Cobia Research in SC

Management Implications Along the Southeastern US Coast

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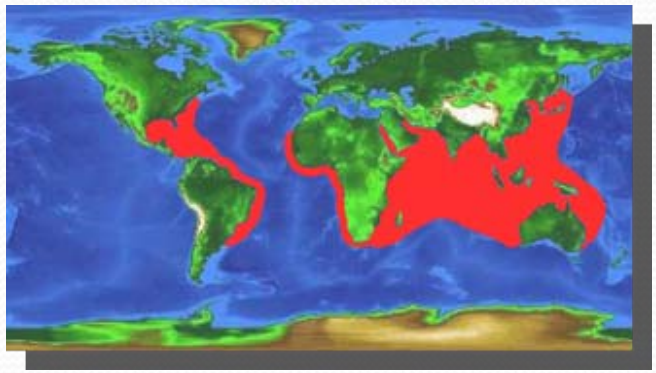
DNR

Cobia

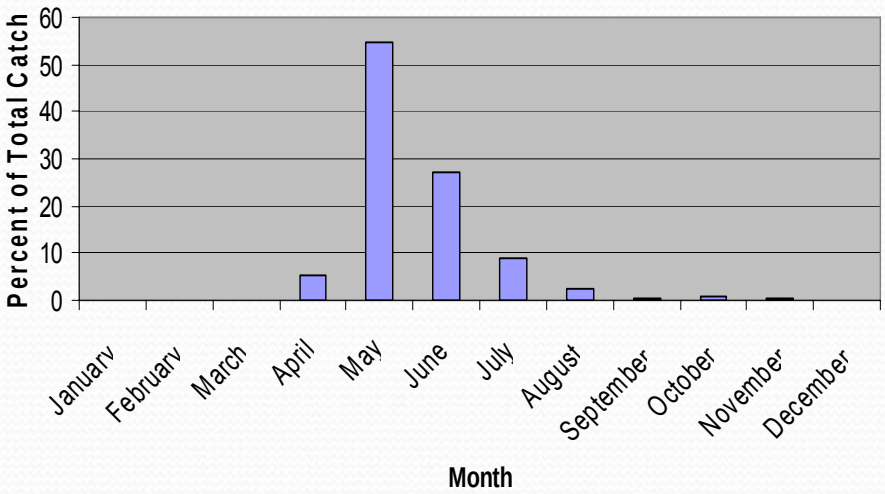
- Pelagic, migratory species
- Commercial and recreational importance
- Harvests steady since 1996
- Recreational pressure increasing
  - Inshore aggregations
  - Overfishing potential
- Single stock management
  - GMFMC; SAFMC



SC Charter Boat Effort for Cobia

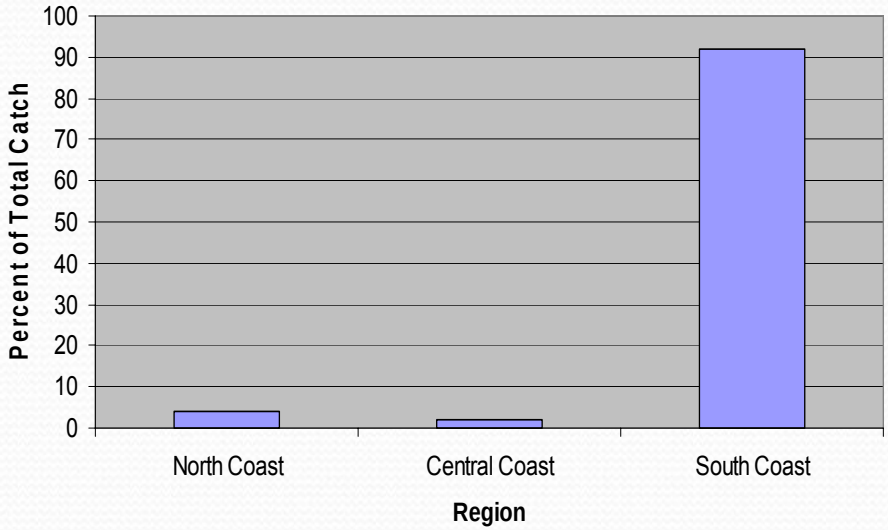
When?

Monthly Distribution of Cobia Caught by Charter Boats in SC
1997 - 2006
Source: SCDNR Charterboat Logbooks



Where?

Regional Distribution of Cobia Caught by Charter Boats in SC
1997 - 2006
Source: SCDNR Charterboat Logbooks



Why Cobia Research in SC?

- Attractive aquaculture species
  - Fast growth rates
  - Excellent flesh
- Applied Fisheries Research?
  - Best tags?
  - Movement?
  - Genetic tag development?
  - Spawning?
- Recreational fisherman
- Charter boat captains
- Conservation groups
  - Concerns about overfishing
  - Interest in understanding more about the life history

