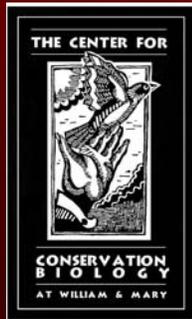


## Wind and Waterbirds

**Bryan Watts**

Center for Conservation Biology  
College of William and Mary  
Virginia Commonwealth University  
<http://www.ccb-wm.org>



**Producing information that enables conservation**

## Wind and Waterbirds

### CONTEXT

Offshore wind  
Atlantic Flyway

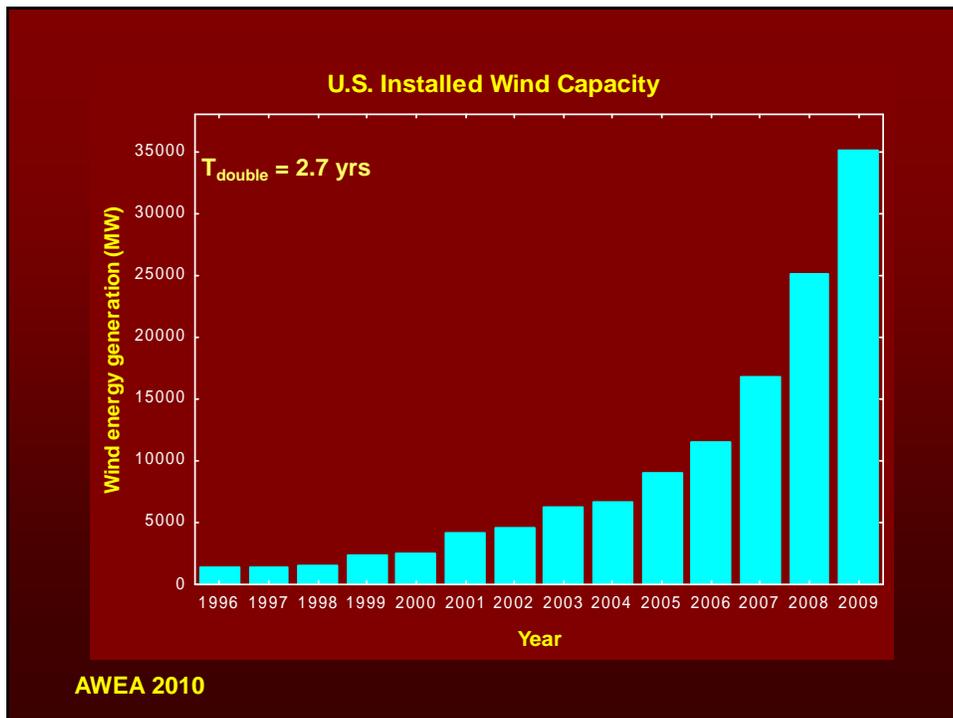
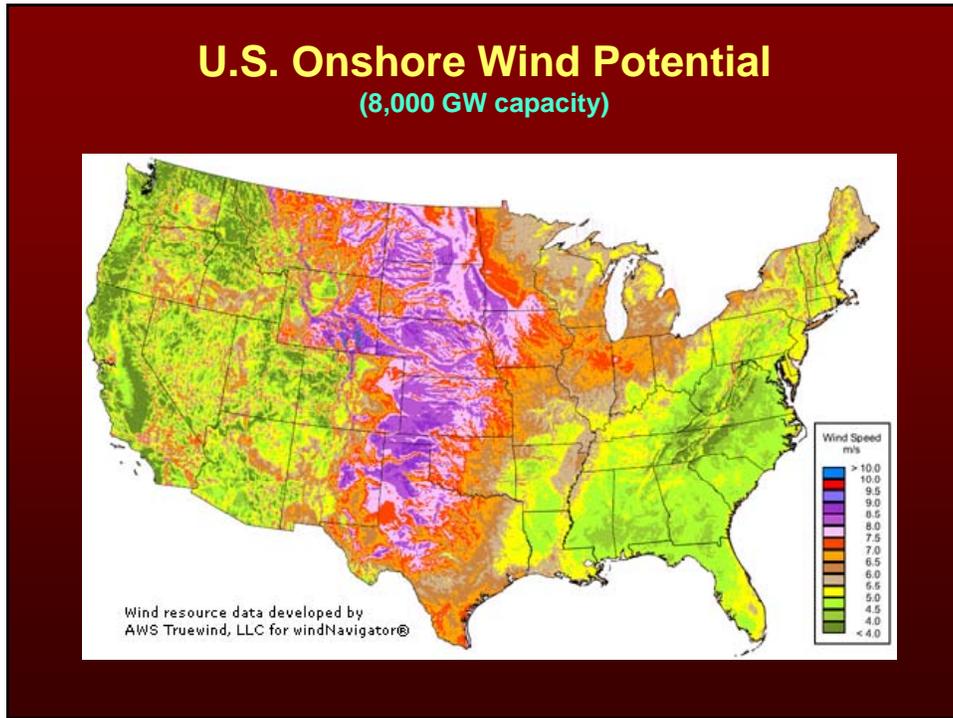
### POTENTIAL POPULATION IMPACTS

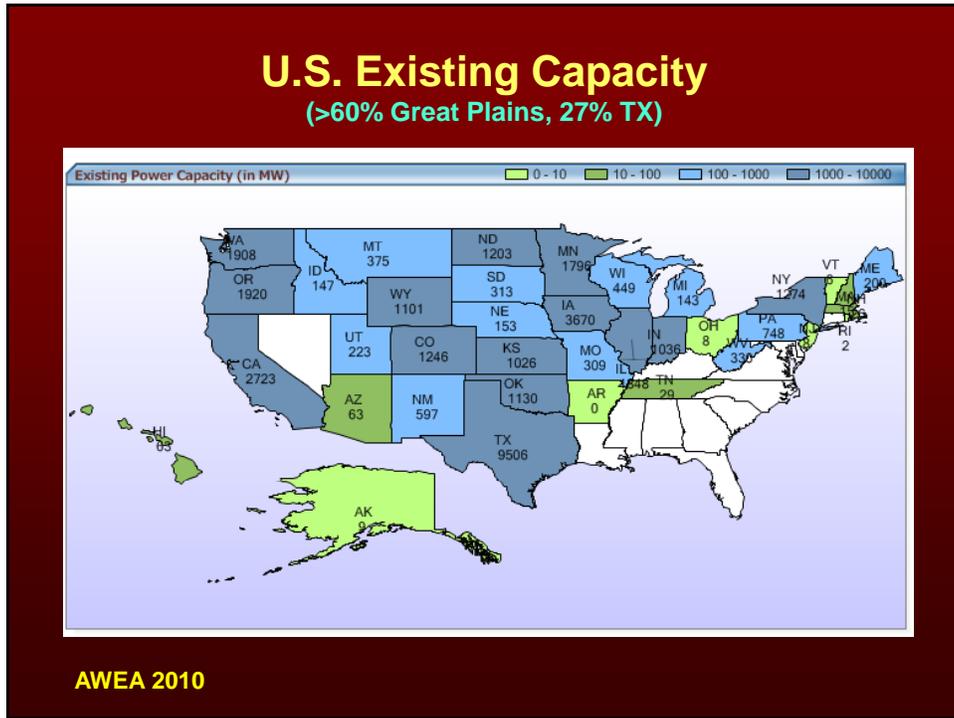
Exposure  
Vulnerability  
Priority Species

### INFORMATION

Existing Information  
Information Needs  
Techniques







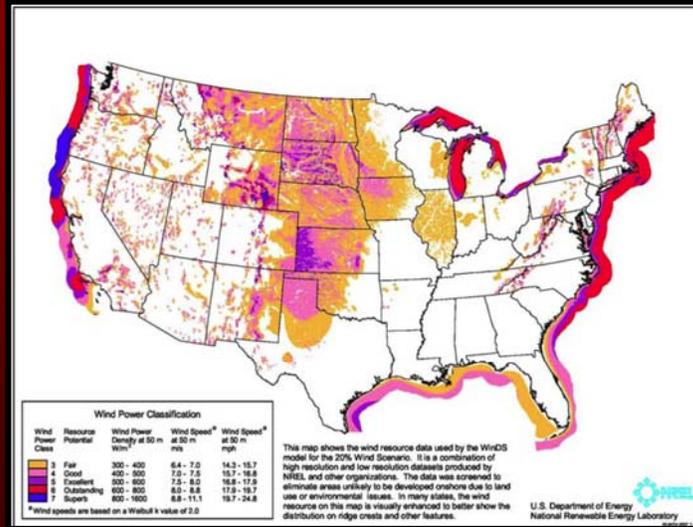
## Great Plains Strategy

**UP SIDE**  
Good, stable wind resources

**DOWN SIDE**  
Land consumption  
Transport to major load centers

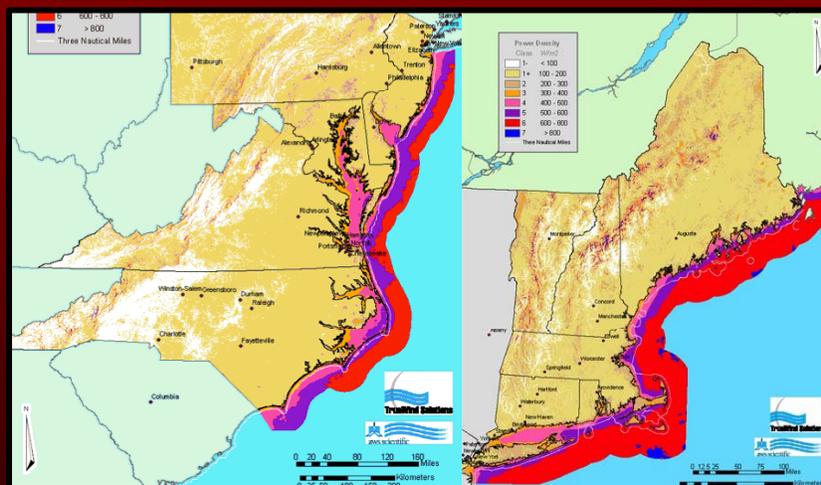


## U.S. Wind Potential

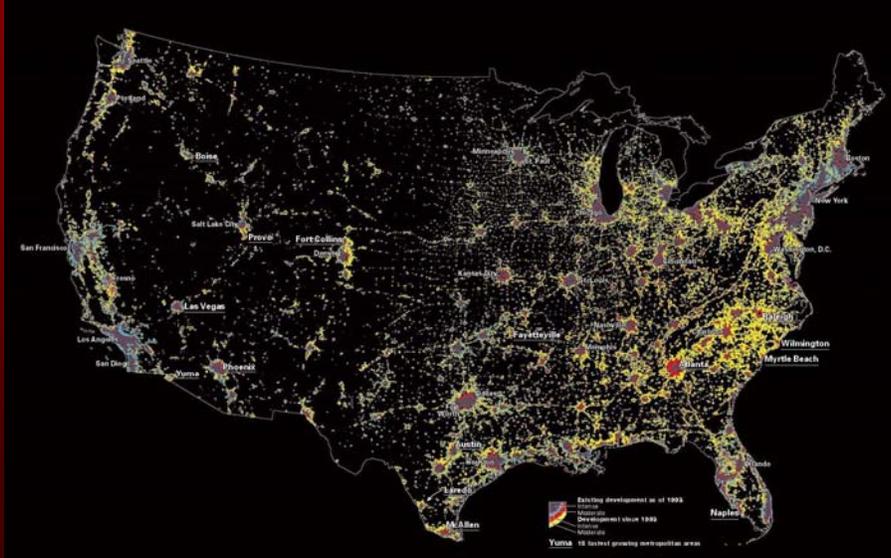


DOE 2030 report

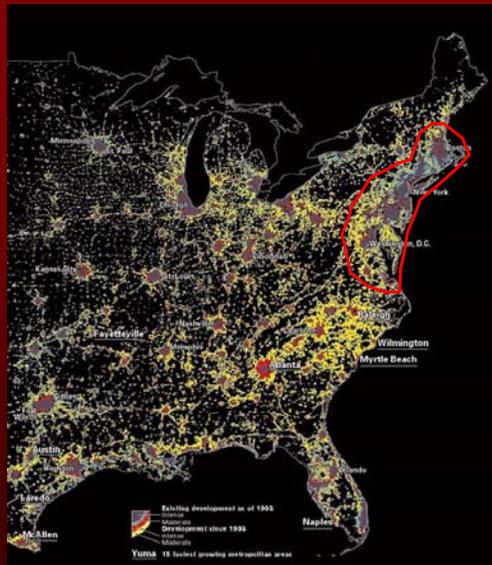
## NORTHEAST OFFSHORE Wind Potential (96 GW in <30-m water, 386 GW within 50 nm)



