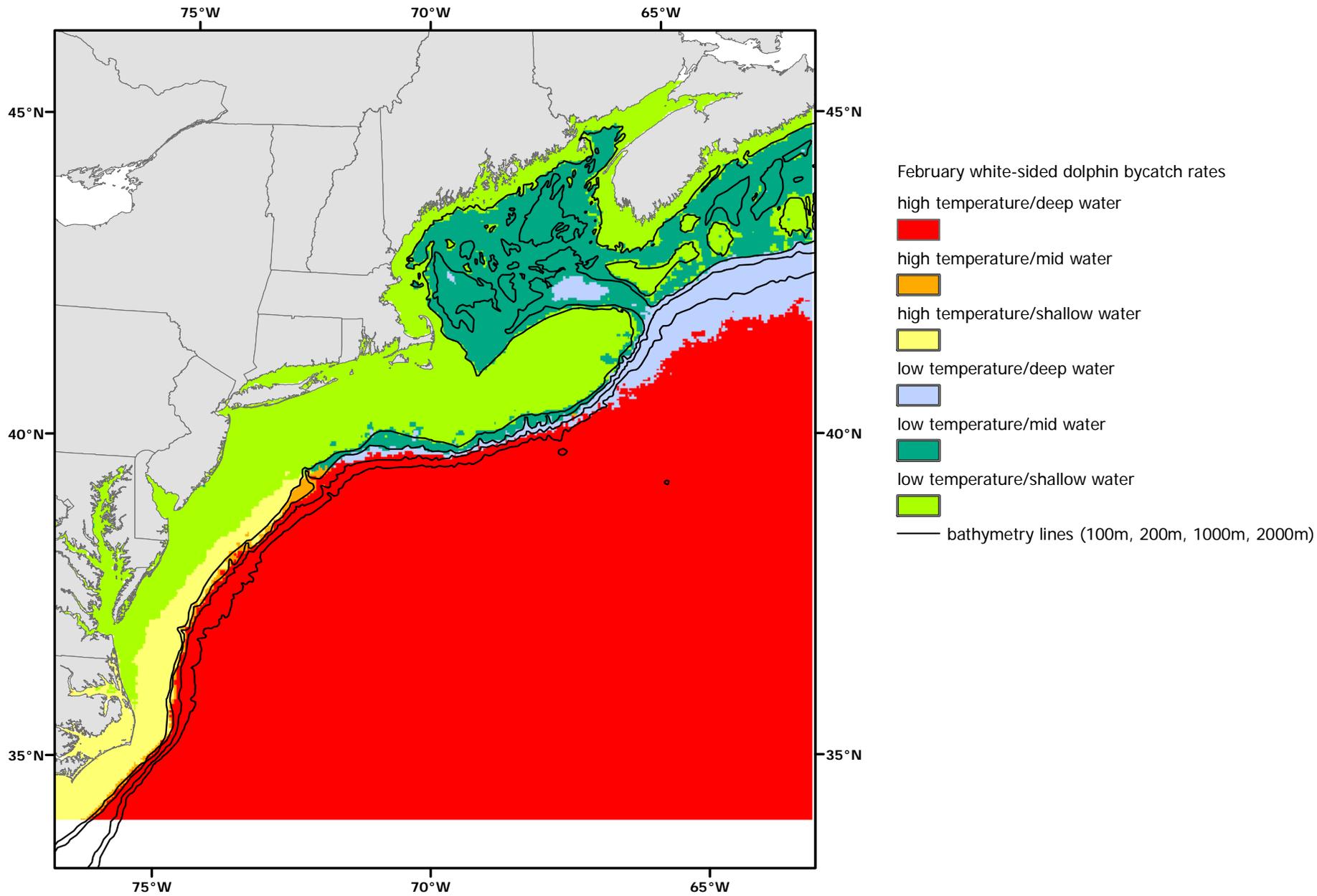


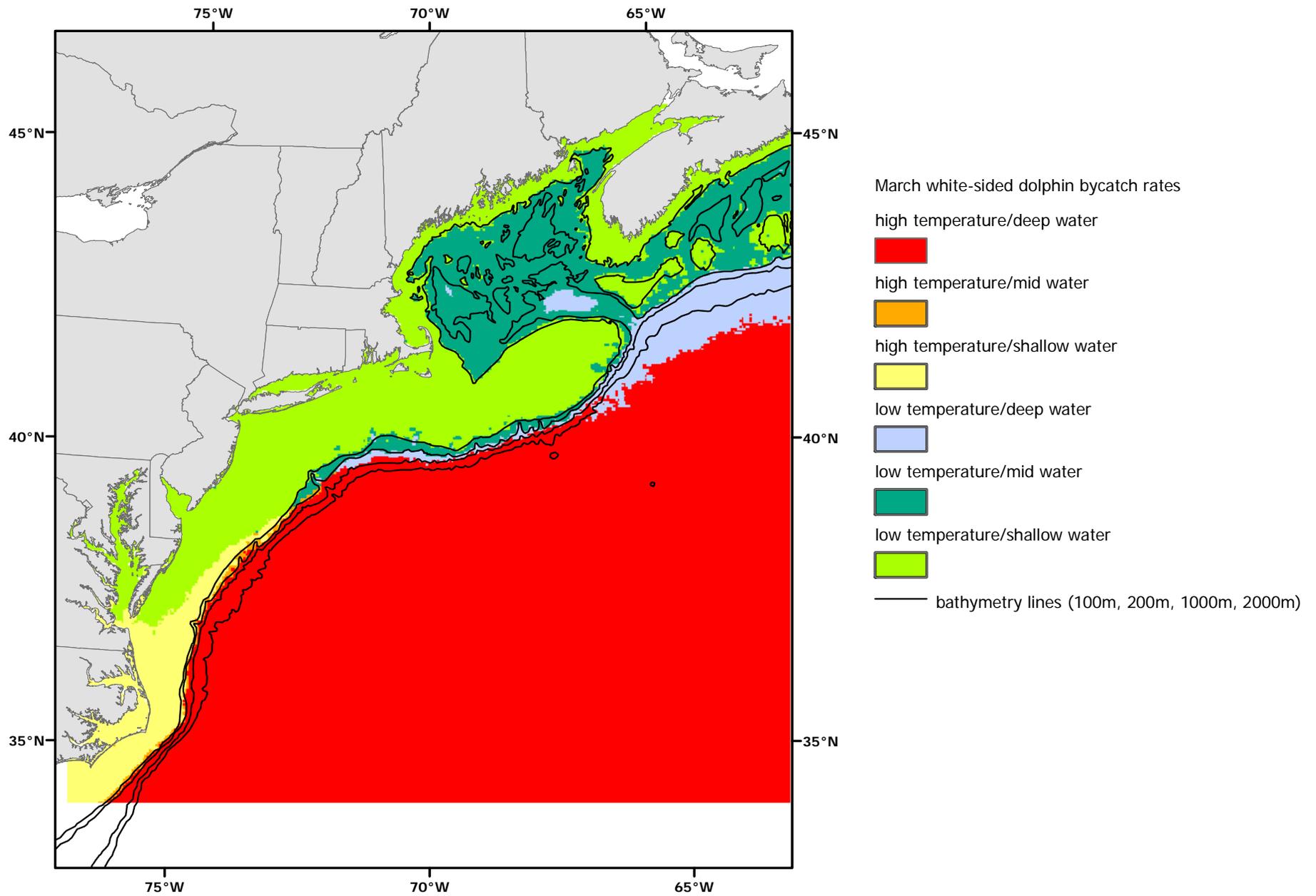
# Bottom Trawl

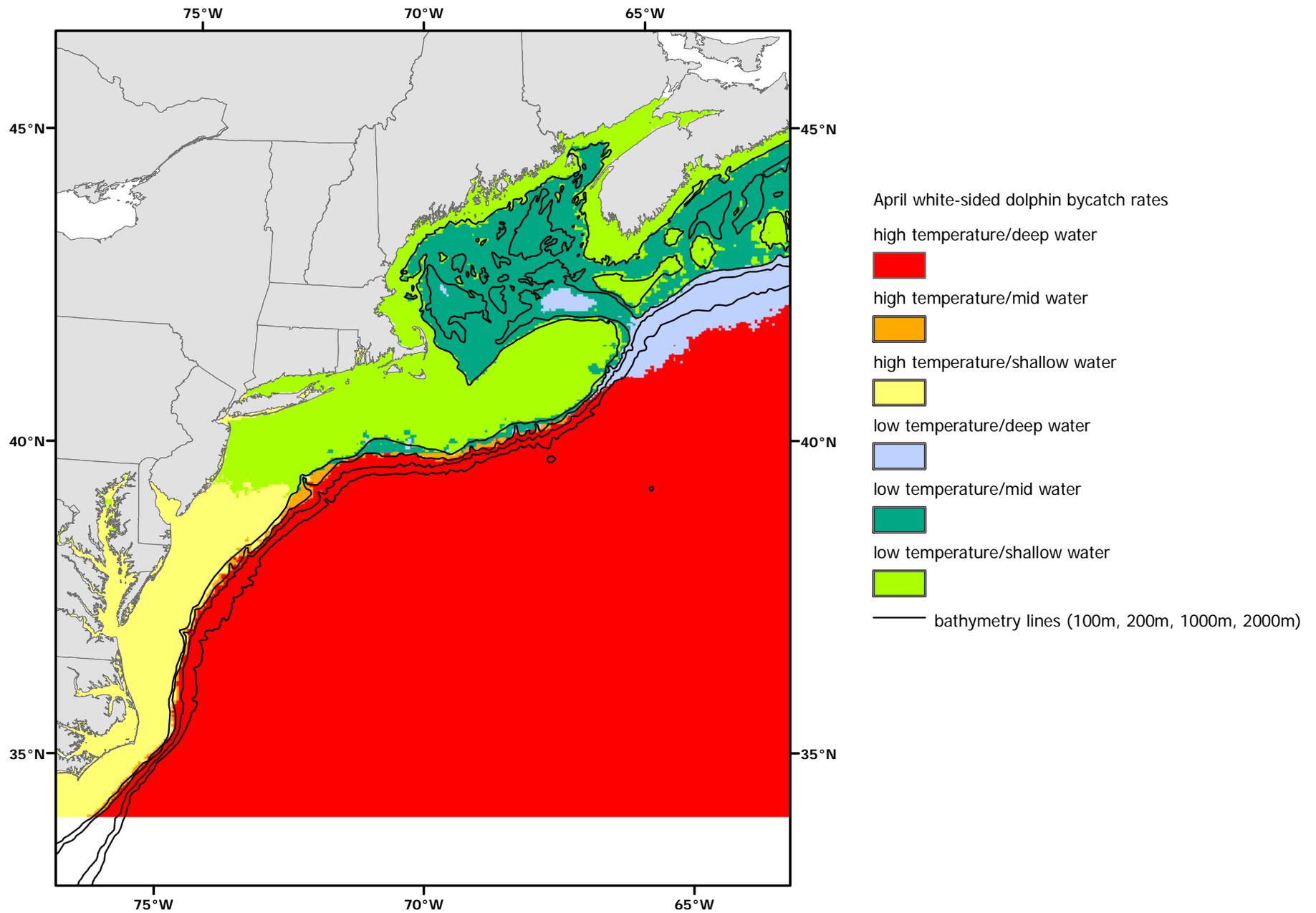
## Annual Observer Coverage in White-sided Dolphin Strata