Research Questions

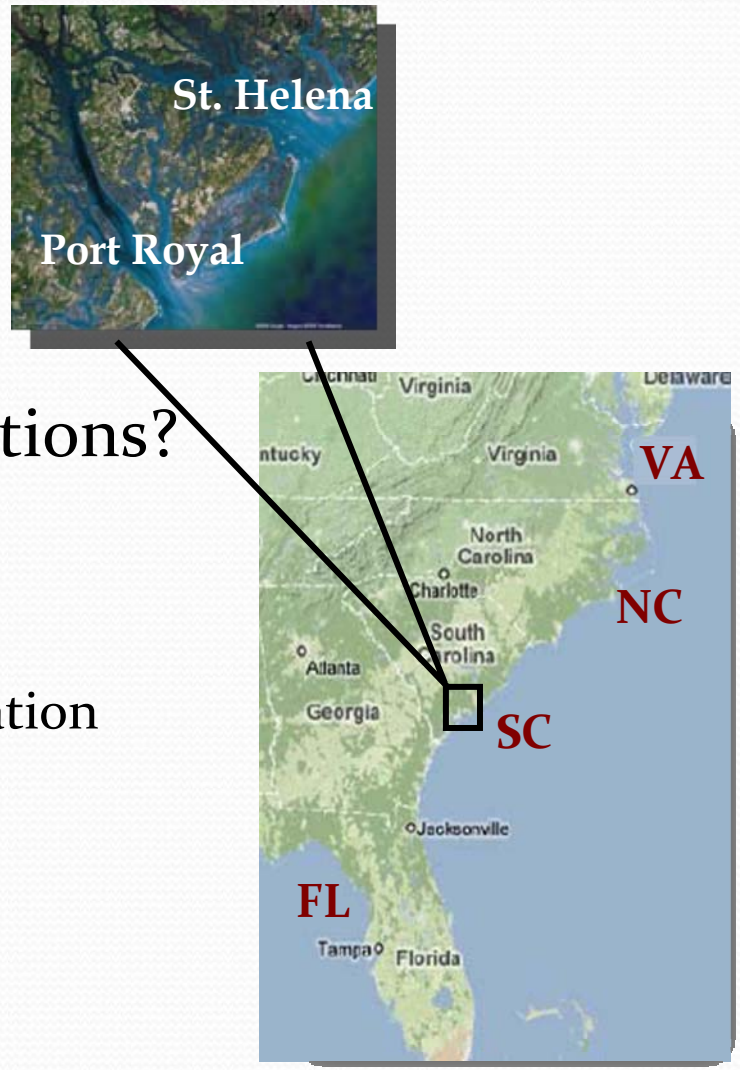
- Aquaculture Potential?
- Growth rates?
- Tolerance limits?
  - *Denson, M.R., K.R. Stuart, T.I.J. Smith, C.R. Weirich, and A. Segars. 2003. Effects of salinity on growth, survival, and selected hematological parameters of juvenile cobia Rachycentron canadum. Journal of the World Aquaculture Society 34(4):496-504.*
  - *Weirich, C.R., T.I.J. Smith, A.D. Stokes, M.R. Denson, and W.E. Jenkins. 2004. Pond rearing of larval and juvenile cobia Rachycentron canadum, in the southeastern United States: initial observations. Journal of Applied Aquaculture 16(1-2):27-44.*
  - *Weirich, C.R. A.D. Stokes, T.I.J. Smith, W.E. Jenkins, and M.R. Denson. 2006. Outdoor tank and pond spawning of cobia Rachycentron canadum in coastal South Carolina. Accepted by the Journal of Applied Aquaculture.*
  - *Weirich, C.R., T.I.J. Smith, W.E. Jenkins, M.R. Denson, A.D. Stokes, J.R. Tomasso, J. Chappell, and D. Burnside. 2006. Cobia aquaculture research in South Carolina, USA: captive reproduction, pond nursery production, and selected environmental requirements of juveniles. In Liao (editor). Cobia Aquaculture. National Taiwan Ocean University and National Pingtung University of Science and Technology, Keelung, Taiwan.*
- Results of interest for fisheries management
  - Tagged fish return annually exhibiting site fidelity?
  - Recently collected broodstock spawn volitionally
  - Genetic tags developed and used successfully

Research Questions

- What is the age structure?
  - Fishery statistics
  - Mortality estimates
  - Survival estimates
- Sex ratio?
- Feeding habits?
- Spawning behavior?
  - Histological evaluation
  - Plankton sampling

Research Questions

- Genetic composition?
  - Population structure
  - Migration
  - Estuarine fidelity
- Role of seasonal inshore aggregations?
  - Challenges…
    - Relatively little known
    - Potential long distance migration
      - Distribution
      - Pelagic, oceanic nature
    - Annual inshore aggregations
    - GOM reproductive groups??



Today's Presentation

- Spawning aggregations
- Age Growth information
- Population structure (genetic)

Sample Collection?

- Fisheries dependent data
  - Freezer program
  - Charter boat captains
  - Recreational anglers
  - Tournaments
- Fisheries independent
  - DNR anglers
  - Plankton surveys
- Data collected—total length, fork length, total weight, site and time of capture, gonads, fin clips, saggital otoliths, and stomach contents

Are fish spawning in estuaries?

- Gonad weighed and portion preserved
- Tissue processed by standard histological techniques
- Female samples staged according to ovarian development