## U.S. Map of Night Lights



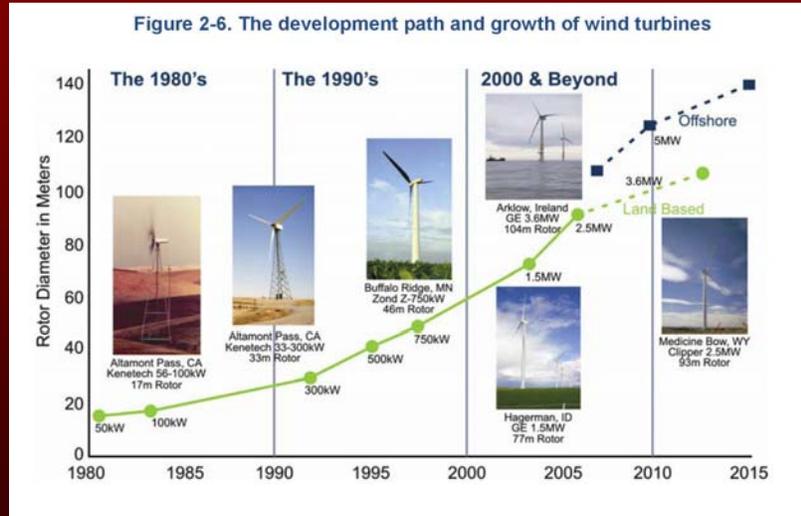
National Geographic Society



## Bo-Wash

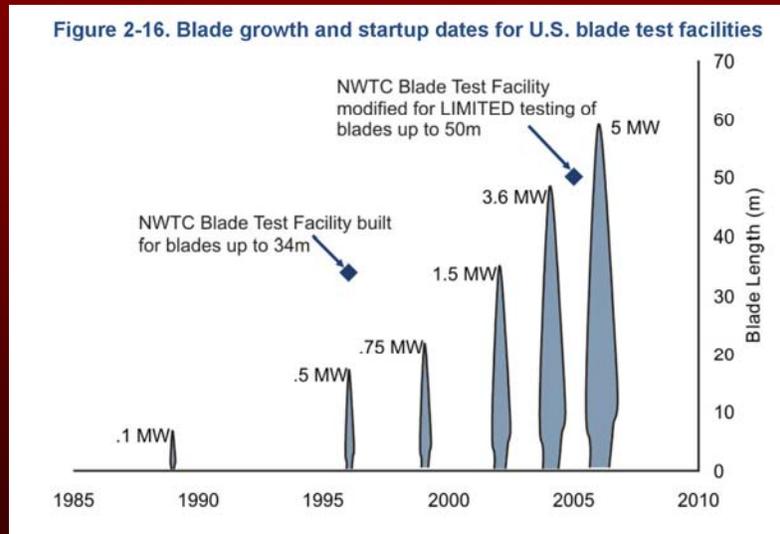
2.2 Trillion Dollars  
Human density  
Transportation  
Land development

## Wind Turbine Evolution

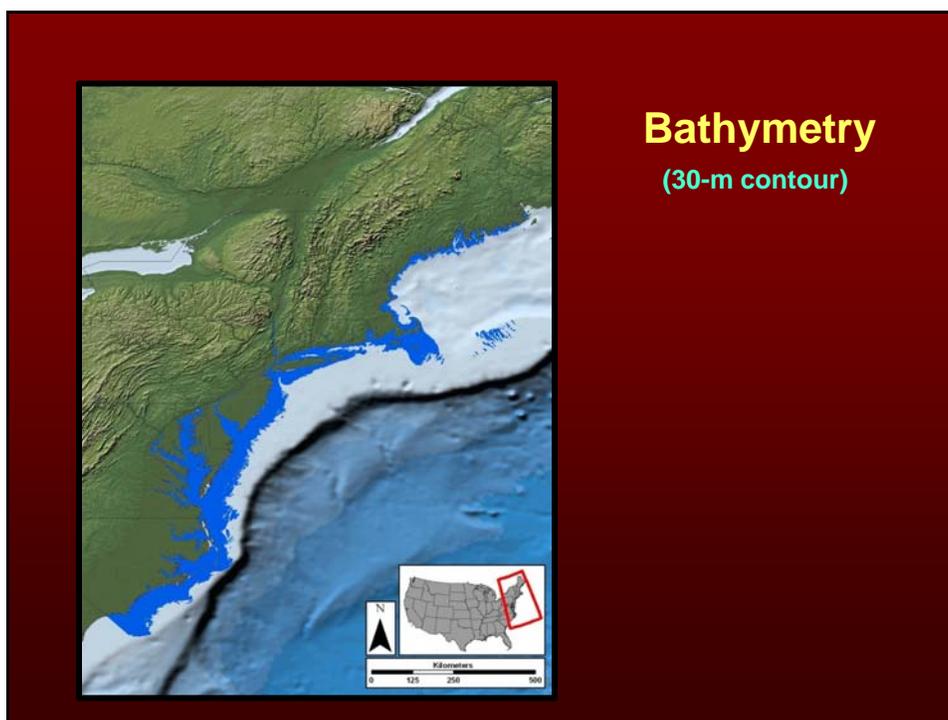
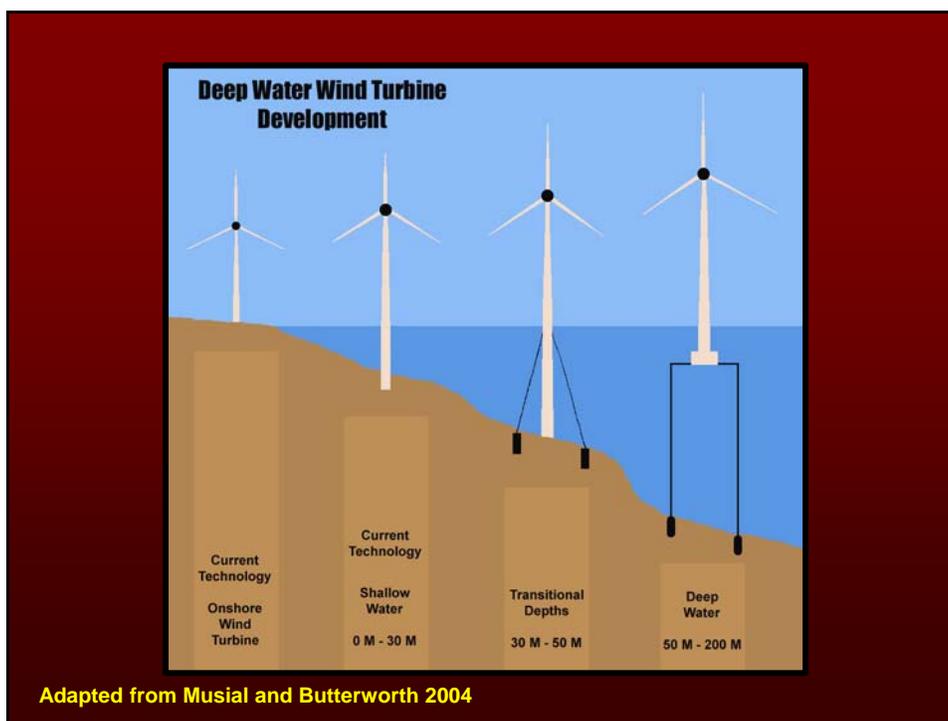


DOE 2030 report

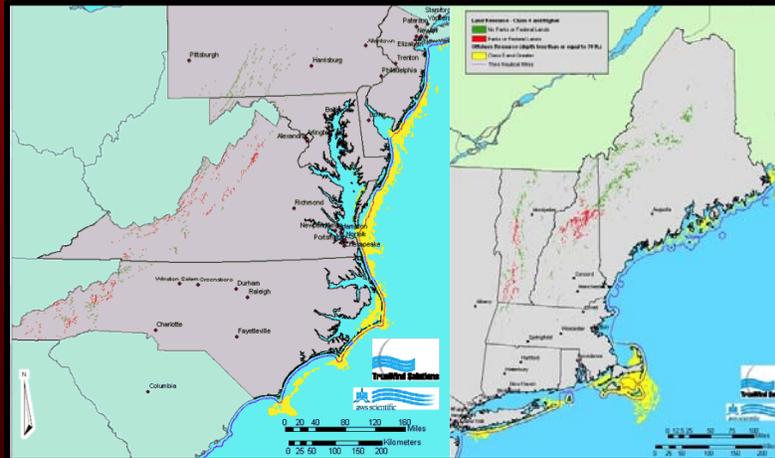
## Rotor Blade Development



DOE 2030 report



## Exploitable Winds with Existing Technology (class 5 winds in <21-m water)

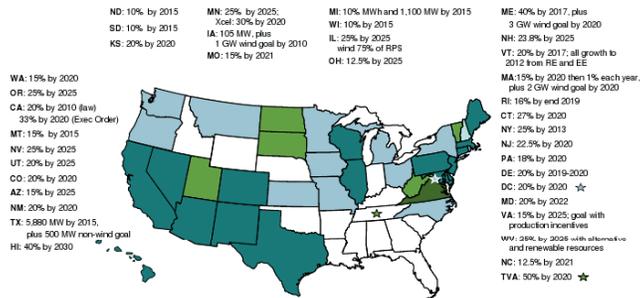


## Policy Drivers (state-level Renewable Portfolio Standards)

Renewable Power & Energy Efficiency Market: Renewable Portfolio Standards

Federal Energy Regulatory Commission - Market Oversight @ FERC.gov

### 30 States including D.C. have Renewable Energy Portfolio Standards (RPS)



Updates at: <http://www.ferc.gov/marketoversight/efm/energy/renew.asp>

Abbreviations: EE - Energy Efficiency; RE - Renewable Energy  
Notes: An RPS requires a percent of an electric provider's energy sales (MWh) or installed capacity (MW) to come from renewable resources. Most specify sales (MWh). Map percents are final years' targets. TVA's goal is not state policy; it calls for 50% zero- or low-carbon generation by 2020. Alaska has no RPS.  
Sources: Derived from data in: LBW, PUCs, State legislative tracking services, Pew Center, and the Union of Concerned Scientists. Details, including timelines, are in the Database of State Incentives for Renewables and Energy Efficiency: <http://www.dsireusa.org>

■ RPS  
■ Accelerated or strengthened RPS  
■ Voluntary standards or goals  
■ Strengthened voluntary standard

Updated December 8, 2009

## Policy Drivers

(state-level Renewable Portfolio Standards)

State	Energy from RPS	Deadline
Maine	40.0%	2017
New Hampshire	25.0%	2025
Massachusetts	25.0%	2025
Rhode Island	16.0%	2019
Connecticut	27.0%	2020
New York	25.0%	2013
New Jersey	22.5%	2021
Delaware	20.0%	2019
Maryland	20.0%	2022
Virginia	15.0%	2025
North Carolina	12.5%	2021