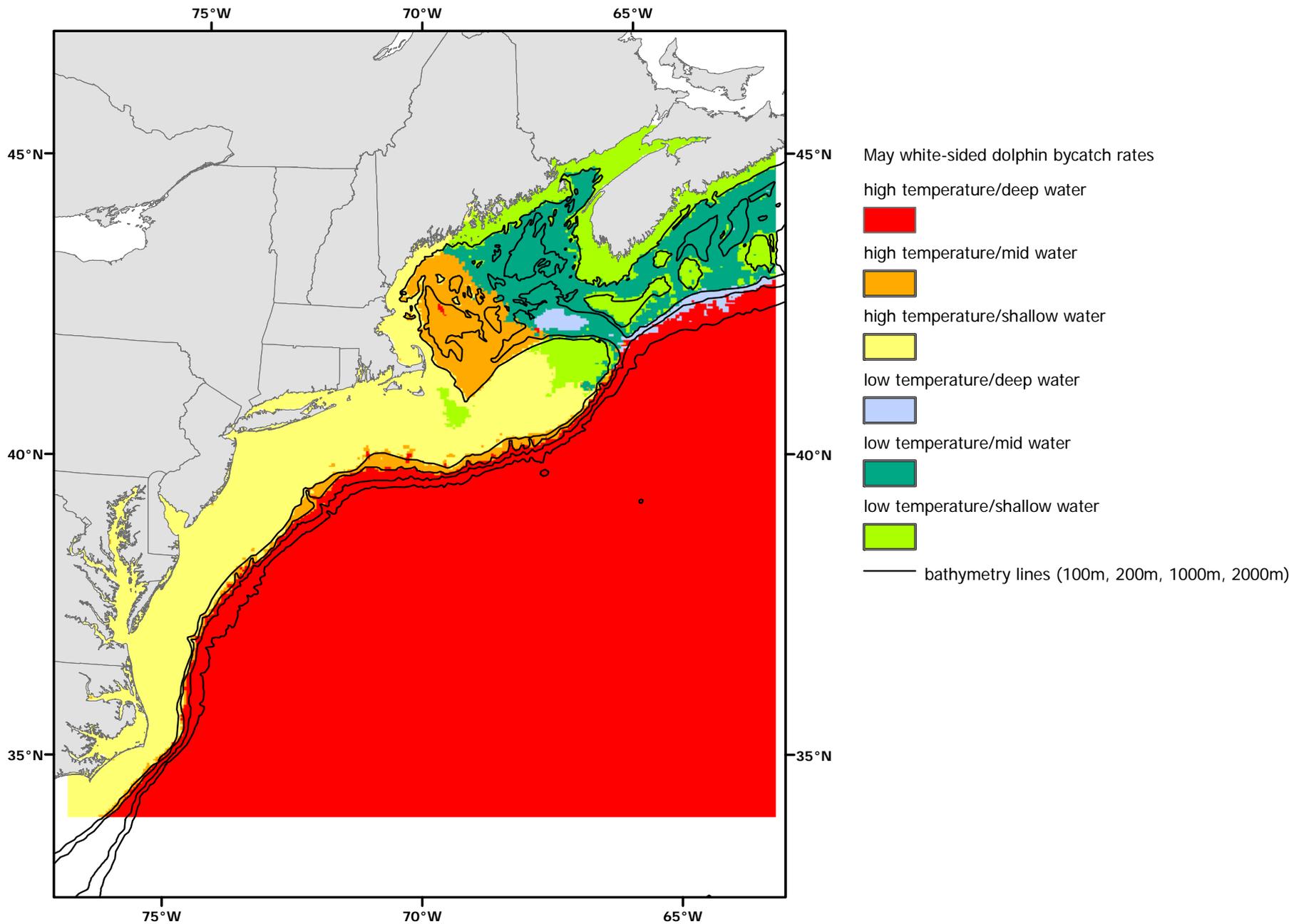


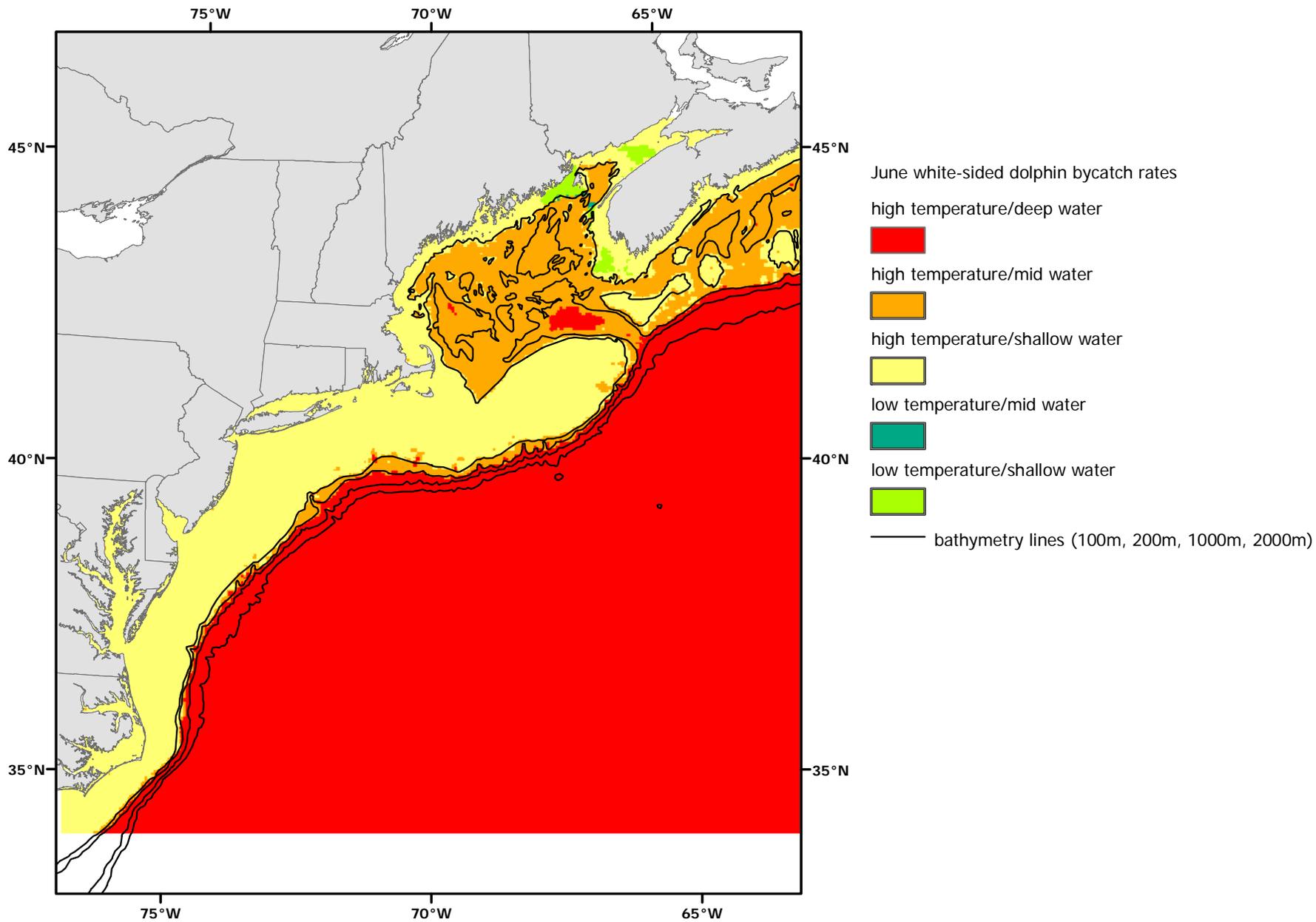


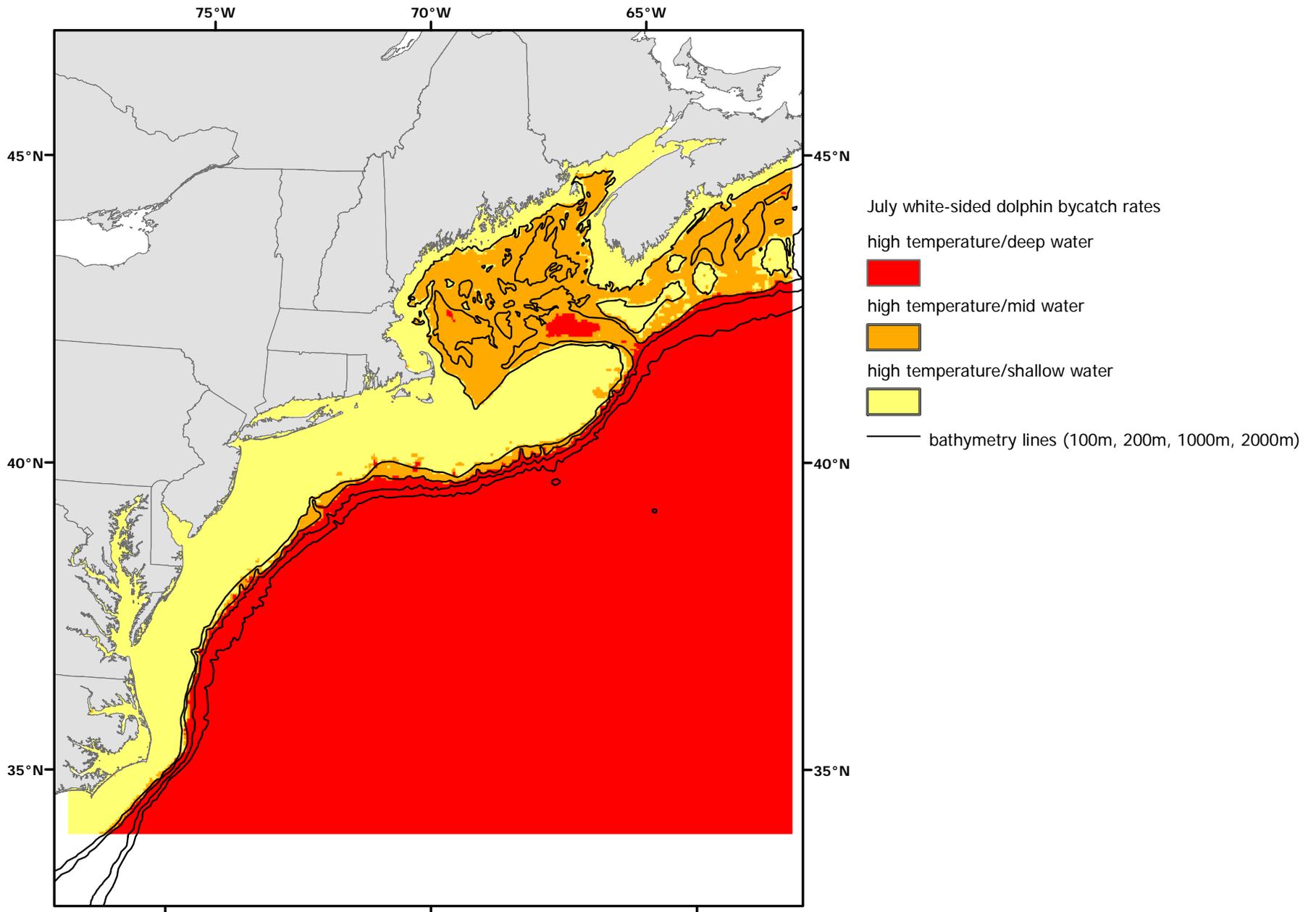