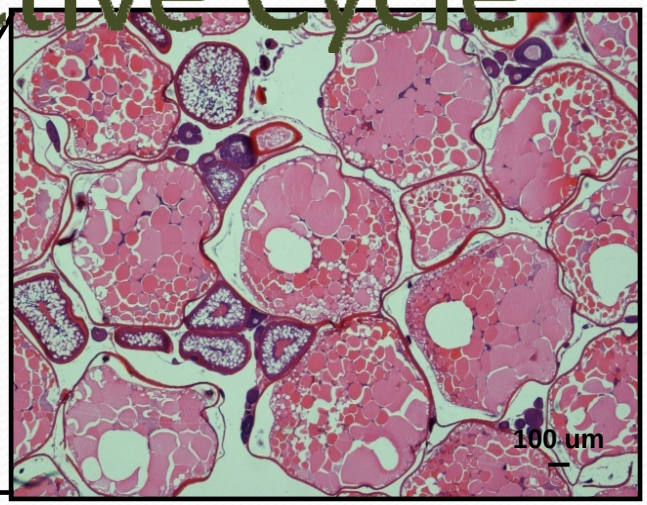
Female Reproductive Cycle

Immature

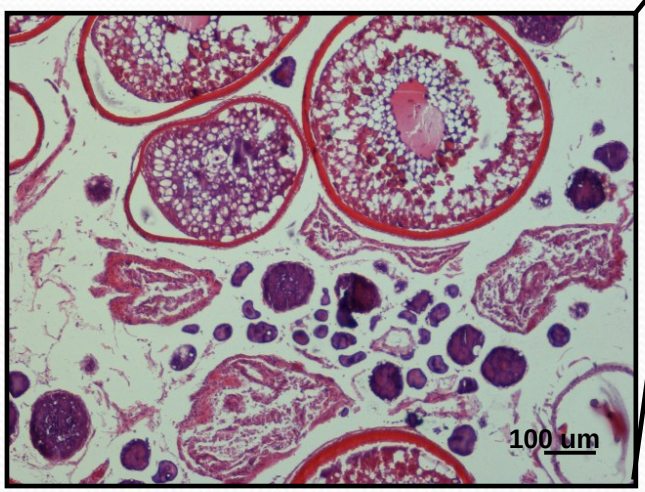
Early Developing

Late Developing

Gravid



0-24 hours Post-spawn



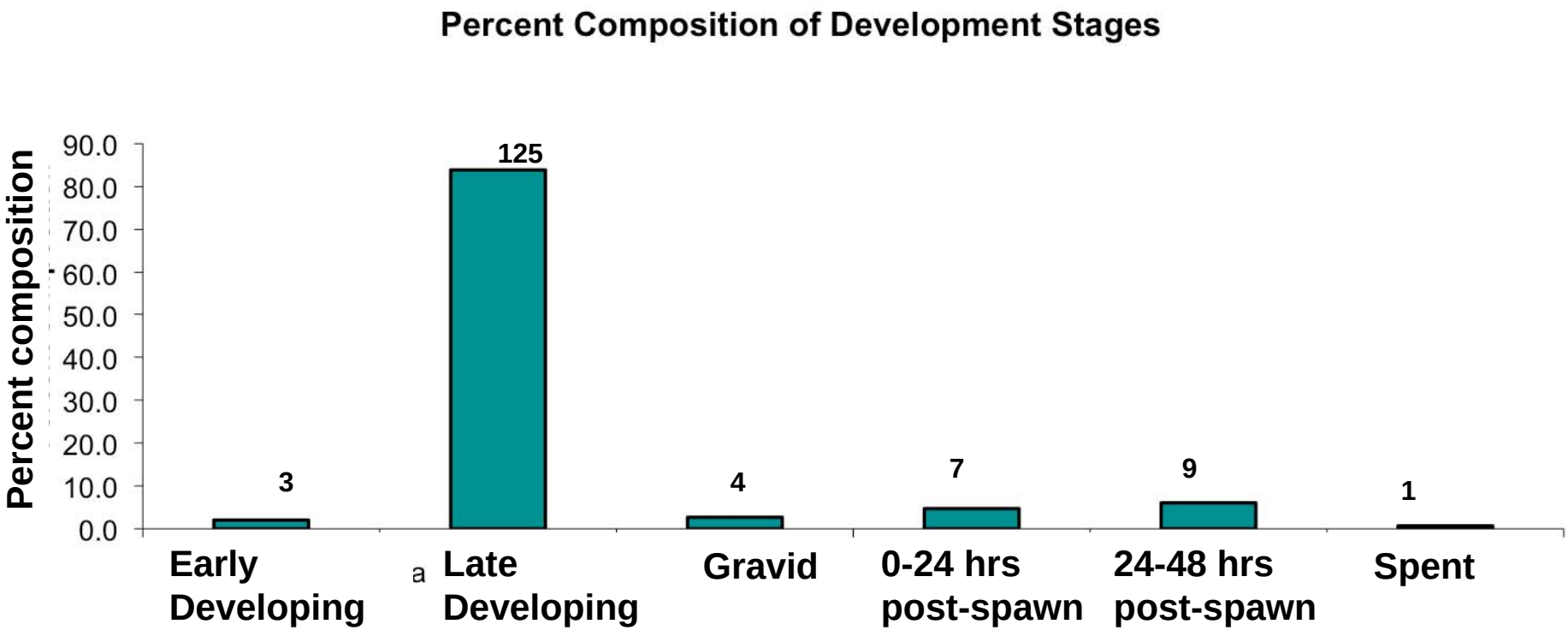
24-48 hours Post-spawn

Spent

Resting

2007 Data

- 149 female tissue samples



Plankton Sampling

- 2007
  - April, May, & June
  - Time of capture, site of capture
- Plankton surveys
  - Anchored nets
  - Flood tides
  - 2 times per week
  - 2 estuaries