Source: Pew Center

## WIND DEVELOPMENT

### Development of US wind industry

Initial focus on midwest

Current focus on offshore resources

### Tremendous policy drivers (RPS)

Collective RPS from offshore 54,000 MW

Buildout = 10,000-20,000 turbines

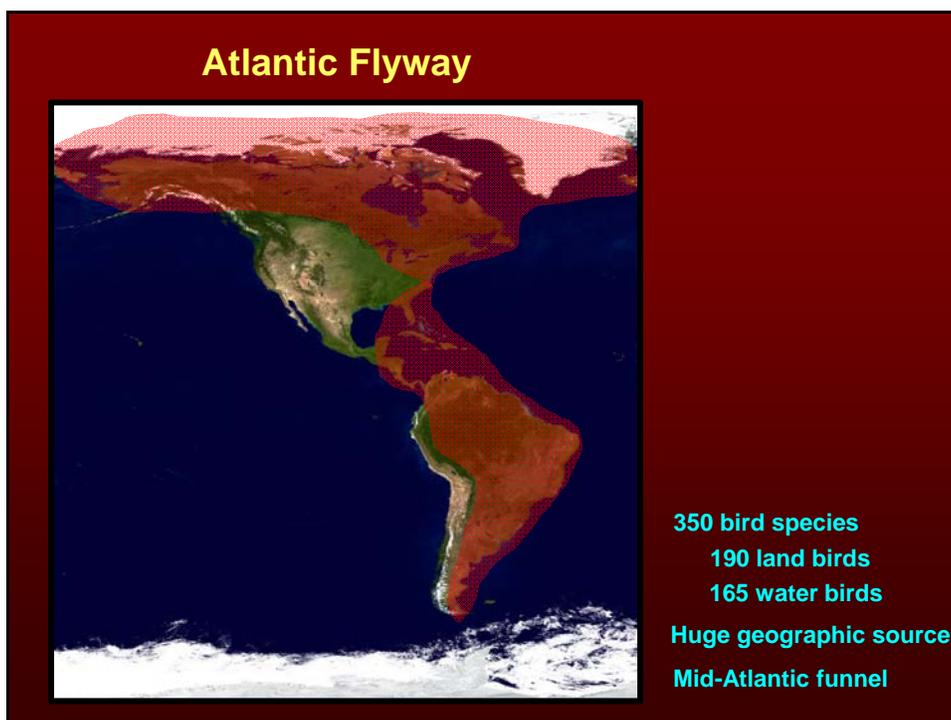
Space required = 10,000-20,000 sq km

### Industry incentives

170 billion dollar industry

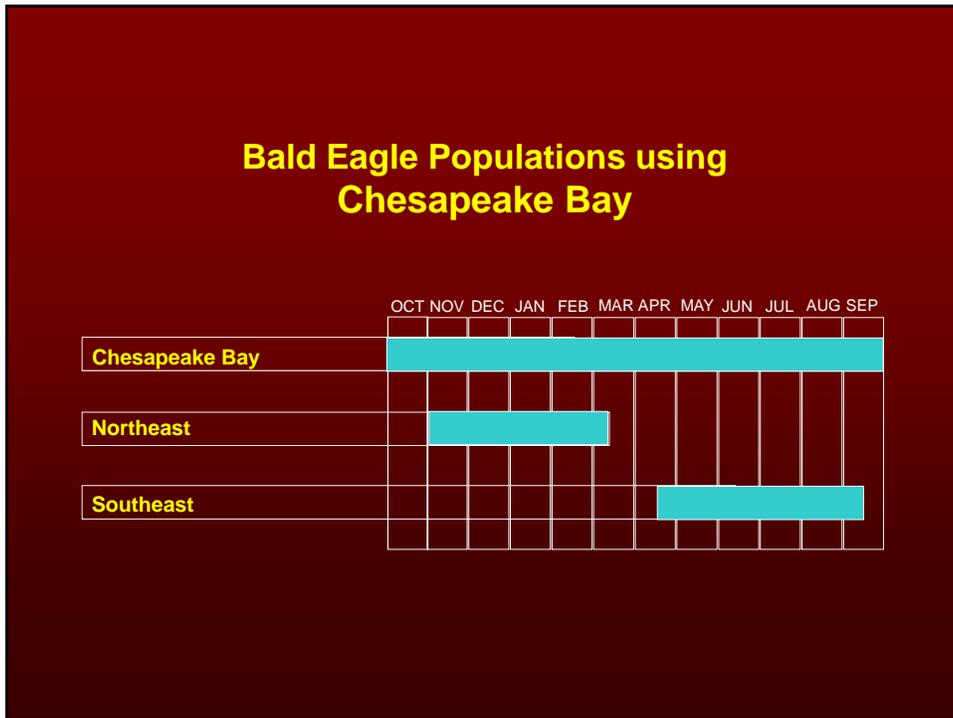
Favorable policy incentives



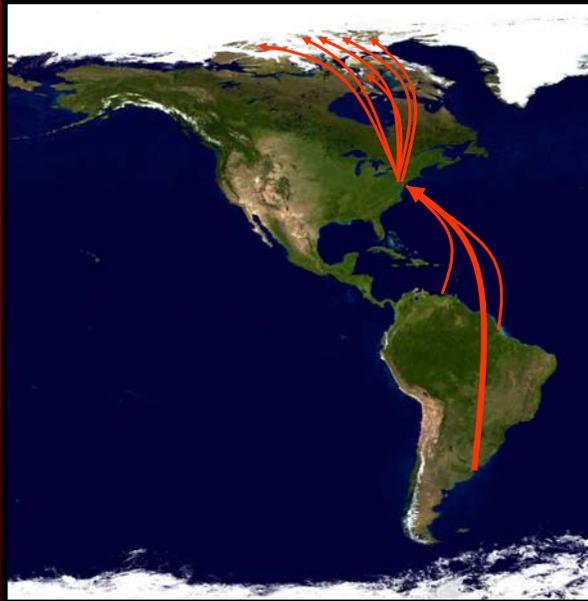




**Chesapeake Bay**  
Area of eagle convergence  
for the entire Atlantic Coast



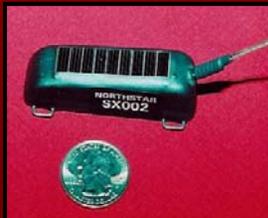
### Mid-Atlantic Staging Area



Red Knot



### Peregrine Falcon Tracking



## Association with Atlantic Flyway (Waterbirds)

No. Species	Breeding	Wintering	Summering	Fall Migration	Spring Migration
4					
33					
7					
33					
1					
53					
7					
14					
11					

160 species migrating through flyway

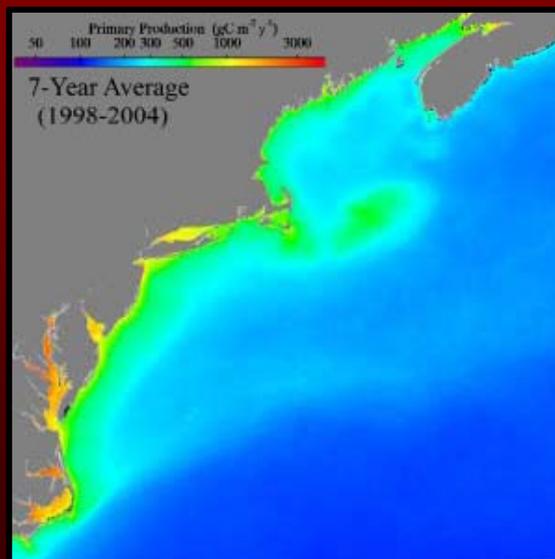
## Breeding Waterbirds Restricted to Nearshore



### Northern Gannet Foraging Flock



### Primary Productivity





**Coast-line  
Wind Installations**



**Blythe, UK**



**Blockstigen, SE**

**True Pelagics**



Bermuda Petrel 30nm SE of Hatteras Inlet July 3, 2005  
Photo Copyright Brian Patteson

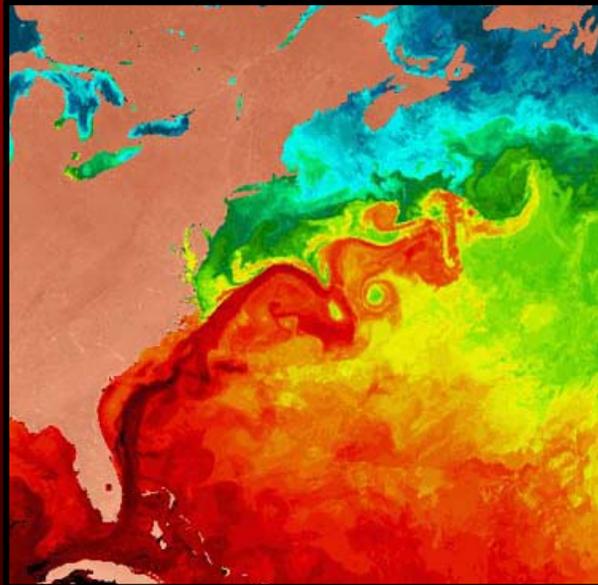
**Global population  
30 breeding pairs**



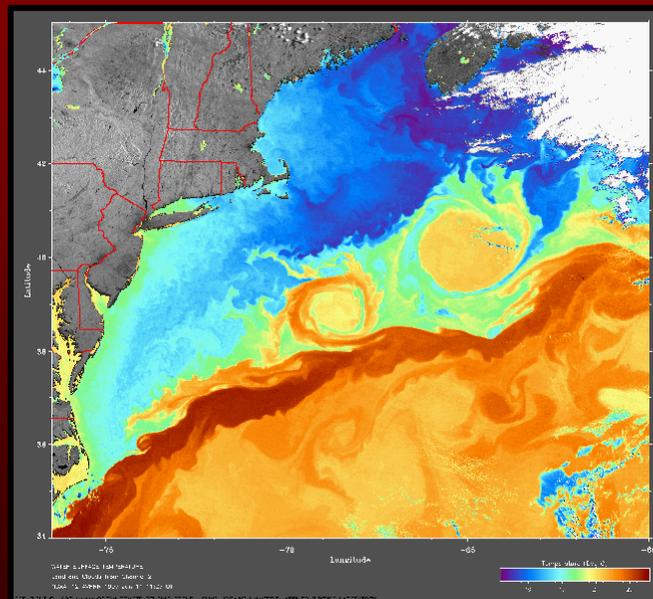
Pee's Petrel about 30 nm SSE of Hatteras Inlet, NC June 19, 2005  
Image Copyright Brian Patteson

**Global population  
700 breeding pairs**

### Sea Surface Temperature



### Warm Core Rings



### Hurricane Isabel



### Nor'easter



## ATLANTIC FLYWAY

### Huge movement corridor for birds

Hundreds of millions of individuals

>300 species included

Populations drawn from large area

### Ecological role of Atlantic Coast

Complex and species-specific

### Distribution relative to coast line

Highest diversity and volume nearshore

Community of species offshore



## Wind and Waterbirds

### CONTEXT

Offshore wind

Atlantic Flyway

### POTENTIAL POPULATION IMPACTS

Exposure

Vulnerability

Priority Species

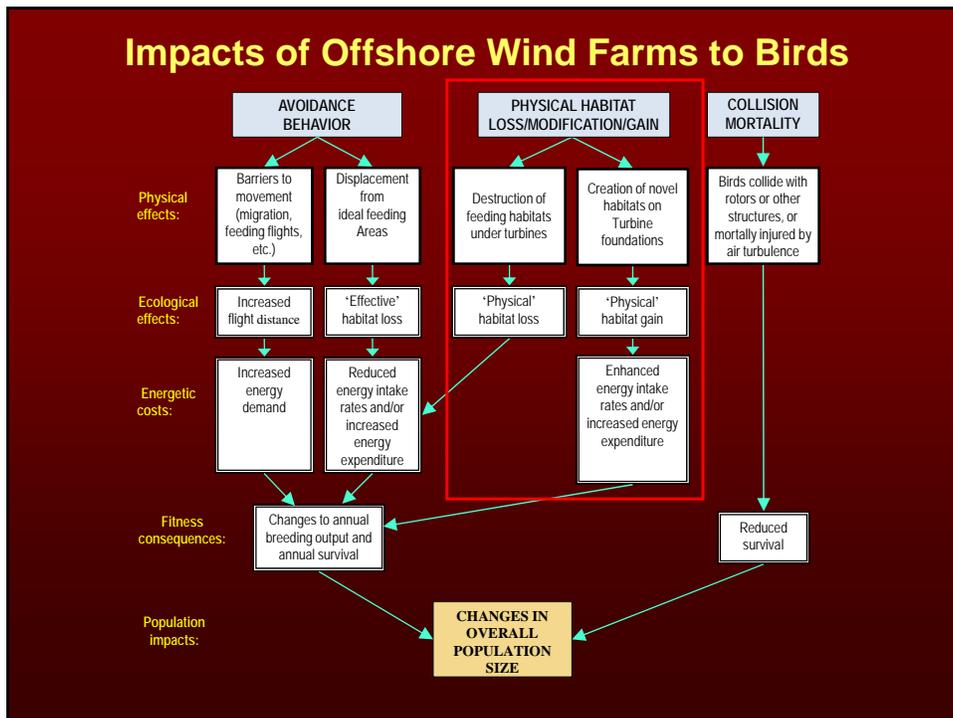
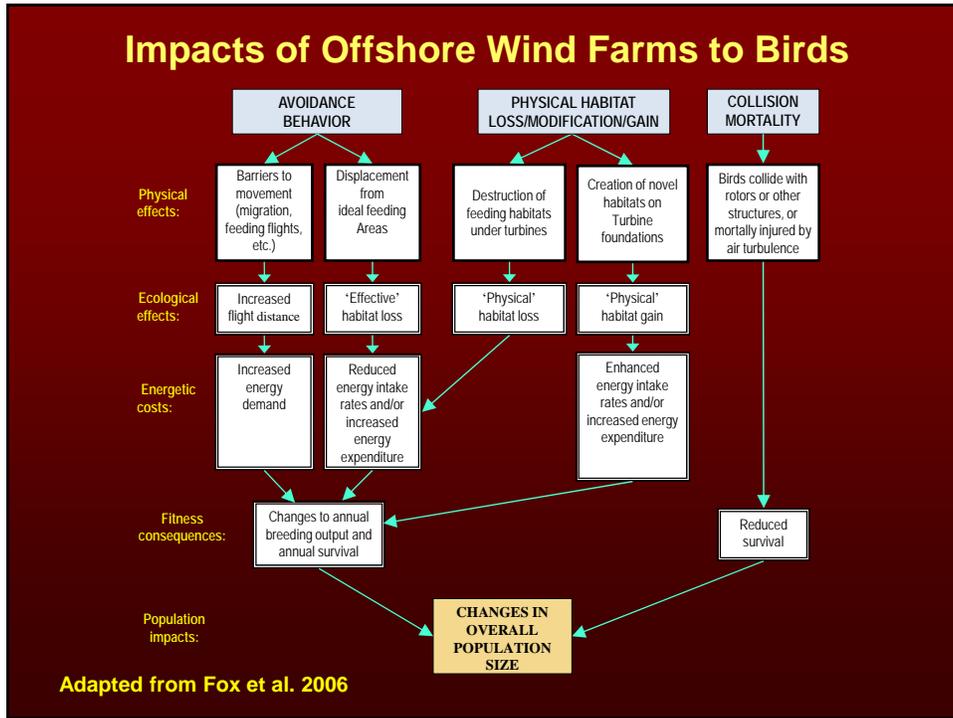
### INFORMATION