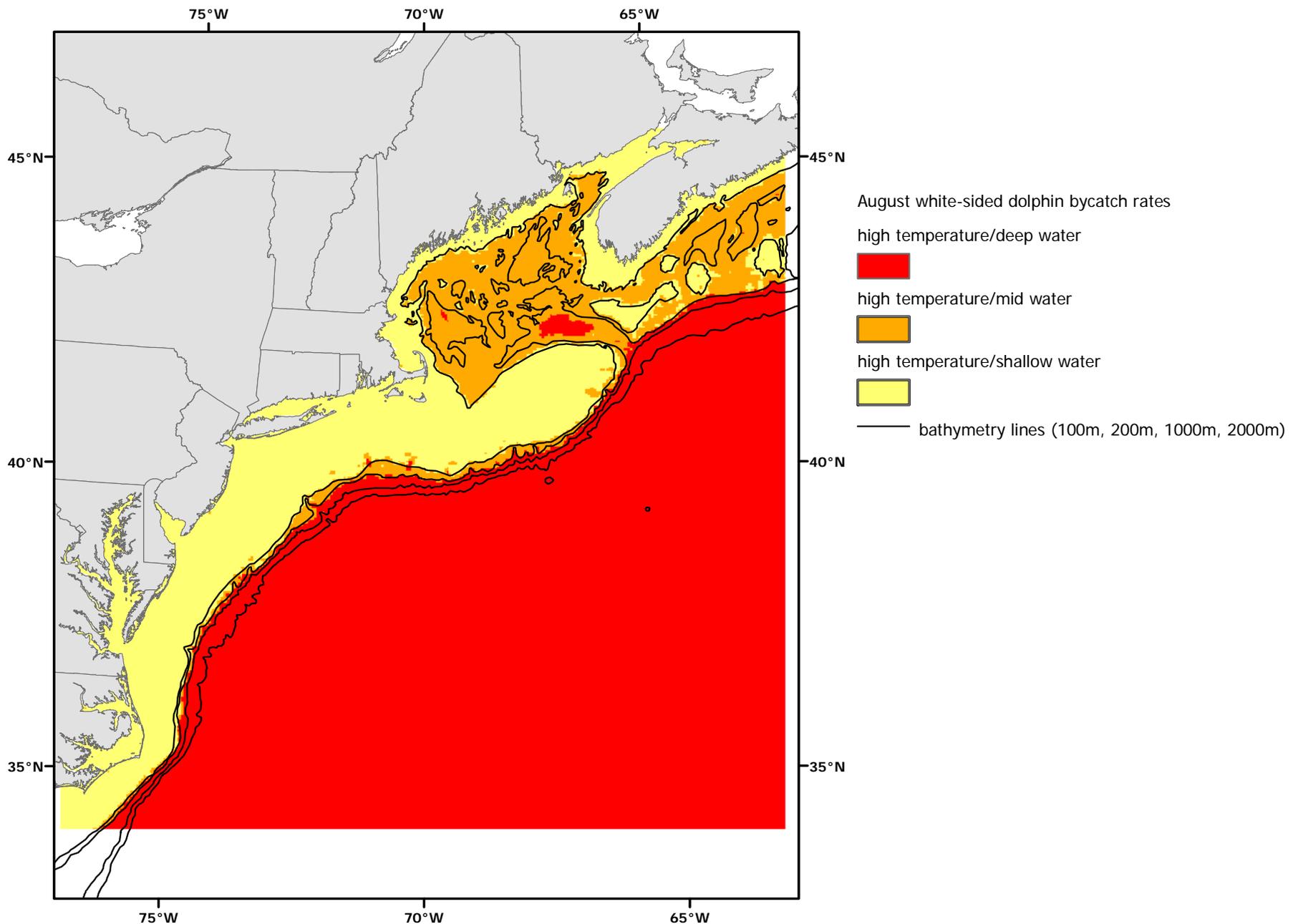






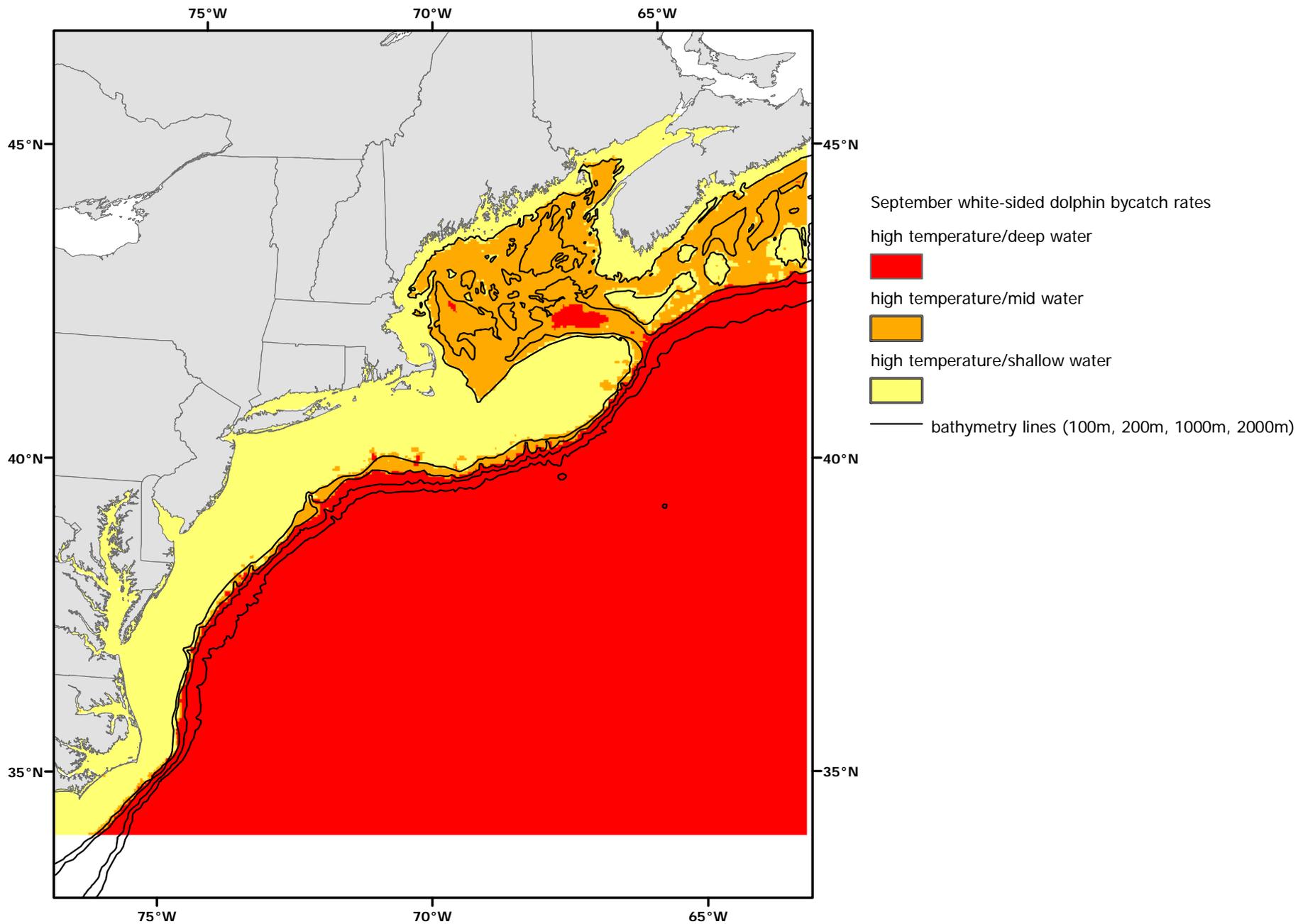
ATGTRT Sept 19, 2006