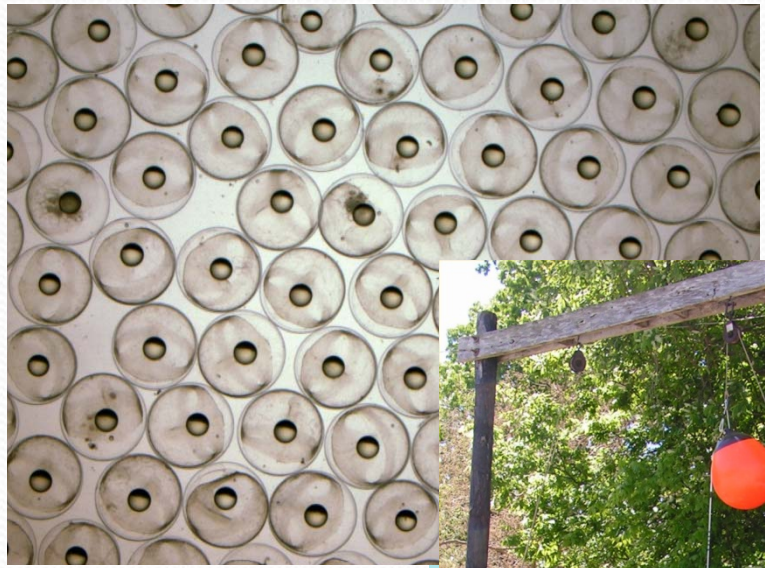
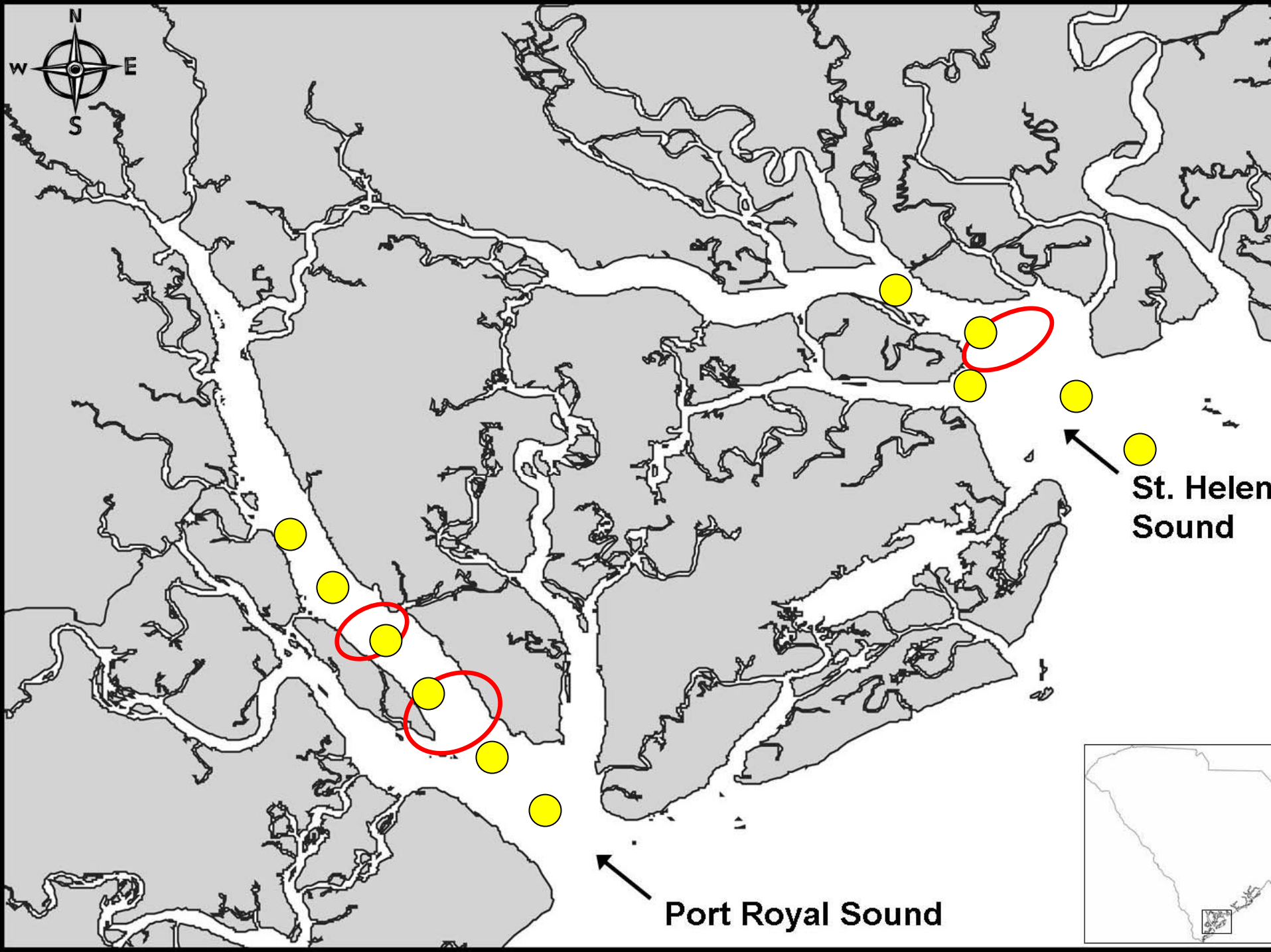


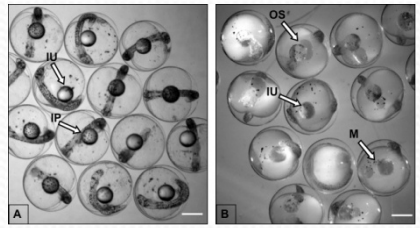
Photo: Brian Watkins


N
W
E
S
St. Helen
Sound
Port Royal Sound

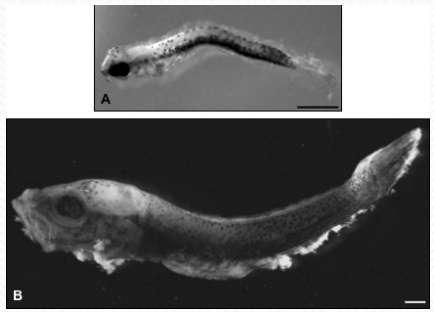
Plankton Samples from Port Royal and St. Helena Sounds