Existing Information

Information Needs

Techniques



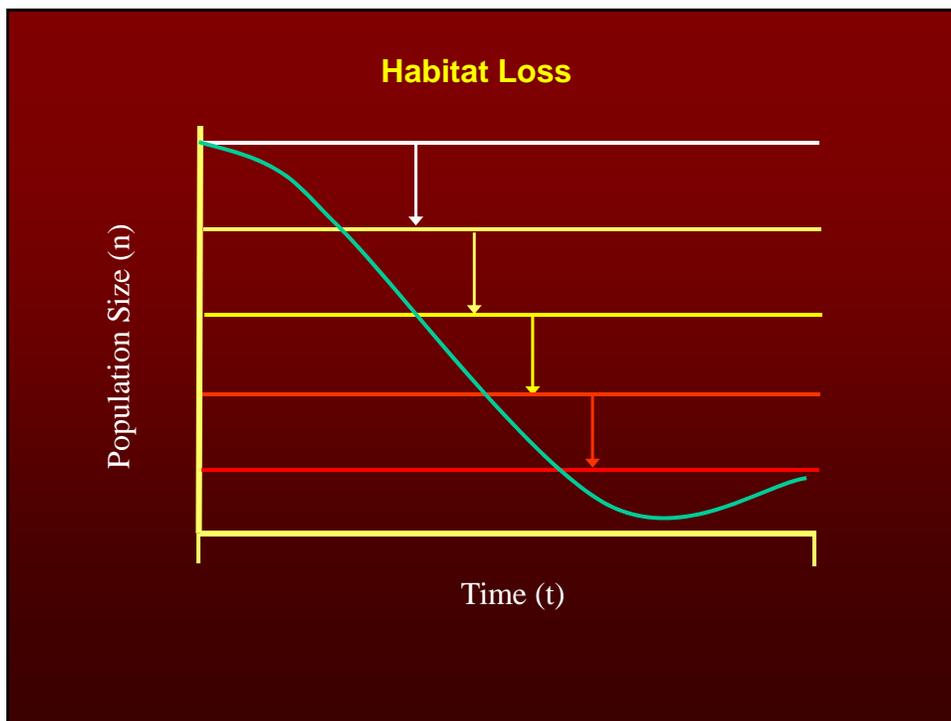


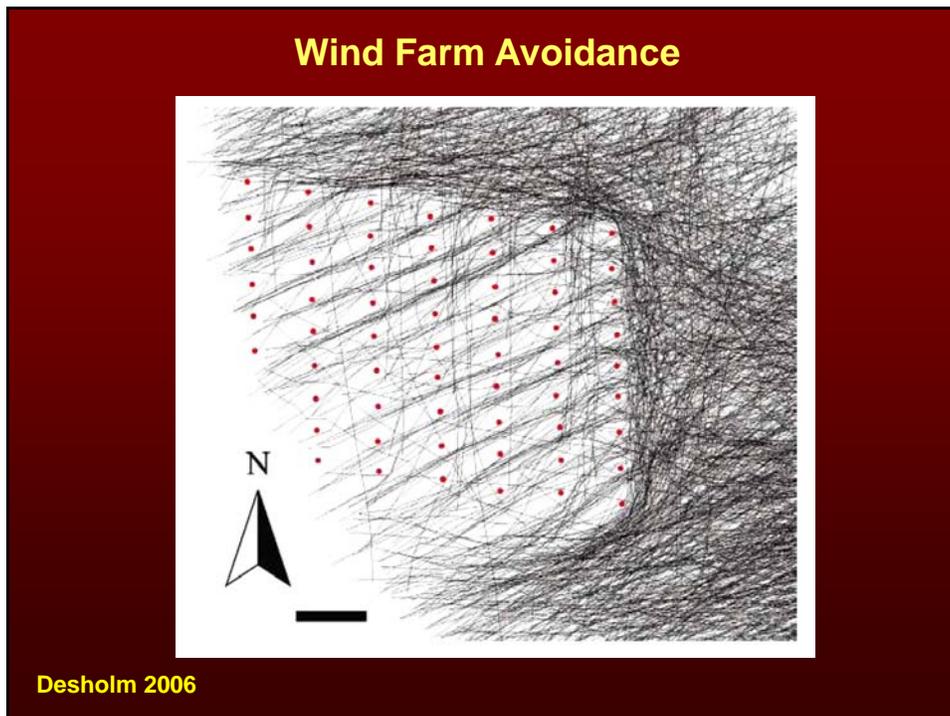
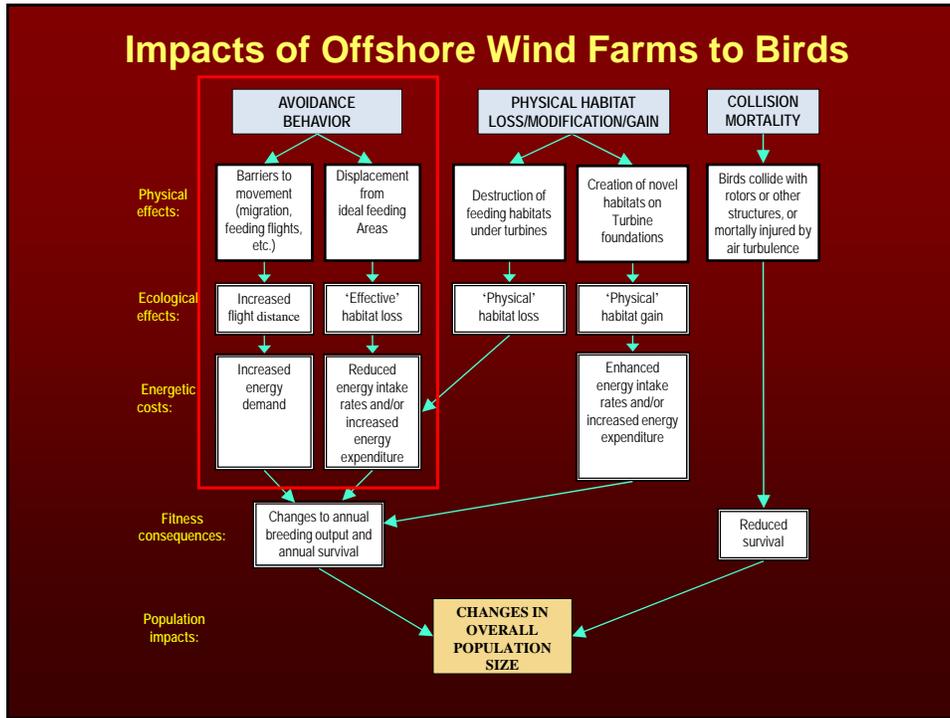
### Wind Farms Consume Space/Habitat

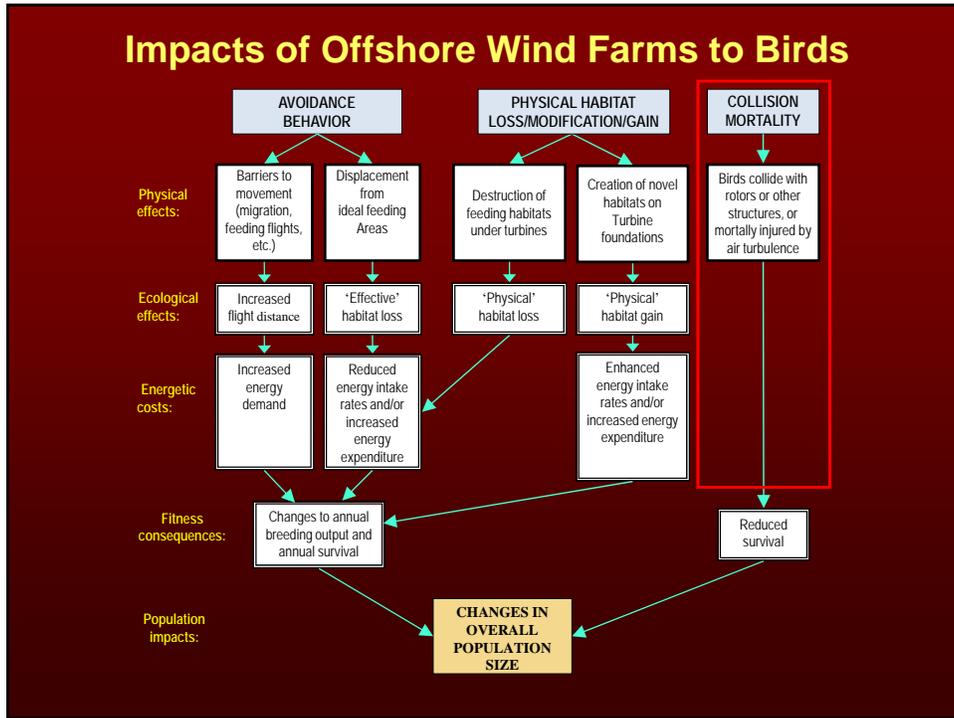


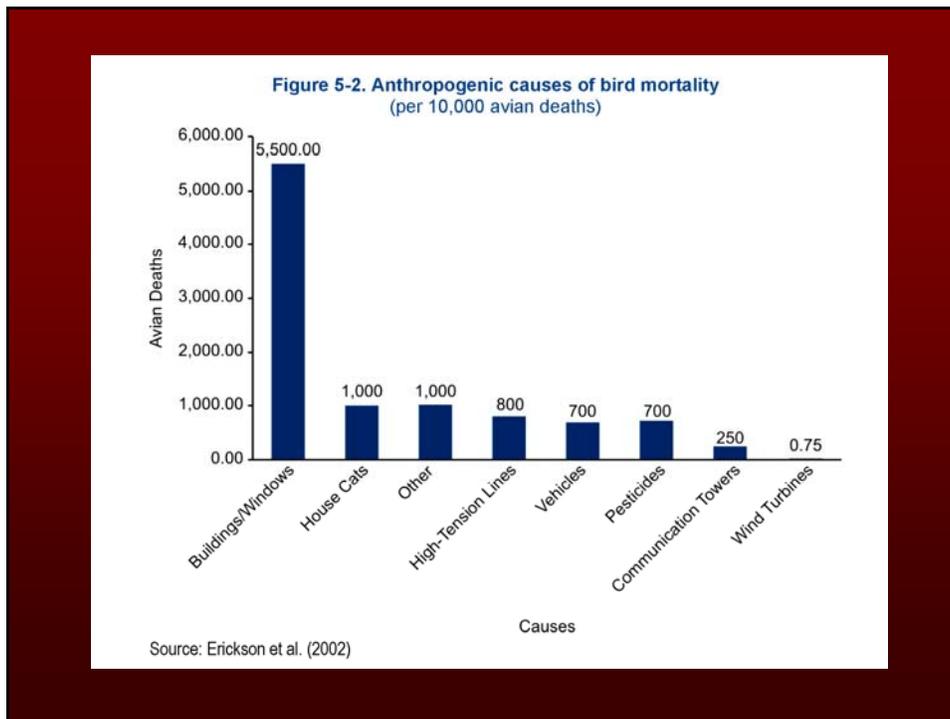
### Available Surface Area by State (sq km)

State	State Waters Bays and Sounds	State Waters (0-3 miles)	Federal Waters (3-200 miles)	Total
Maine	11.7	2,758.0	15.9	2,785.6
New Hampshire	122.9	159.9	0.4	283.2
Connecticut	1,319.1	0.5	0.0	1,319.6
Massachusetts	2,429.6	2,283.5	5,989.7	10,702.8
Rhode Island	318.9	349.3	152.6	820.8
New York	2,563.4	1,250.8	2,296.5	6,110.7
New Jersey	1,460.7	1,199.0	6,306.1	8,965.8
Delaware	762.7	244.7	973.1	1,980.5
Maryland	5,186.1	258.7	1,339.4	6,784.2
Virginia	4,491.7	1,053.8	8,591.3	14,136.8
North Carolina	6,362.6	2,807.8	18,132.8	27,303.2
<b>Total</b>	<b>25,029.4</b>	<b>12,366.1</b>	<b>43,797.8</b>	<b>81,193.4</b>

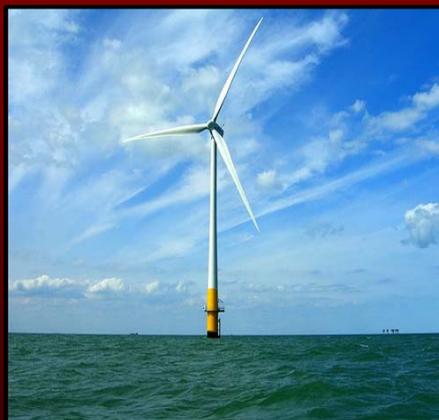




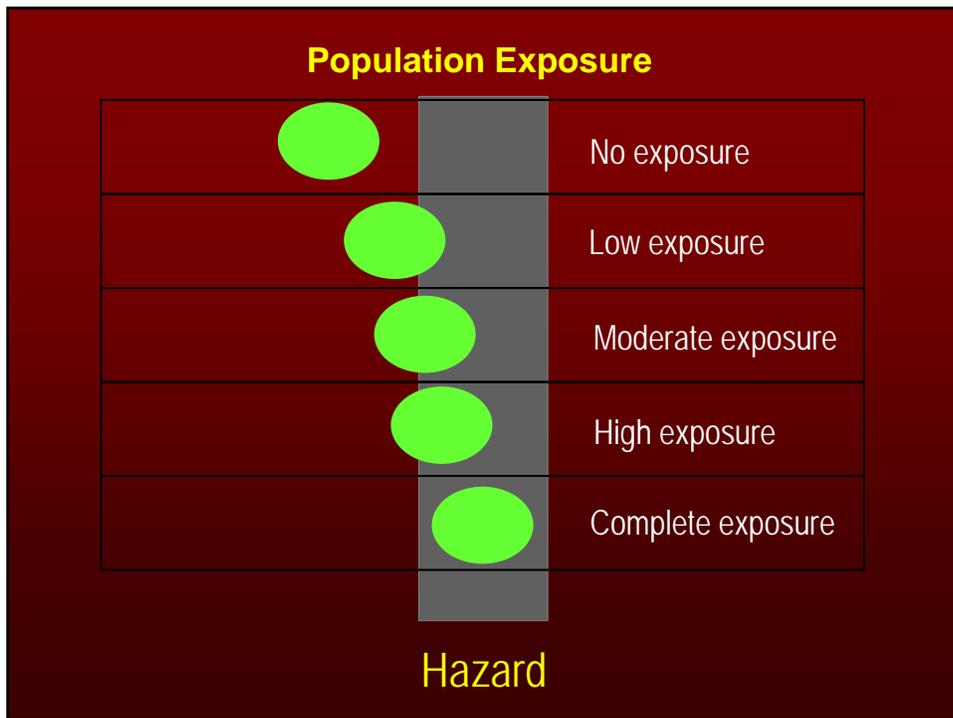
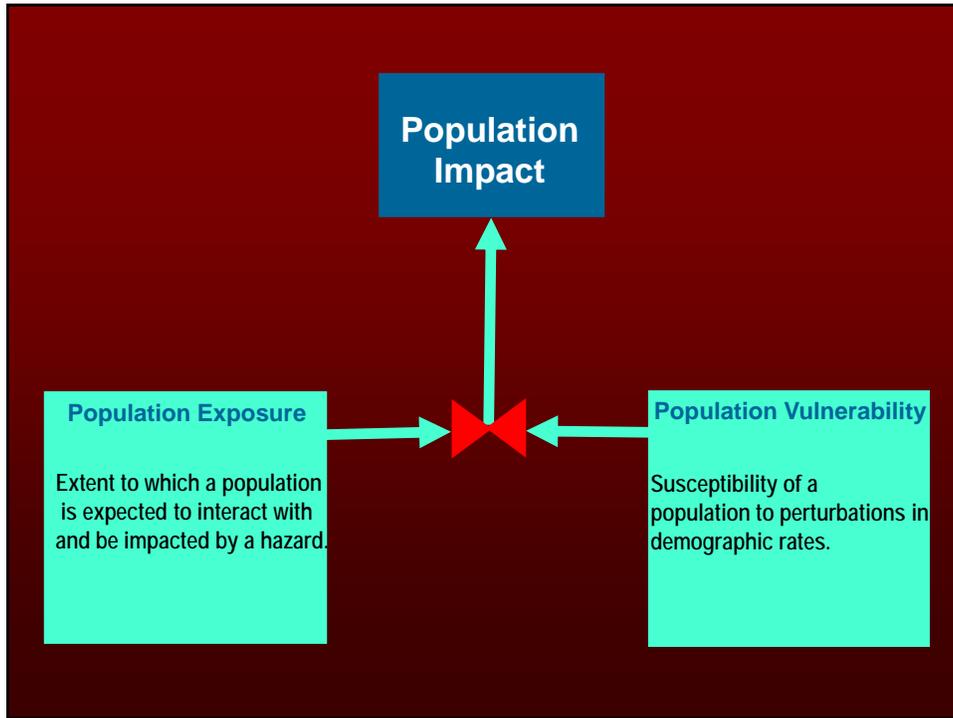