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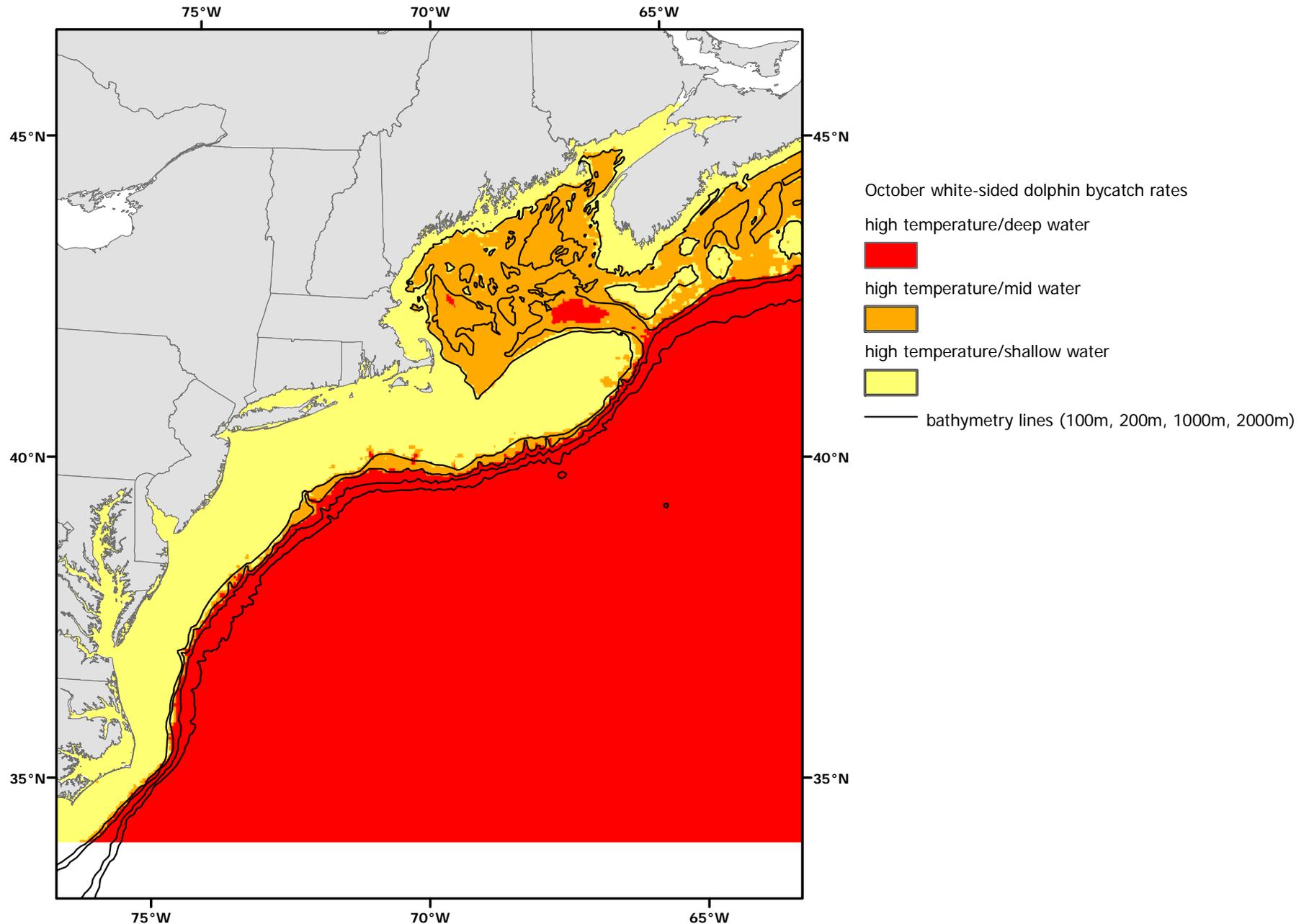
ATGTRT Sept 19, 2006