Date	Location	Early Eggs	Late Eggs	Larvae
May 6	PR	0	3	0
May 8	SHS	1	0	0
May 14	PR	0	0	5
May 21	SHS	12	121	5
May 28	SHS	2	29	7
May 29	PR	0	29	2
June 3	SHS	520	152	12
June 5	PR	27	7	2
June 12	PR	0	20	10
June 18	SHS	0	4	2

Cultured cobia eggs



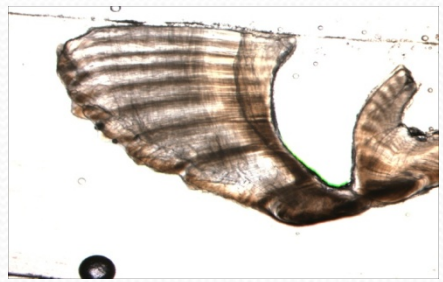
Wild caught cobia eggs



Eggs estimated 2-26 hrs old

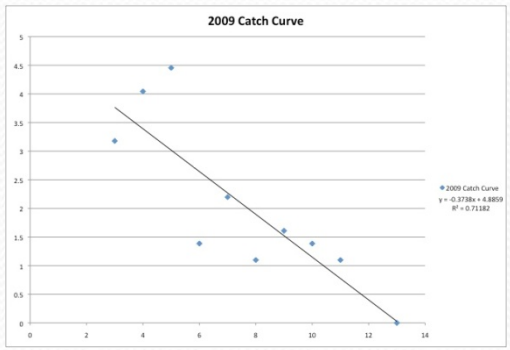
Estimating Survival and Mortality

- Conduct age validation studies in lab, and w/tagged fish in wild
- Use age composition and catch frequencies
- ***Catch curve accounts for some variation in year class
  - Assumptions: 1) survival rate is uniform with age 2) no change in mortality rate with time 3) sample is taken randomly 4) fishing and natural mortality individually uniform 5) only moderate fluctuations in recruitment
  - Use only age classes that are fully recruited to sampling gear (3+ years for cobia)
  - Instantaneous rate of mortality is Z= l slope l
  - Annual rate of survival is $S = e^{-z}$ (Ricker 1975)
  - Annual rate of mortality is 1 - S