**Offshore Mortality Rates**  
(Range 0.34-3.4 birds/turbine/year)  
(Percival 2001)



**Very few estimates**  
**None from Atlantic Flyway**  
**None from large turbines**  
**Collisions underestimate impacts**  
**Absolute rates inadequate**



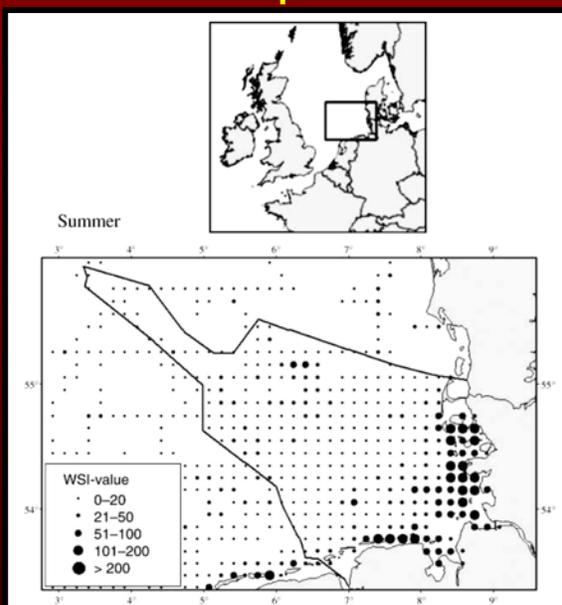
### Mid-Atlantic Staging Area



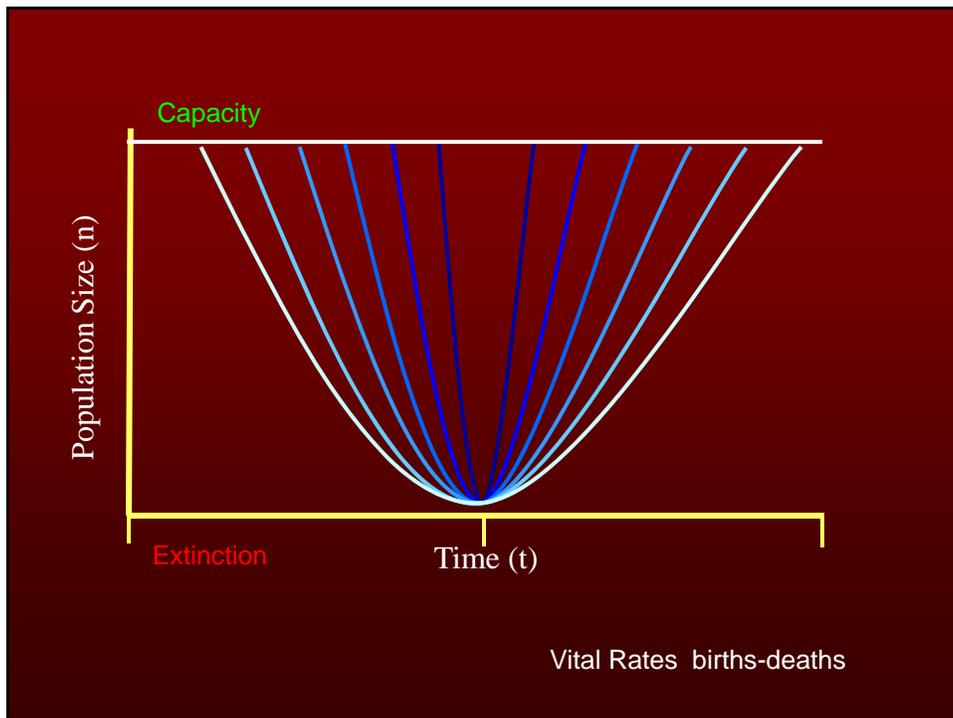
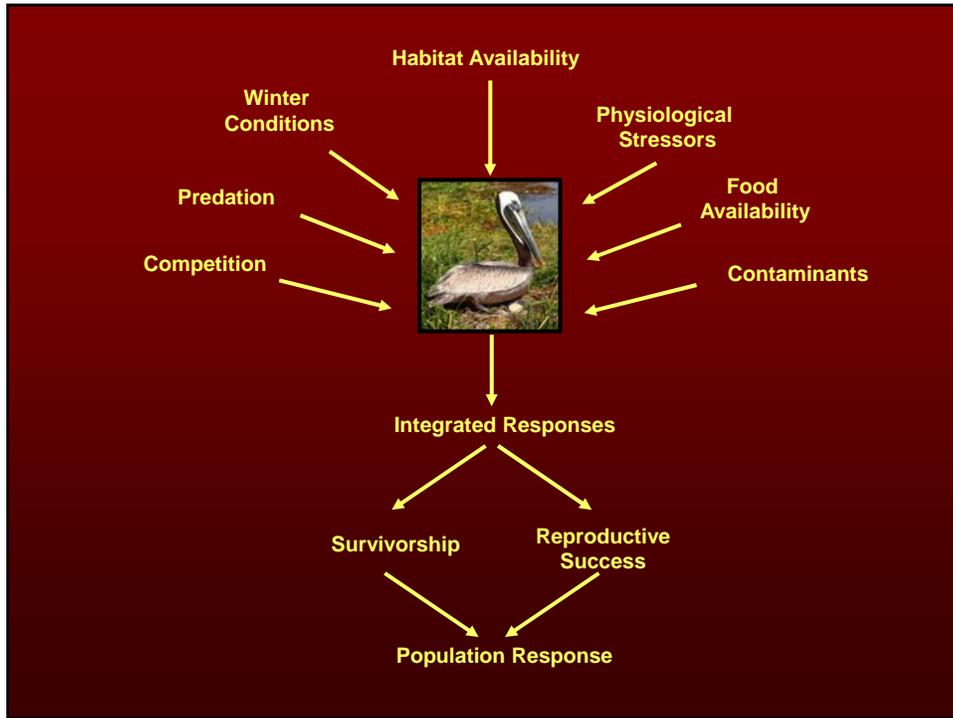
Red Knot

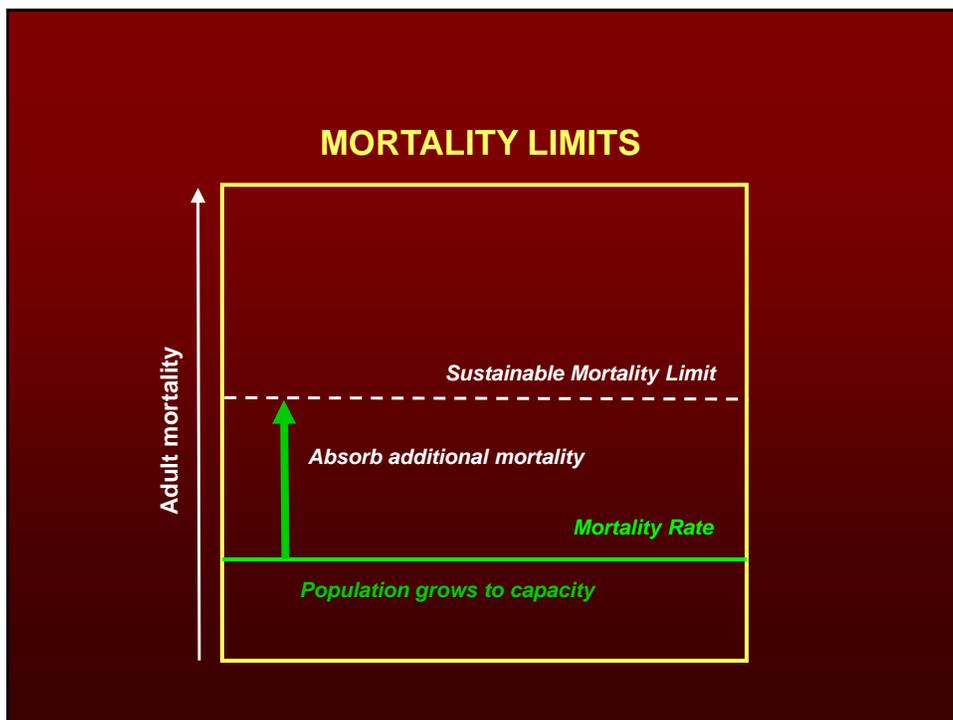
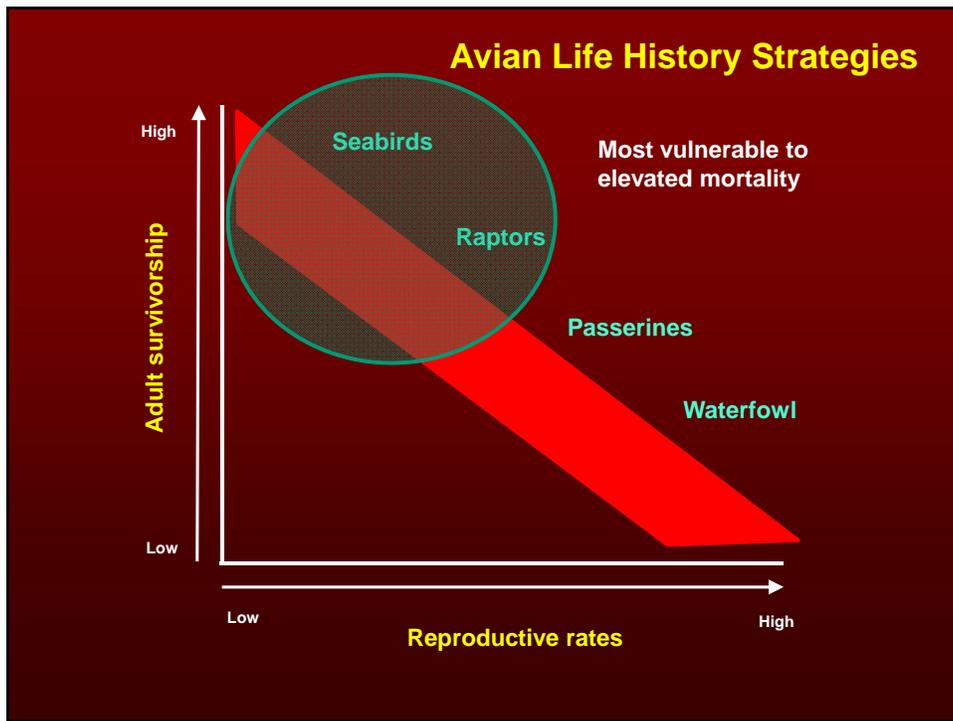


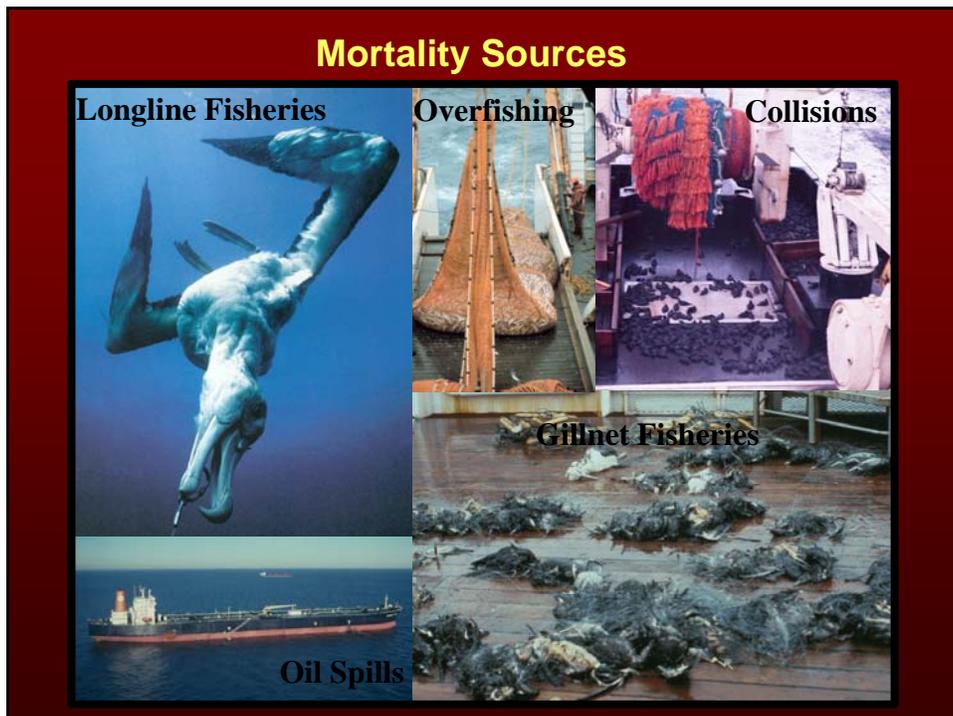
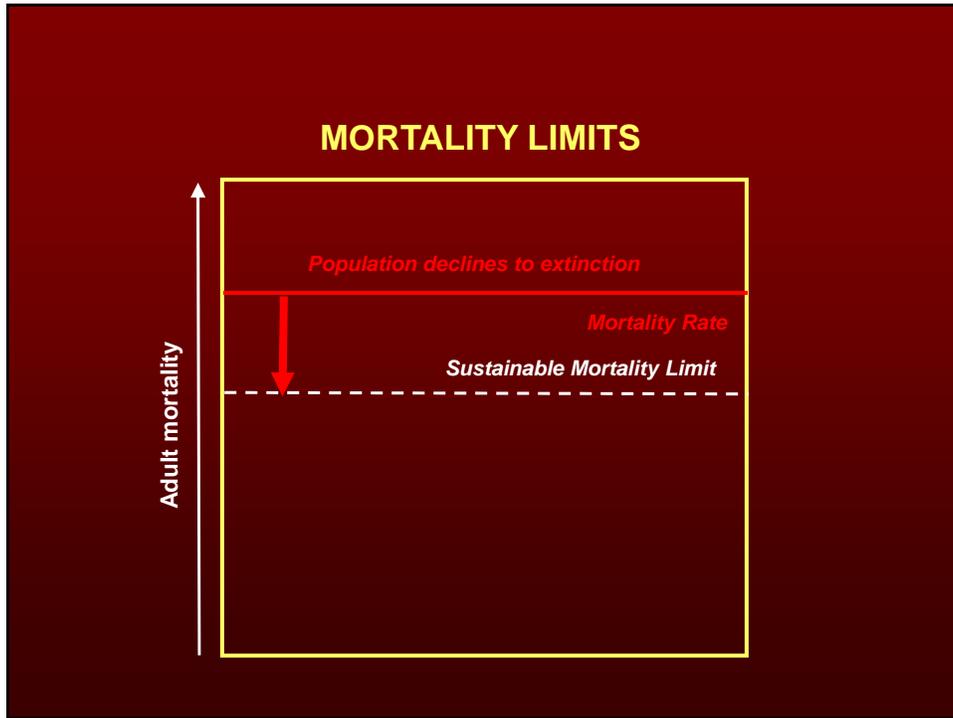
### Waterbird Exposure Index