Marine Mammal Mortality Estimates



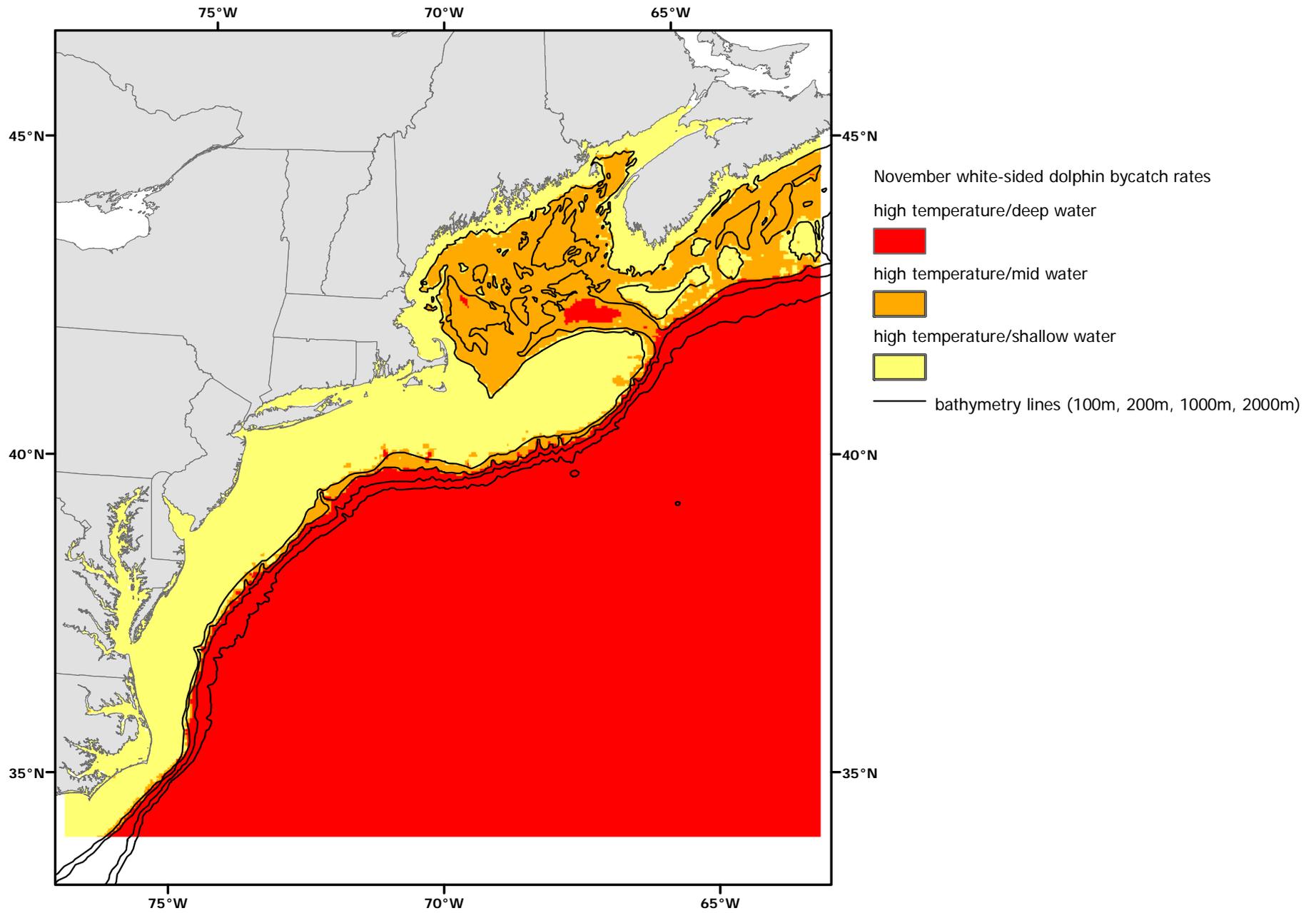
ATGTRT Sept 19, 2006

Marine Mammal Mortality Estimates



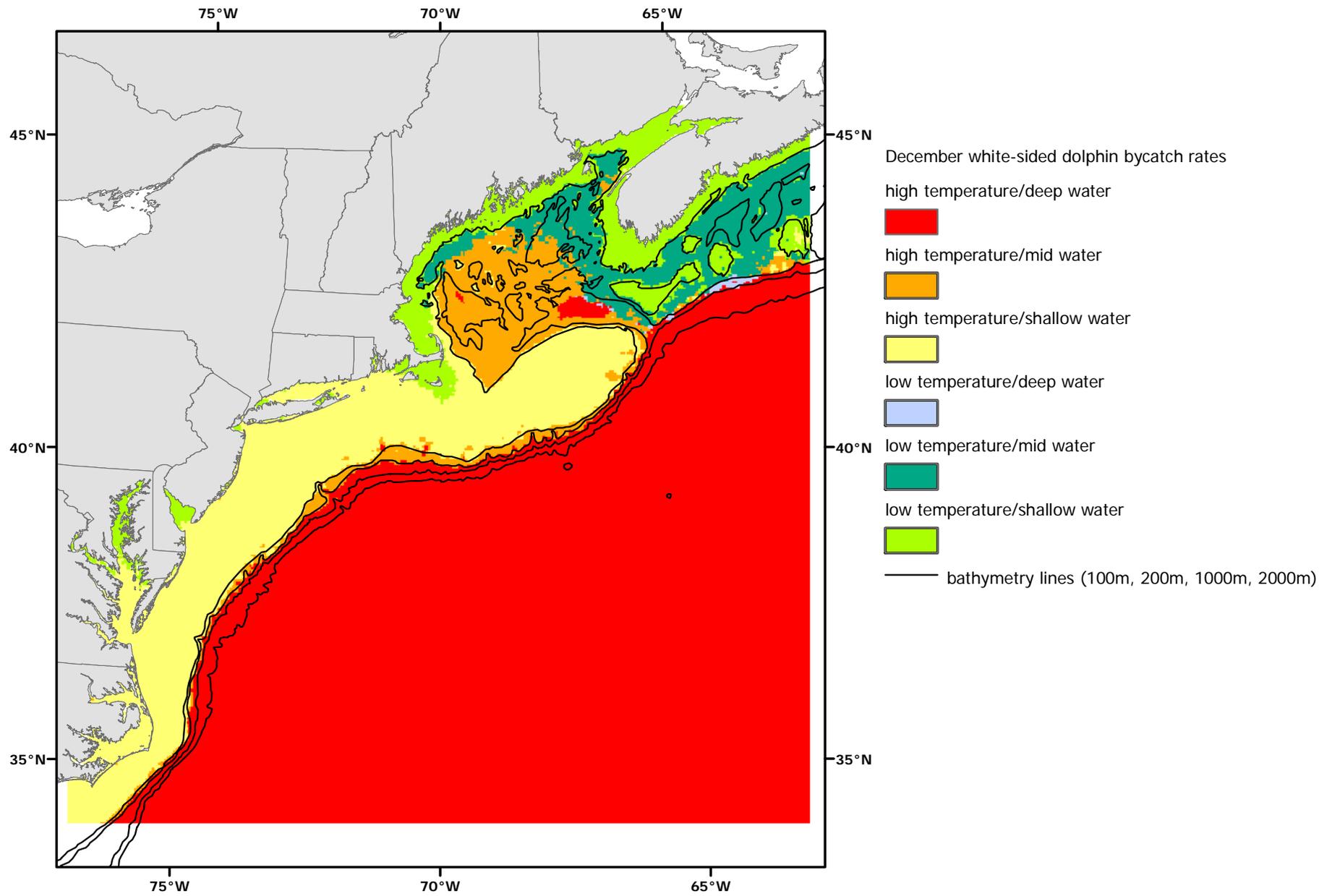
ATGTRT Sept 19, 2006

Marine Mammal Mortality Estimates



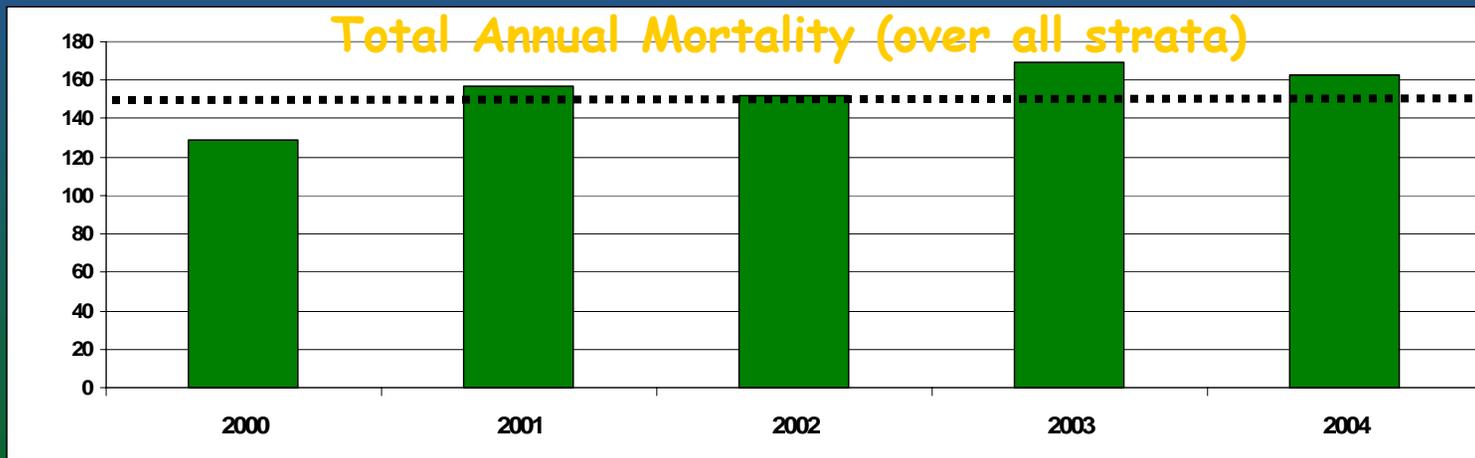