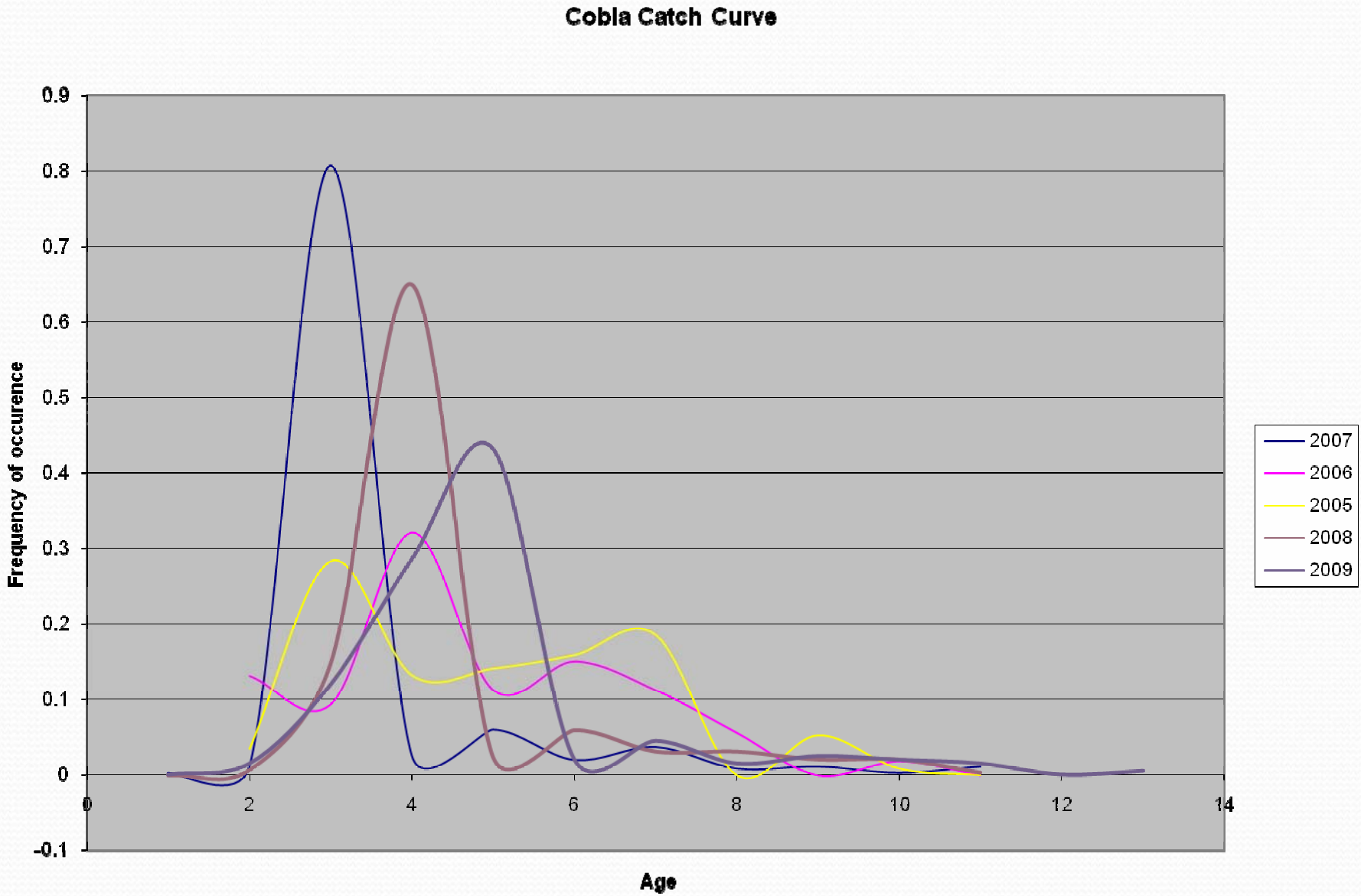


Estimating Survival and Mortality

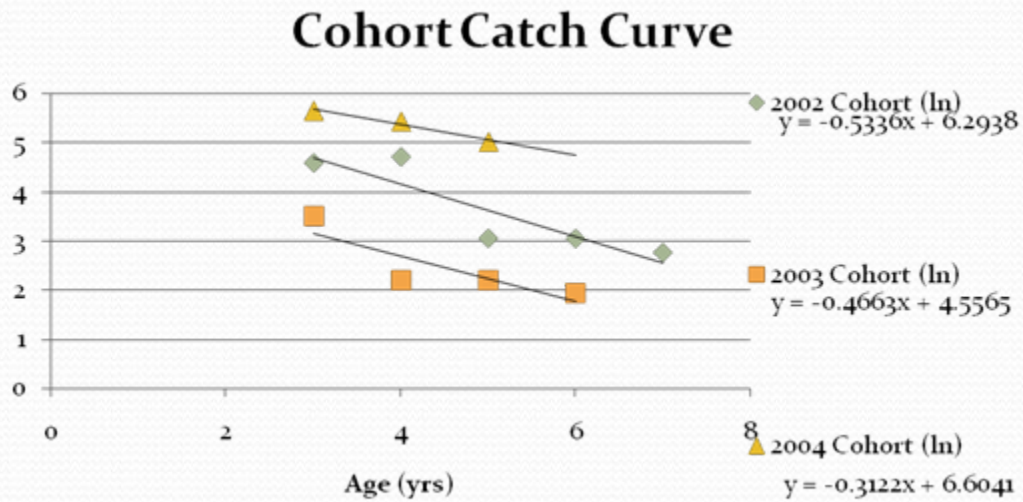
Year	Sample (n)	Instantaneous Mortality (Z)	Annual Survival (S)	Annual Mortality (A)
2005	113	0.38	0.68	0.32
2006	53	0.28	0.76	0.24
2007	347	0.46	0.63	0.37
2008	283	0.43	0.64	0.36
2009	199	0.37	0.69	0.31
2005-2009	995	0.49	0.61	0.39
2007-2009	829	0.52	**0.59**	0.41



Evidence of Strong Recruitment



Fishery Statistics



Cohort	Instantaneous Mortality (Z)	Annual Survival (S)	Annual Mortality (A)
2002	0.53	0.59	0.41
2003	0.47	0.63	0.38
2004	0.31	0.73	0.27

Hyperstability?*

- Is a situation that often occurs in aggregating fishes…
- As a fish population declines, fish continue to aggregate or school and therefore their local population density remains constant. Although the number of schools or aggregations present may be declining, fishers will continue to fish these high-density schools, and despite a population decline CPUE remains high.

*Hilborn and Walters 1992

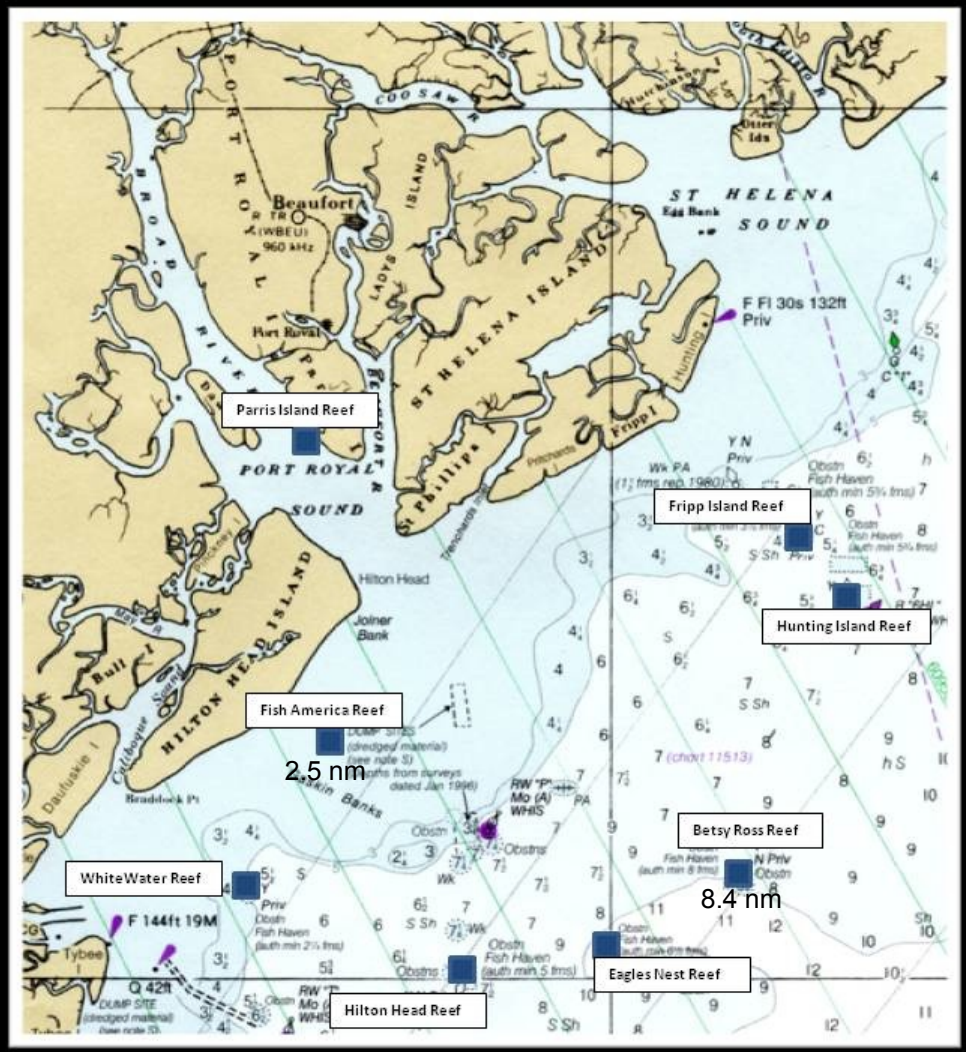
Appropriate Management Unit?