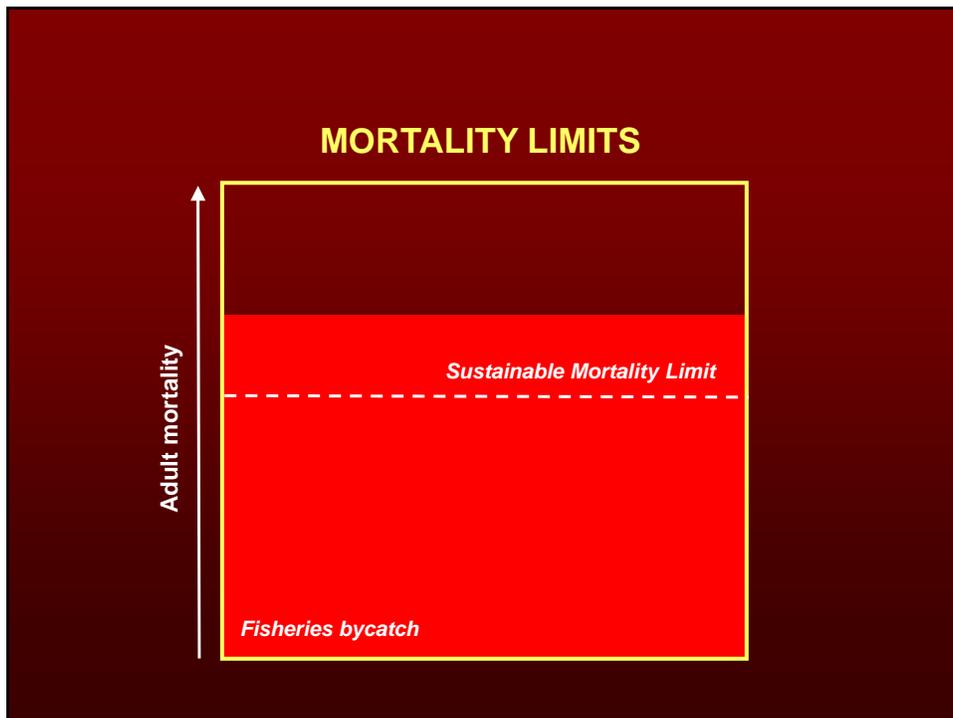
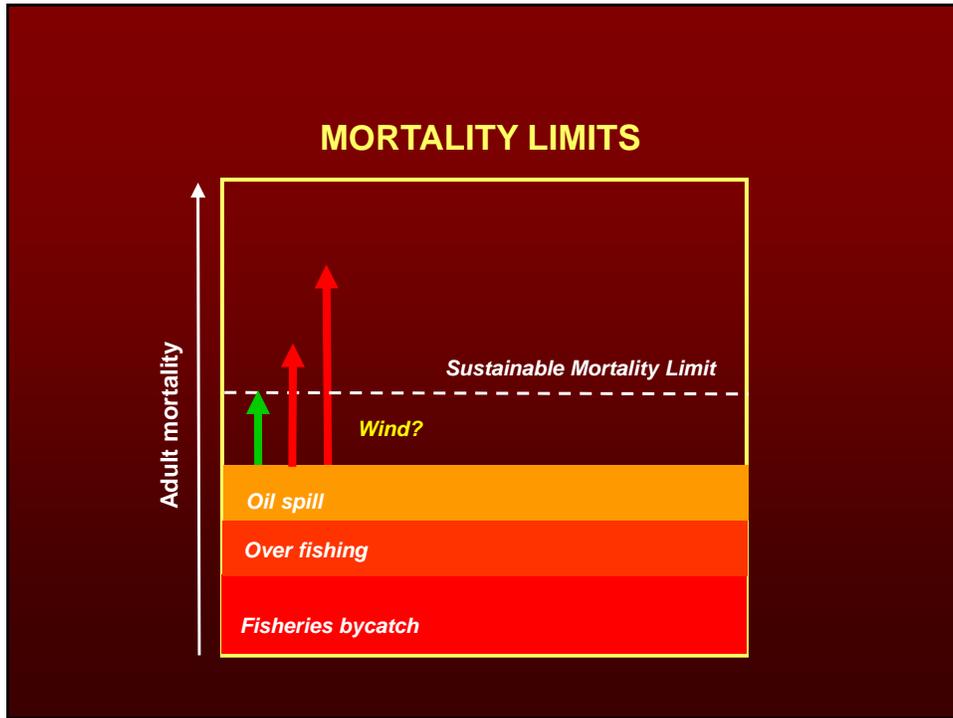


Garthe and Huppopp 2004





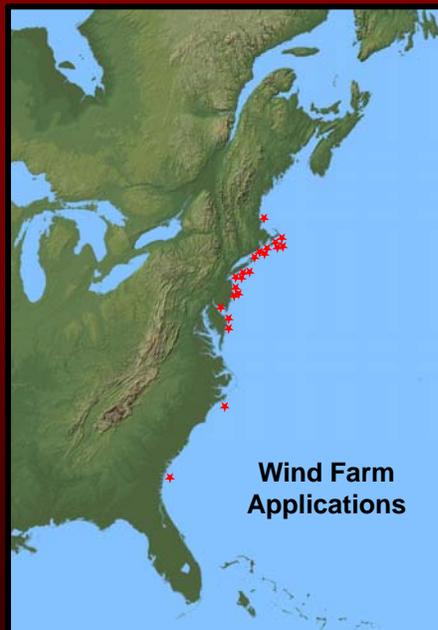




**Mortality is cumulative**

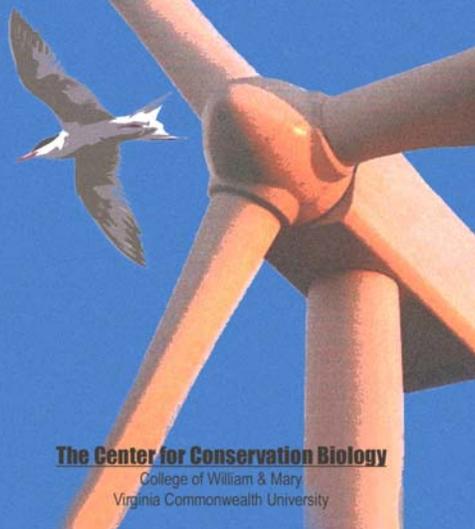
Need integration across network

Assess collective impact

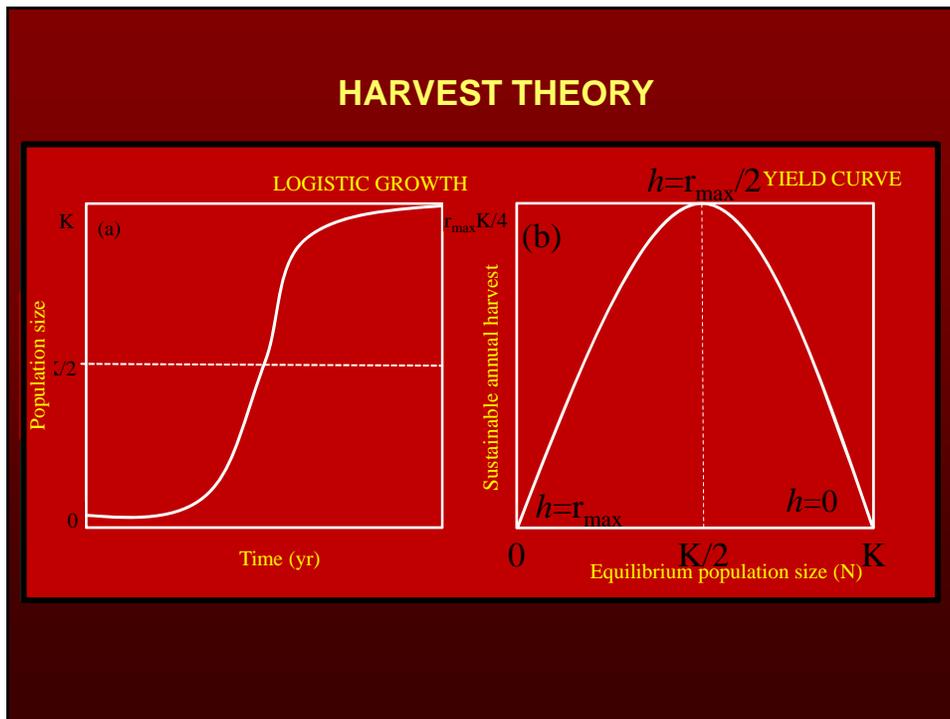


**WIND AND WATERBIRDS**

Establishing sustainable mortality limits within the Atlantic Flyway



**The Center for Conservation Biology**  
College of William & Mary  
Virginia Commonwealth University



Wade 1998

### PBR (Potential Biological Removal)

Uses precautionary principle to estimate limits

Minimum population estimate

60% CI of estimate

Recovery factor

Application to wind industry

Provides upper mortality bound

Provides population framework  
for species prioritization

## PBR Estimates

Table of demographic parameters, population estimates, and PBR estimates.

Species/Subspecies/population	Common Name	1st Breeding	Adult Survival	Growth Rate	Recovery Factor	Population Estimate	60%CI	PBR
<i>Limosa fedoa fedoa (Hudson Bay)</i>	Marbled Godwit	3	0.915	1.1424	0.2	2,200	1,511	43
<i>Charadrius melodus melodus</i>	Piping Plover	2	0.737	1.3028	0.1	2,920	2,006	61
<i>Sterna dougallii dougallii</i>	Roseate Tern	3	0.74	1.2202	0.1	7,000	4,809	106
<i>Gavia immer</i>	Common Loon	5	0.92	1.0985	0.4	7,400	5,084	200
<i>Haematopus palliatus</i>	American Oystercatcher	3	0.85	1.1791	0.2	10,700	7,351	263
<i>Calidris canutus rufa</i>	Red Knot	2	0.68	1.3279	0.1	20,000	13,740	451
<i>Pterodroma cahow</i>	Bermuda Petrel							2
<i>Pterodroma feae</i>	Fea's Petrel							41
<i>Pterodroma arminjoniana</i>	Herald Petrel							54
<i>Gelochelidon nilotica aranea</i>	Gull-billed Tern							66
<i>Puffinus lherminieri lherminieri</i>	Audubon's Shearwater							163
<i>Charadrius wilsonia</i>	Wilson's Plover							165
<i>Calidris maritima belcheri</i>	Purple Sandpiper							408

## POTENTIAL POPULATION IMPACTS

### Types of impacts

Avoidance behavior

Habitat loss

Collision mortality

### Turbines as over-water hazards

Exposure

Vulnerability

### Population framework for prioritization

Atlantic-Flyway dependents highest concern



## Wind and Waterbirds

### CONTEXT

Offshore wind  
Atlantic Flyway

### POTENTIAL POPULATION IMPACTS

Exposure  
Vulnerability  
Priority Species

### INFORMATION

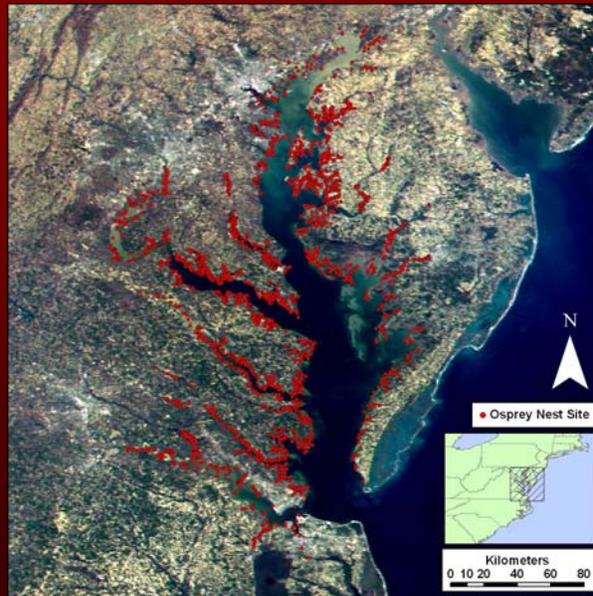
Existing Information  
Information Needs  
Techniques