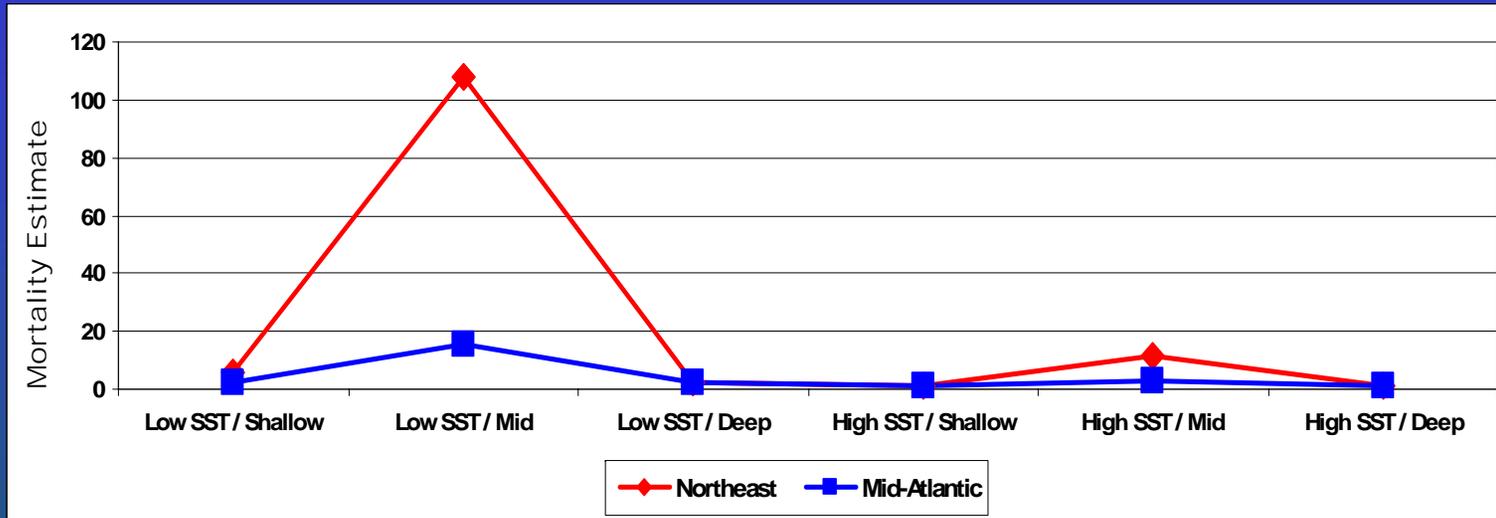
ATGTRT Sept 19, 2006

Marine Mammal Mortality Estimates



# Bottom Trawl

## Mean Annual (00-04) White-sided Dolphin Mortality by Strata



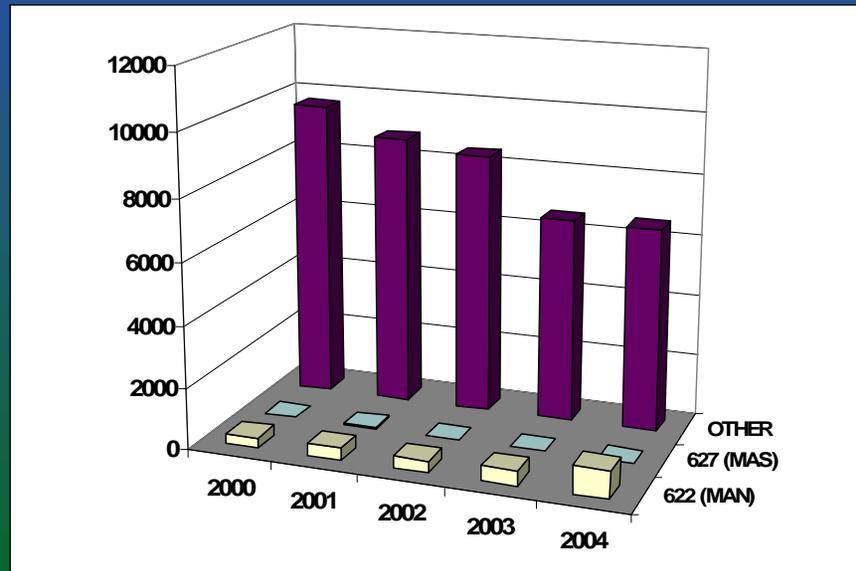
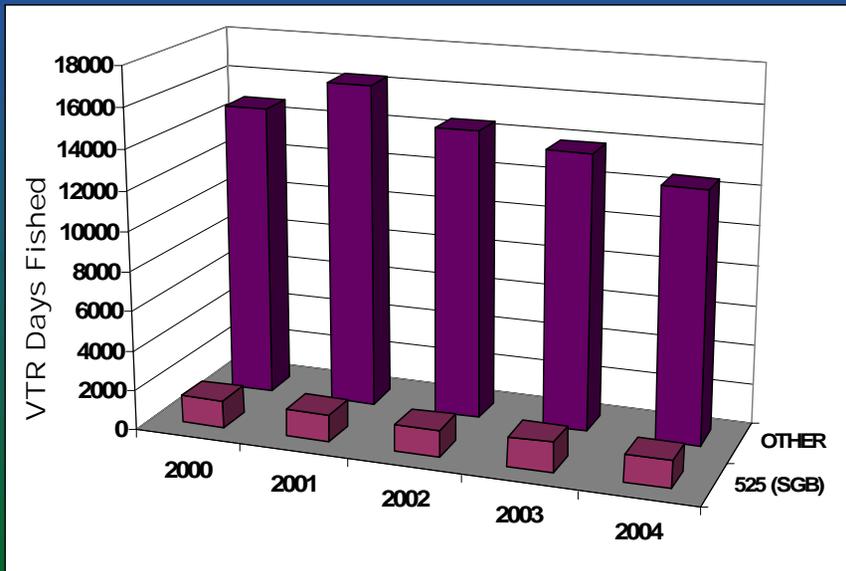
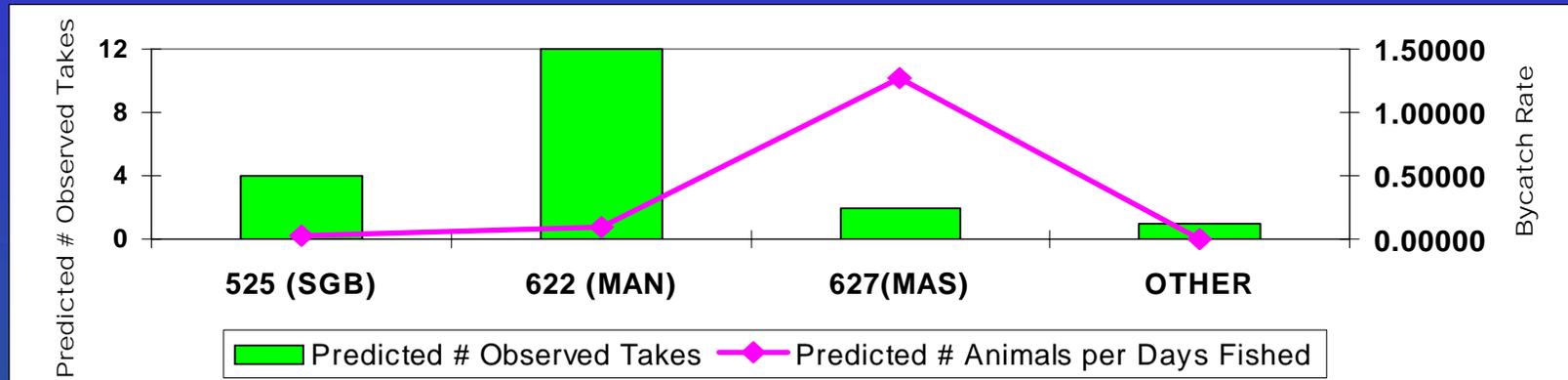
Mean=155