- Based on offshore collections
  - High movement along SE US and with GOM
  - Single population management as overfishing in one offshore area would impact another…
- Based on inshore aggregations
  - Suggestion of distinct population segments (DPSs)
  - Preliminary indications of estuarine fidelity
  - DPSs managed separately as localized inshore fishing pressure would primarily impact the local population

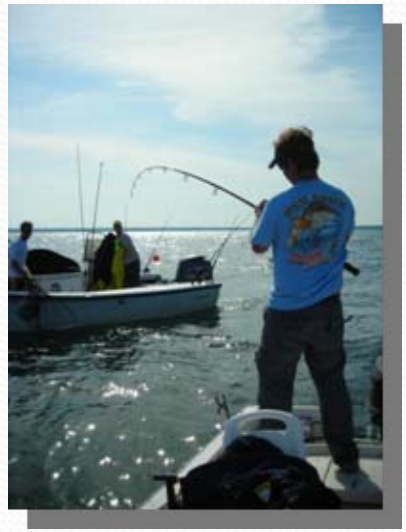
Tools

- Suite of microsatellite loci
  - Inherited in a Mendelian fashion,
  - Hardy Weinberg Equilibrium,
  - No linkage disequilibrium
  - Marker confidence
    - Identity non-exclusion: 9.7×10^{-12}

Multiplex Group	Locus	Repeat Motif	Size Range (bp)	# of Alleles
1	Rca-H10	CA	119-139	10
	Rca-A04	$(CA)_9(CACT)_4$	196-206	8
	Rca-E02	CT	297-315	6
2	Rca-A11	GT	165-201	14
	Rca-H09	GATA	168-224	17
	Rca-E08	CA	181-229	7
	Rca-C06	GATA	336-404	18
3	Rca-D10	CTAT	143-223	23
	Rca-E11	CA	167-183	6
	Rca-C04	GT	217-253	16


Parris Island Reef
Fripp Island Reef
Hunting Island Reef
Fish America Reef
2.5 nm
Betsy Ross Reef
WhiteWater Reef
8.4 nm
Eagles Nest Reef
Hilton Head Reef
Beaufort
PORT ROYAL SOUND
ST HELENA SOUND
HILTON HEAD ISLAND
ST HELENA ISLAND
F Fl 30s 132ft Priv
F 144ft 19M
Q 42ft

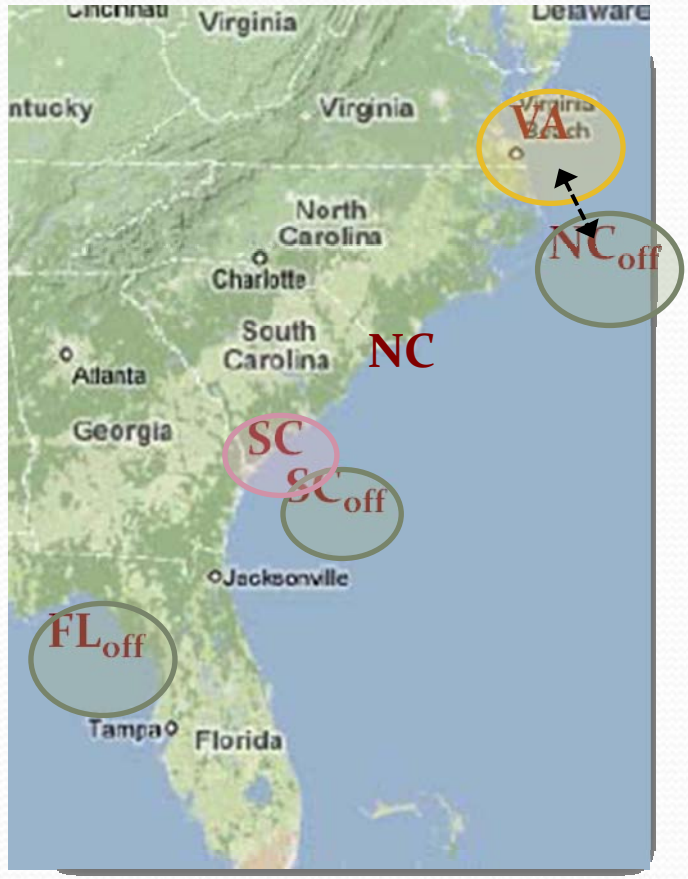
Sample Collections



- Cooperating anglers, SCDNR staff
- April –July
- Field samples genotyped
- Field samples otolith-aged
  - 2008
    - SC (n=75)
    - SC_{off} (n=55)
    - VA (n=36)
    - FL_{off} (n=16)
    - NC_{off} (n=84)