## Osprey Population (1996)



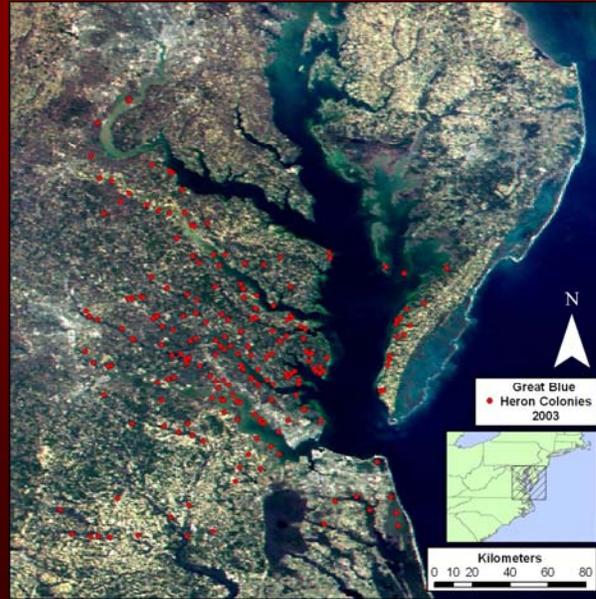
Watts et al. 2004



### Great Blue Heron



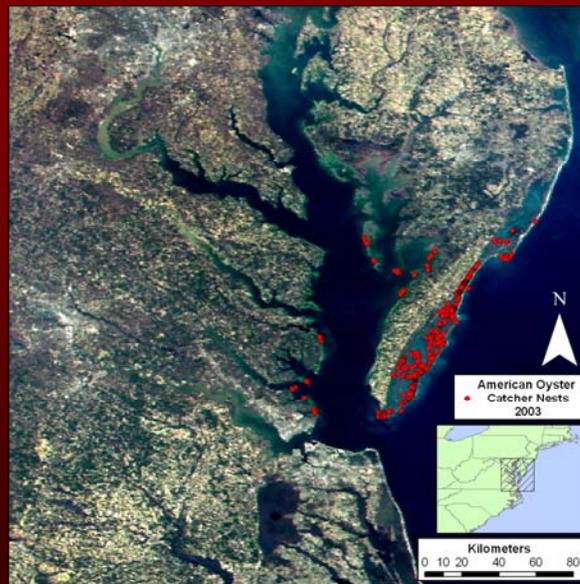
Watts and Byrd 2004

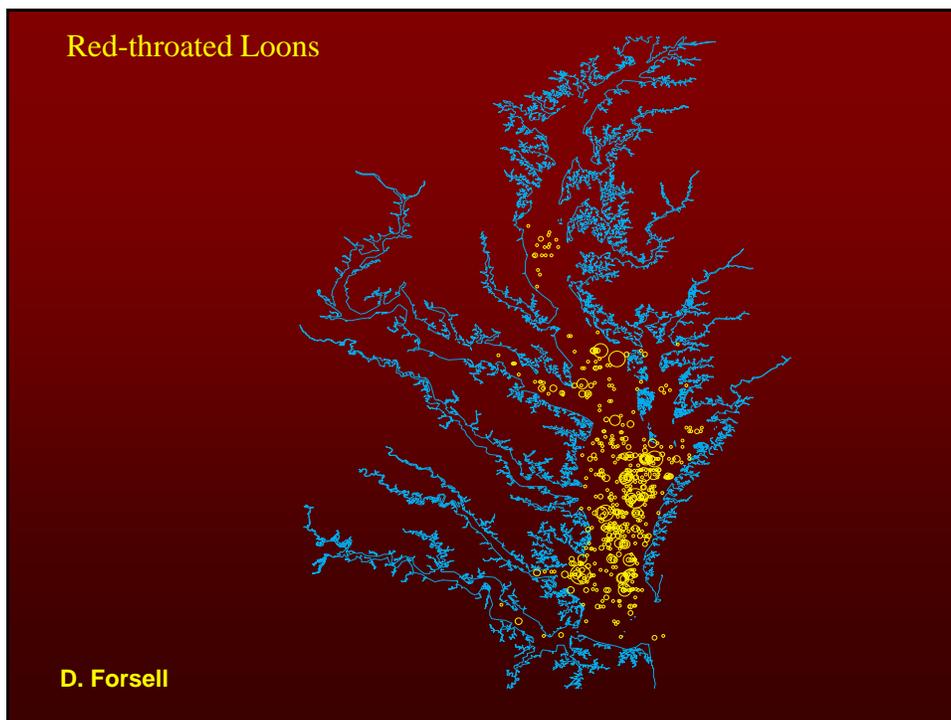
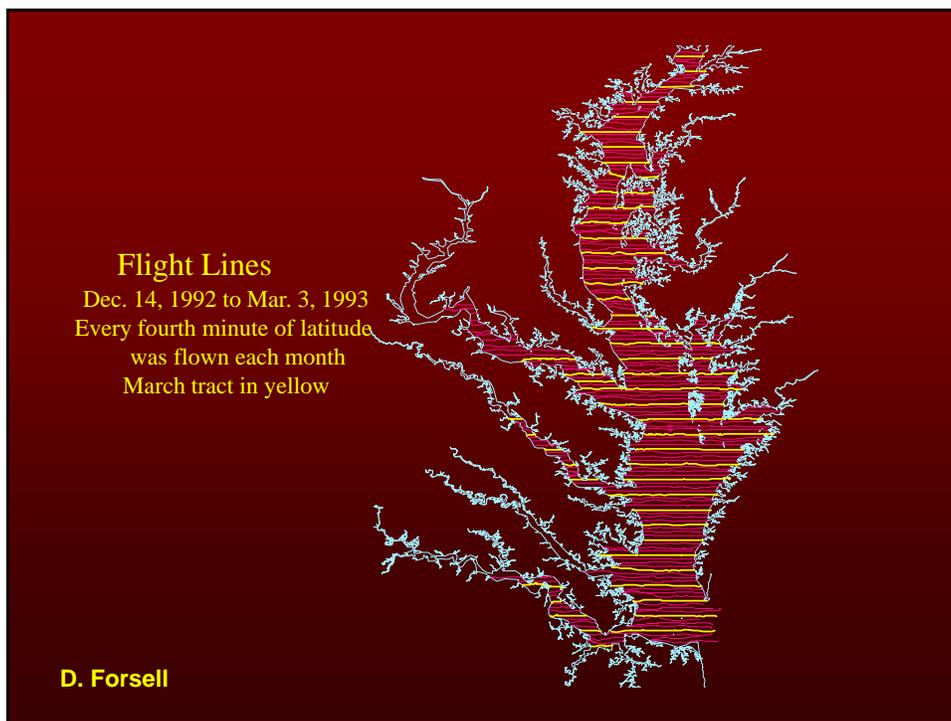


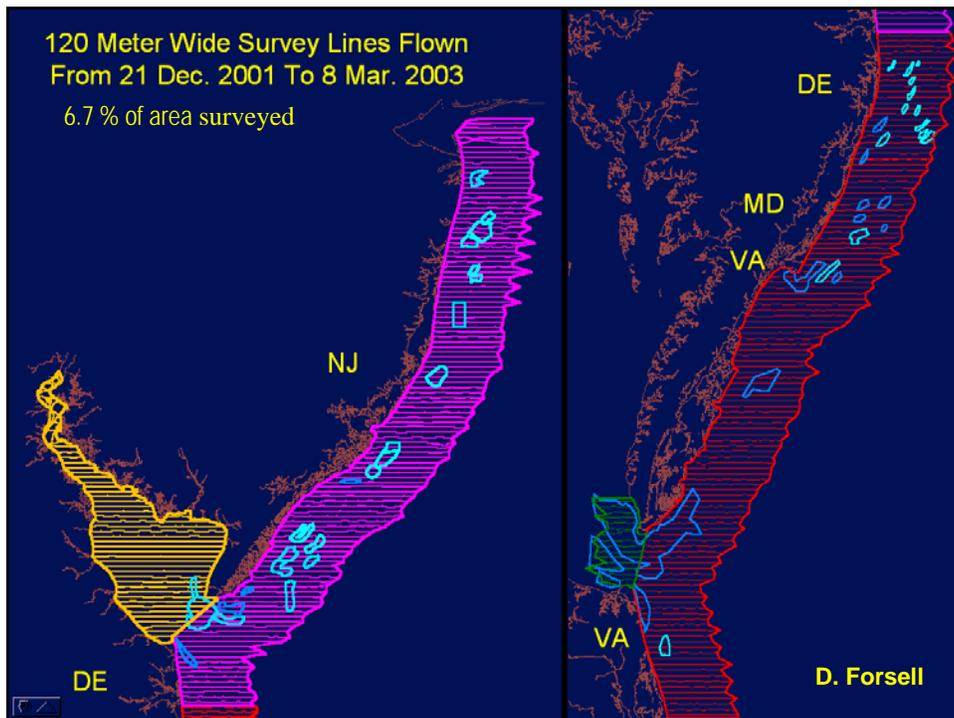
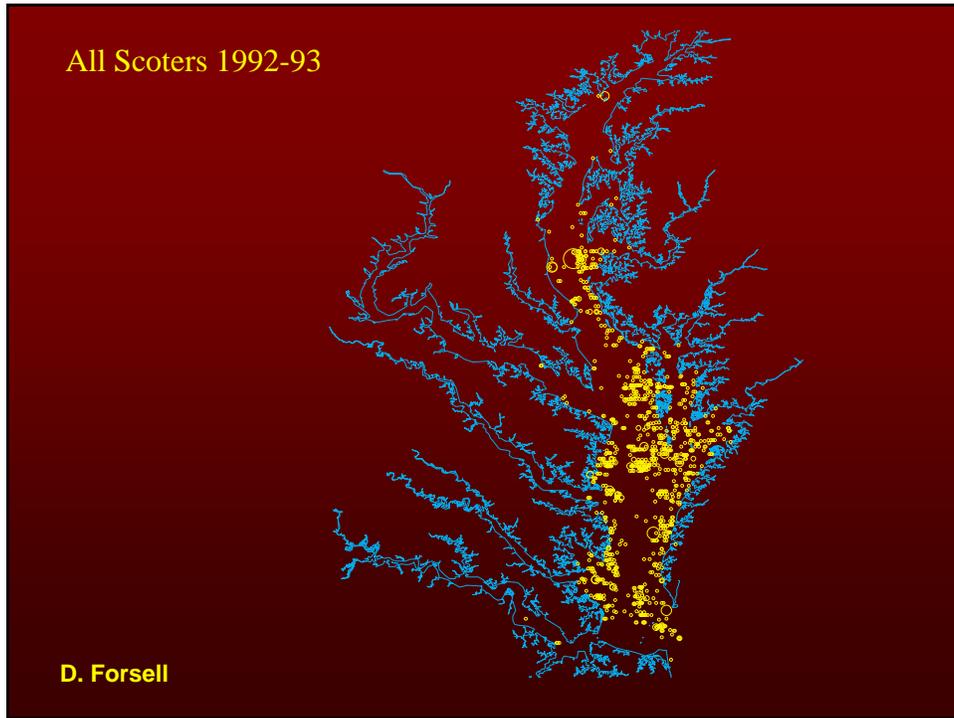
### American Oystercatcher