# Bottom Trawl

## Common Dolphin Bycatch

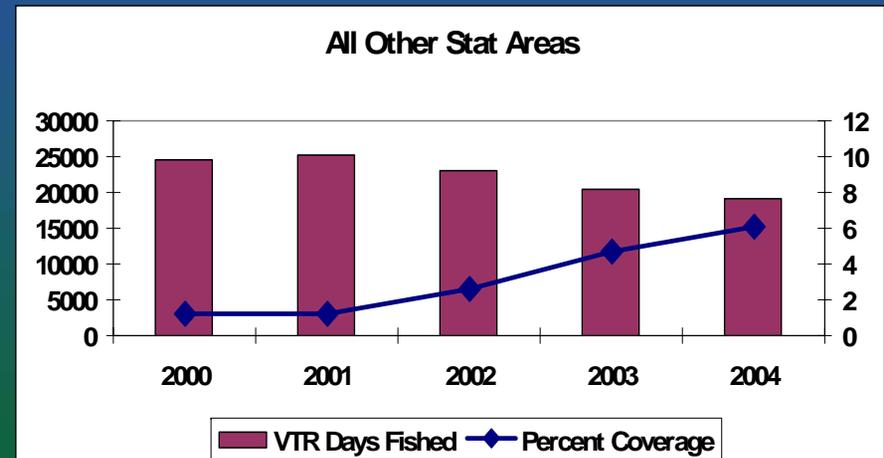
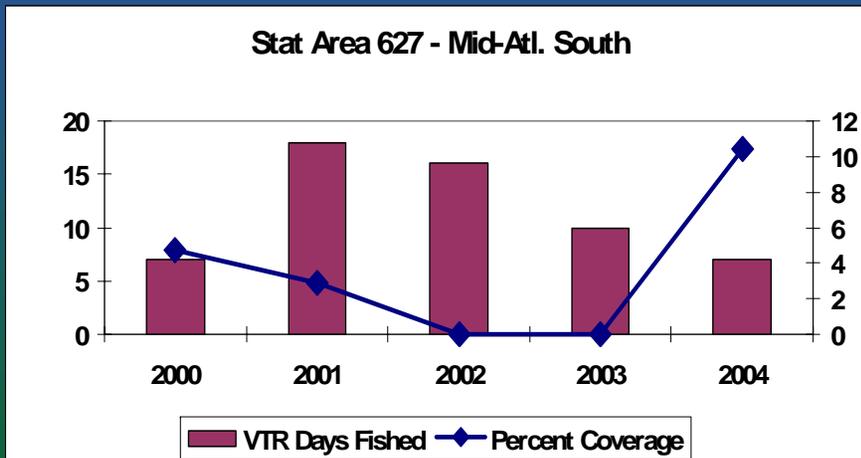
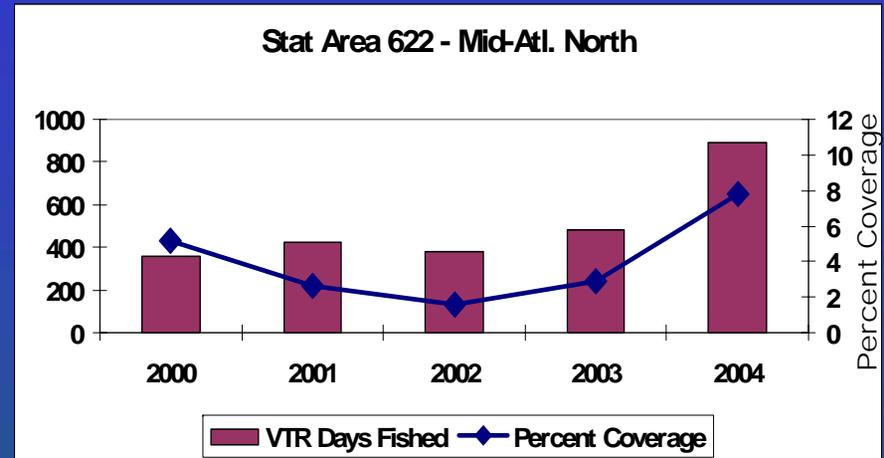
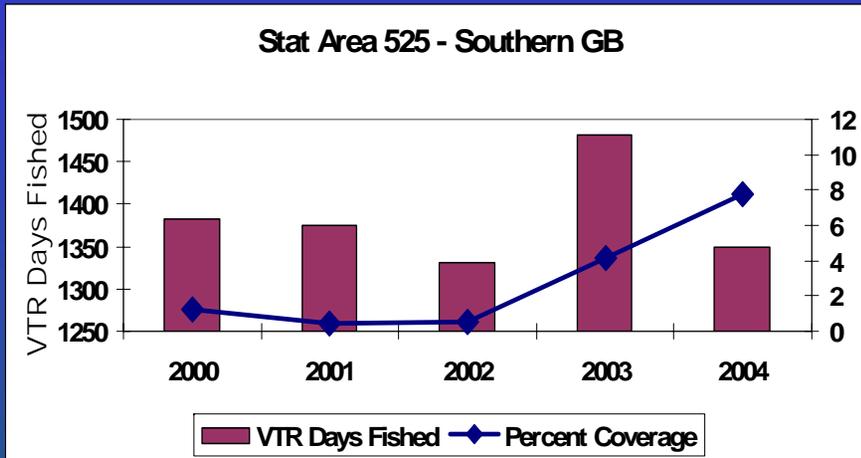
# BOTTOM TRAWL

## Common Dolphin Bycatch Rates and Total Effort by Stratum



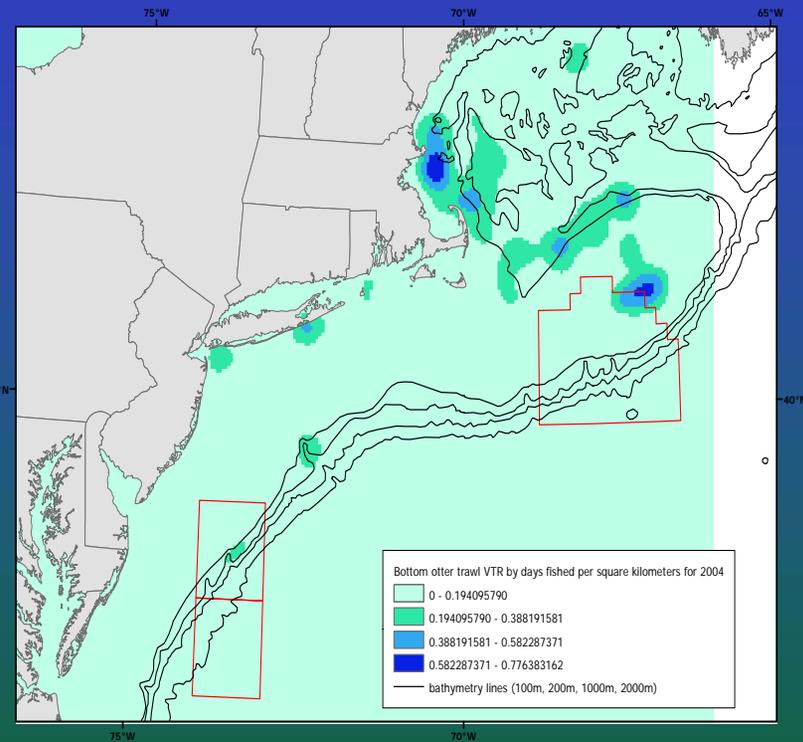
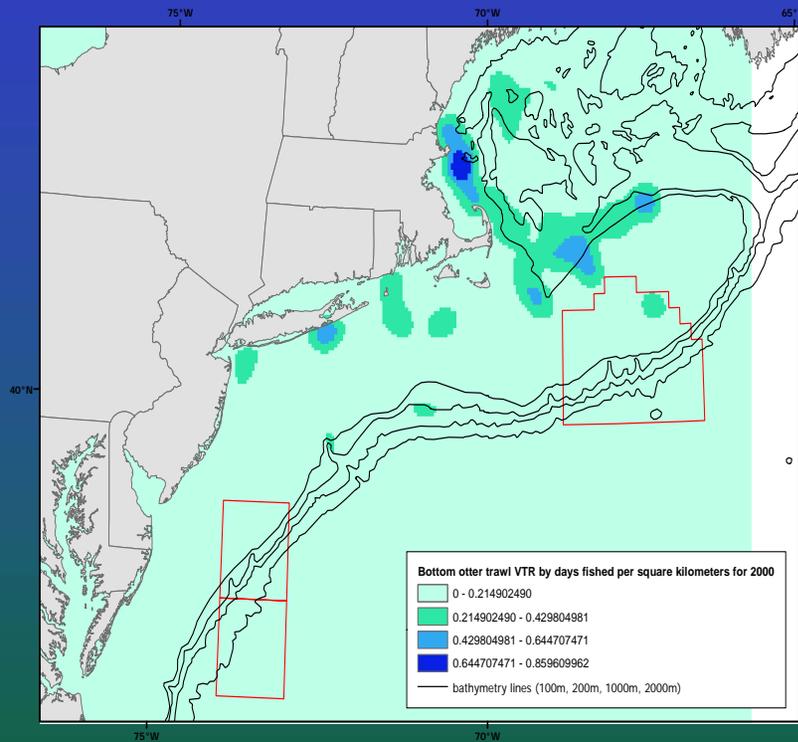
# Bottom Trawl

## Annual Observer Coverage in Common Dolphin Strata



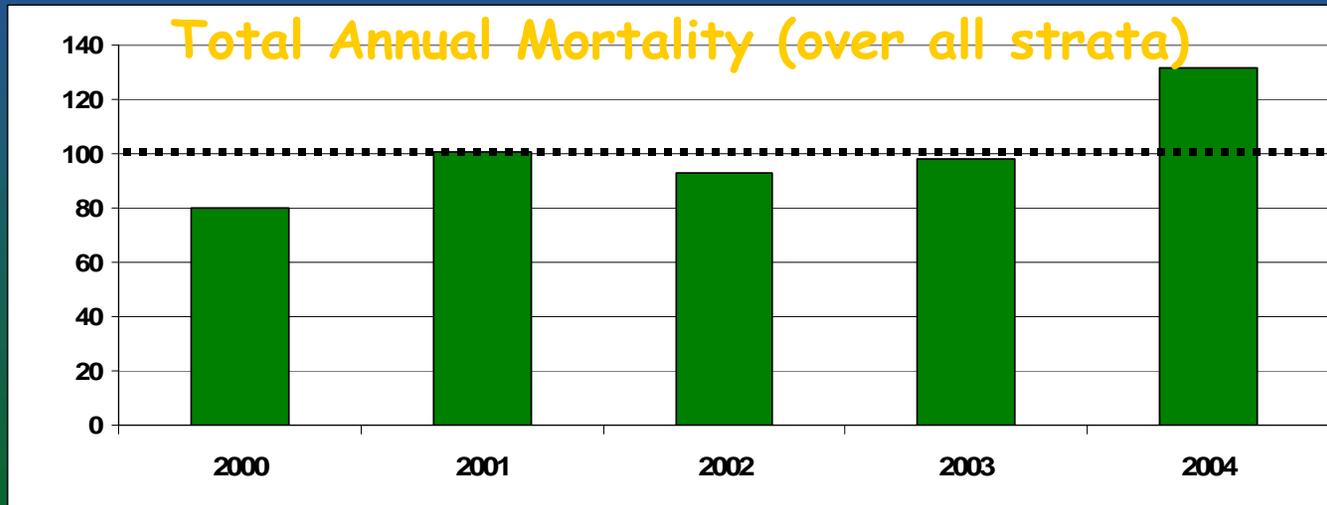
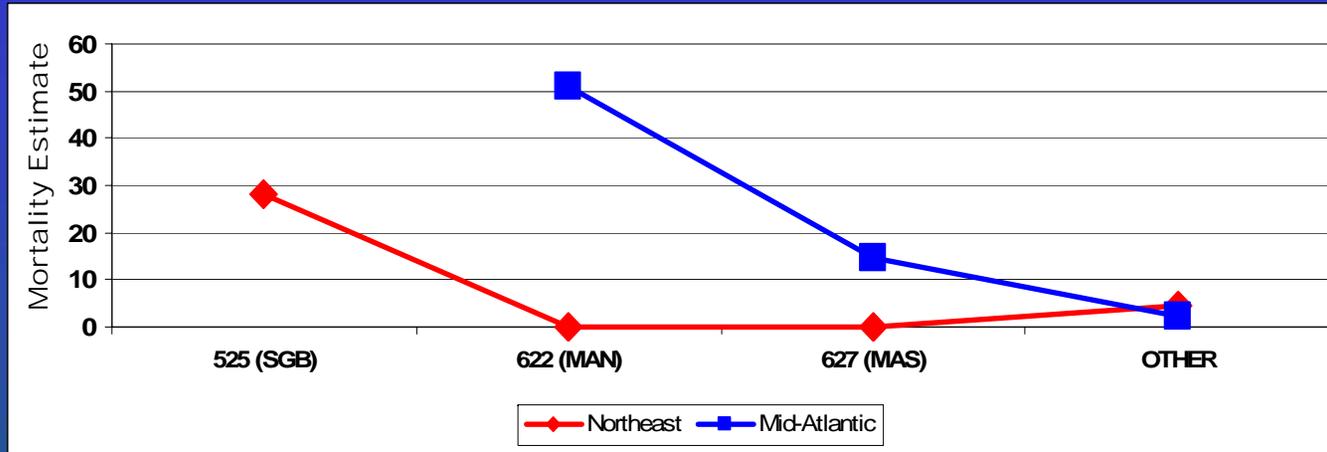
# BOTTOM TRAWL

## VTR Effort Density in Common Dolphin Strata



# Bottom Trawl

## Mean Annual (00-04) Common Dolphin Mortality by Strata



# January 2005 through May 2006 frequency of takes by gear and species

## • Bottom Trawl

- Pilot Whales = 9
- White-sided  
Dolphins = 52
- Common Dolphins = 33
- Harbor Porpoises = 4

## • Mid-water Trawl

- White-sided  
Dolphins = 11