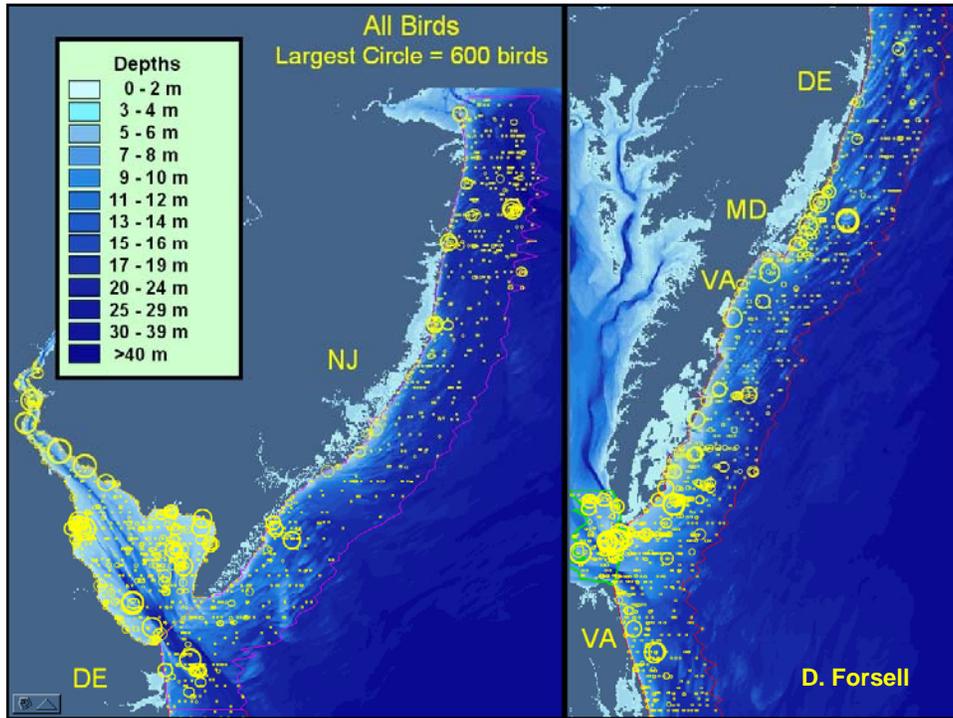


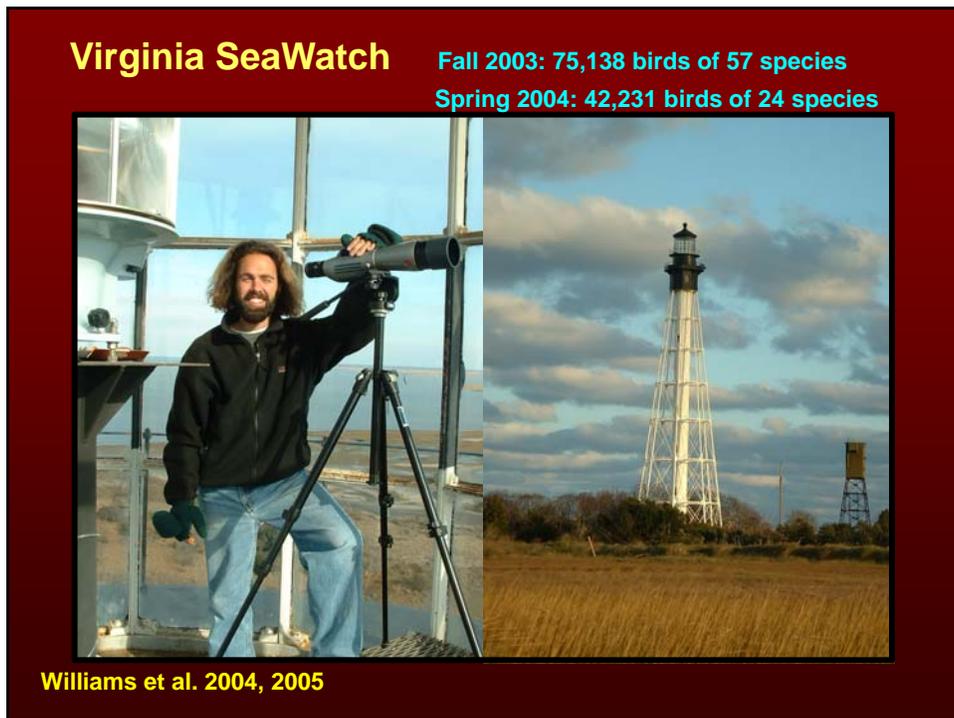
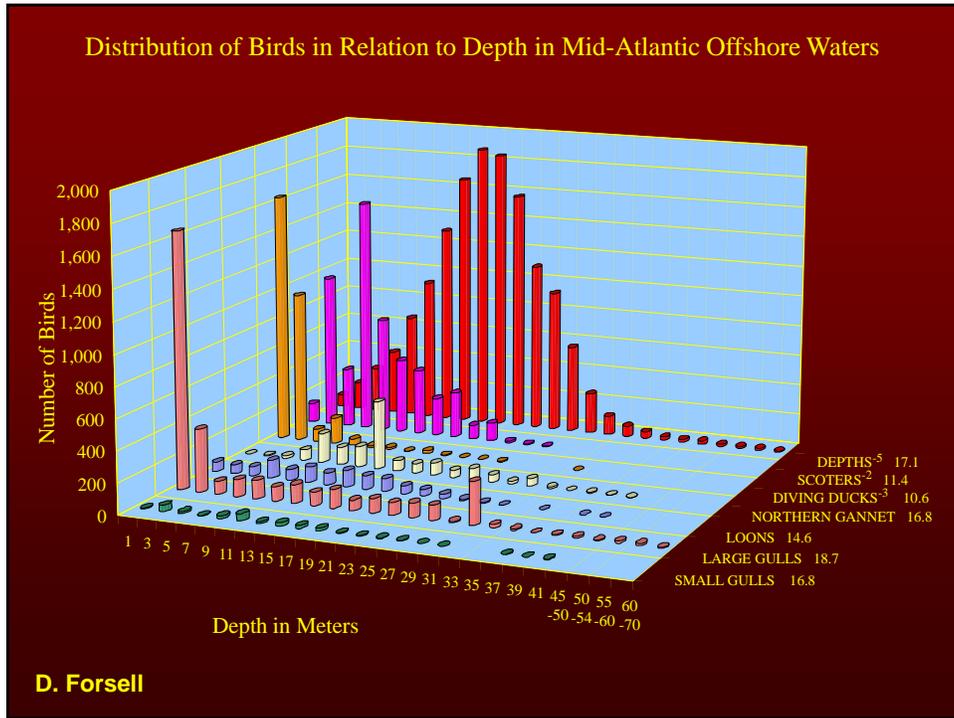
Wilke et al. 2007

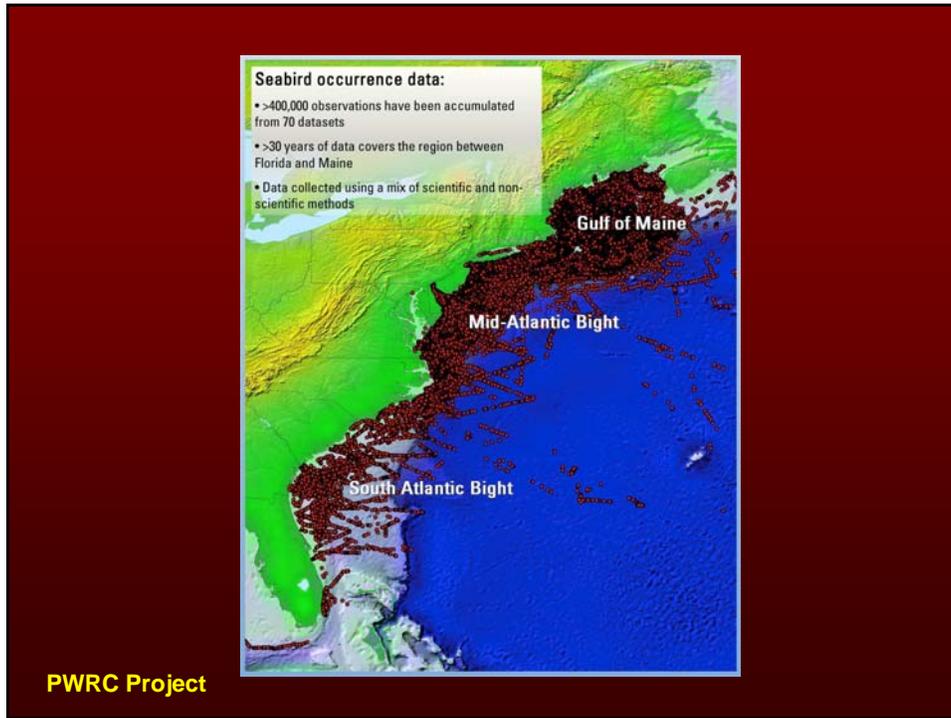












## Information Needs

### Objective 1 – Minimize exposure (particularly for priority species)

#### Information need

- Distribution and abundance
- Species composition
- Seasonality of use
- Behavior

### Objective 2 – Mortality monitoring

#### Information need

- Species/age composition
- Distribution
- Seasonality



## Information Needs

Objective 1 – Minimize exposure (particularly for priority species)

### Techniques

Remote sensing

Radar

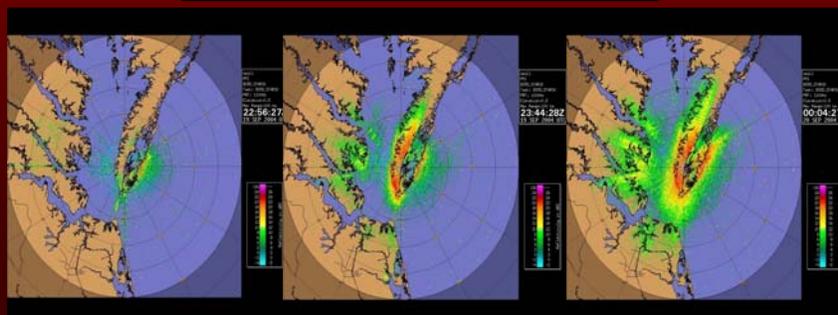
Acoustic monitoring

Imaging – photo/thermal

Direct observation

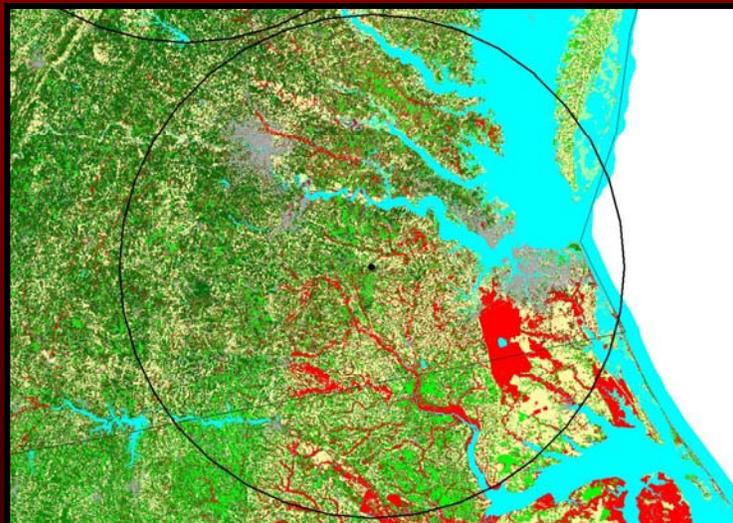


## Radar

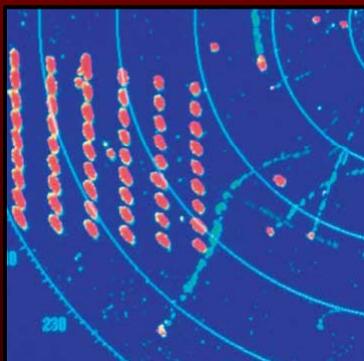


Watts et al. 2007

### NEXRAD RADAR-LANDCOVER ANALYSIS



### Marine Radar

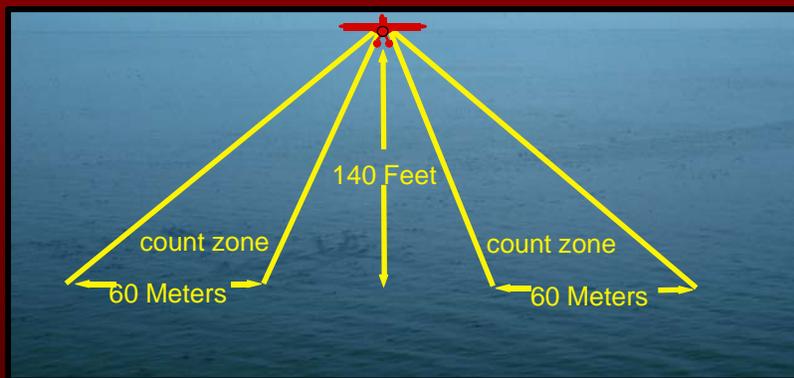


Desholm 2006

### Thermal Imaging and Acoustic Monitoring

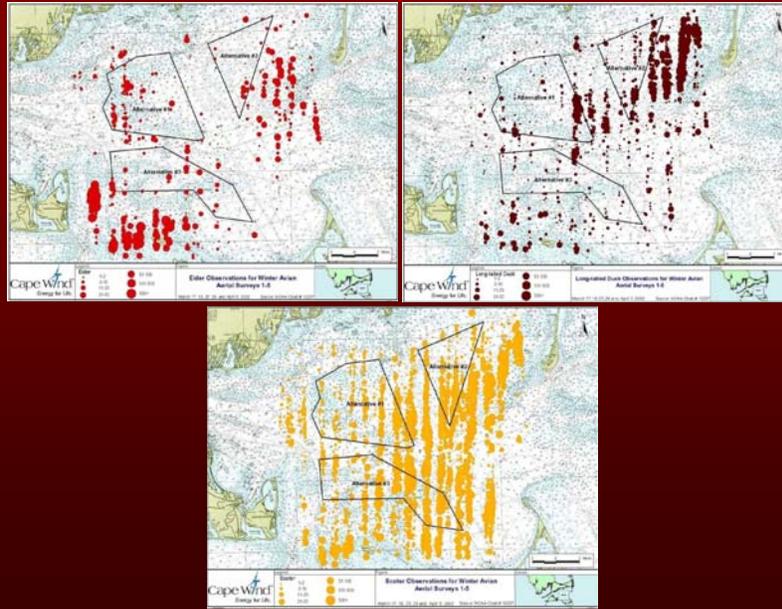


### Aerial Transect Surveys



D. Forsell

## Transect Surveys



## Monitoring Techniques (capabilities)

Information	Radar	Thermal	Acoustic	Observation
Distribution	Red	Yellow	Yellow	Red
Abundance	Red	Yellow	Yellow	Red
Seasonality	Red	Yellow	Yellow	Red
Species Composition	Light Blue	Light Blue	Light Blue	Red
Behavior	Light Blue	Light Blue	Light Blue	Red

## Information Needs

### Objective 2 – Mortality monitoring

#### Techniques

#### Remote sensing

W-T Bird

TADS



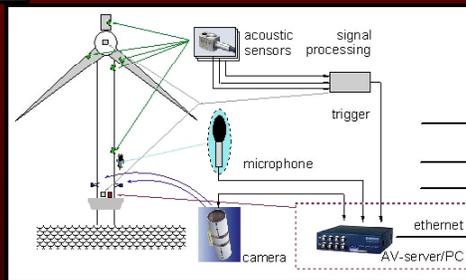
## Thermal Animal Detection System (TADS)



## W-T Bird System



Acoustic triggered photo system



## Wind and Waterbirds

### CONTEXT

- Offshore wind
- Atlantic Flyway

### POTENTIAL POPULATION IMPACTS

- Exposure
- Vulnerability
- Priority Species

### INFORMATION

- Existing Information
- Information Needs
- Techniques