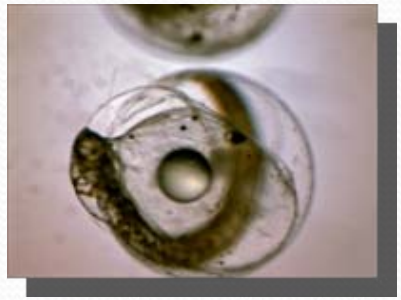
Population Structure

- Pairwise
  - Distribution (G-test)
  - ρ_{ST}
- AMOVA
- IBD/Spatial autocorrelation
- Homogenous offshore groups
- Distinct inshore aggregations
  - G: p=0.000; ρ_{ST}: 0.032,p=0.000
  - G: p=0.000-0.003; ρ_{ST}: 0.007-0.025, p<0.05
  - AMOVA: ρ_{ST}: 0.014, p=0.000
- Overall 'little' isolation



Inshore Aggregations

- Spawning function
  - Genetic structure
  - Fidelity
  - Plankton samples
    - Positive egg & larval identification
    - Histological evidence



- Fishing pressure targeting spawning groups??
- Temporal influences? (Collection vs. Migration timing)

Challenges for Cobia Management

- Life history and migration patterns
  - Limited knowledge
  - Limited accessibility (and confounding temporal issues)
- Primary fishing pressure
  - Occurs inshore where the aggregations are present
    - Implication for potential overfishing of the reproductive pool to occur while on the spawning grounds
  - Occurs offshore where aggregations are not present
- Data poor
  - Original plan (1983) developed for incidental catch
  - Burns et al. 1998

Williams (2001) Assessment of cobia in the GOM

- Not genetically distinct
- Rarely gather in large numbers
- Percent maturity at size and age fixed
- Very little information on age 0-1
- Suggest great uncertainty
- Some probability that the stock is overfished

Management Needs

Multiple Data Sets

- Commercial data limited to by catch
- Random independent fishery indices not available
- Charter boat logs
- MRFSS data

Growth & Mortality Statistics

- Von Bertalanffy
- Survival and mortality
- Morphometrics

Spawning Stock

- Age at maturity
- Sex ratios
- Fecundity estimates
- Longevity

Genetic Identification

- Multiple stocks?
- Management unit?

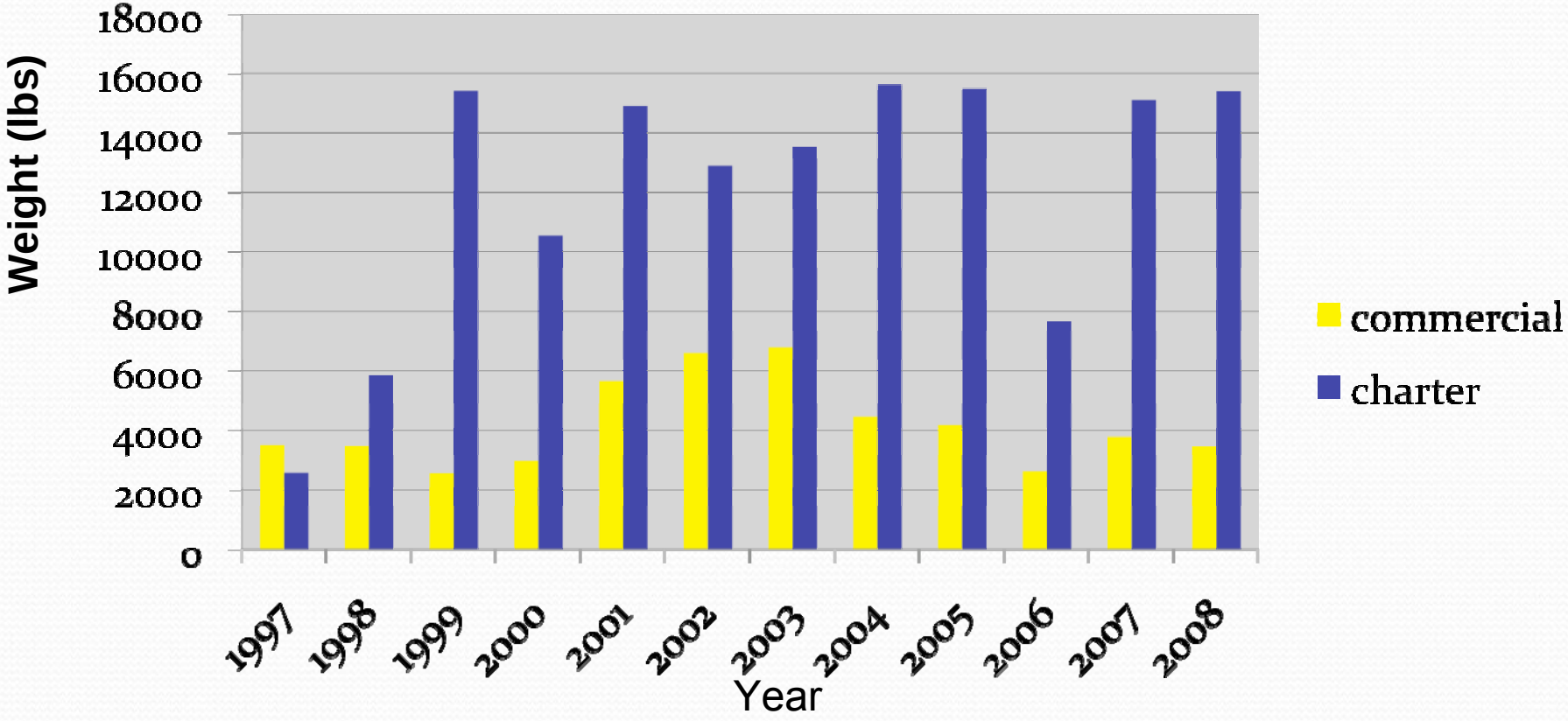

CAUTION


Ranger

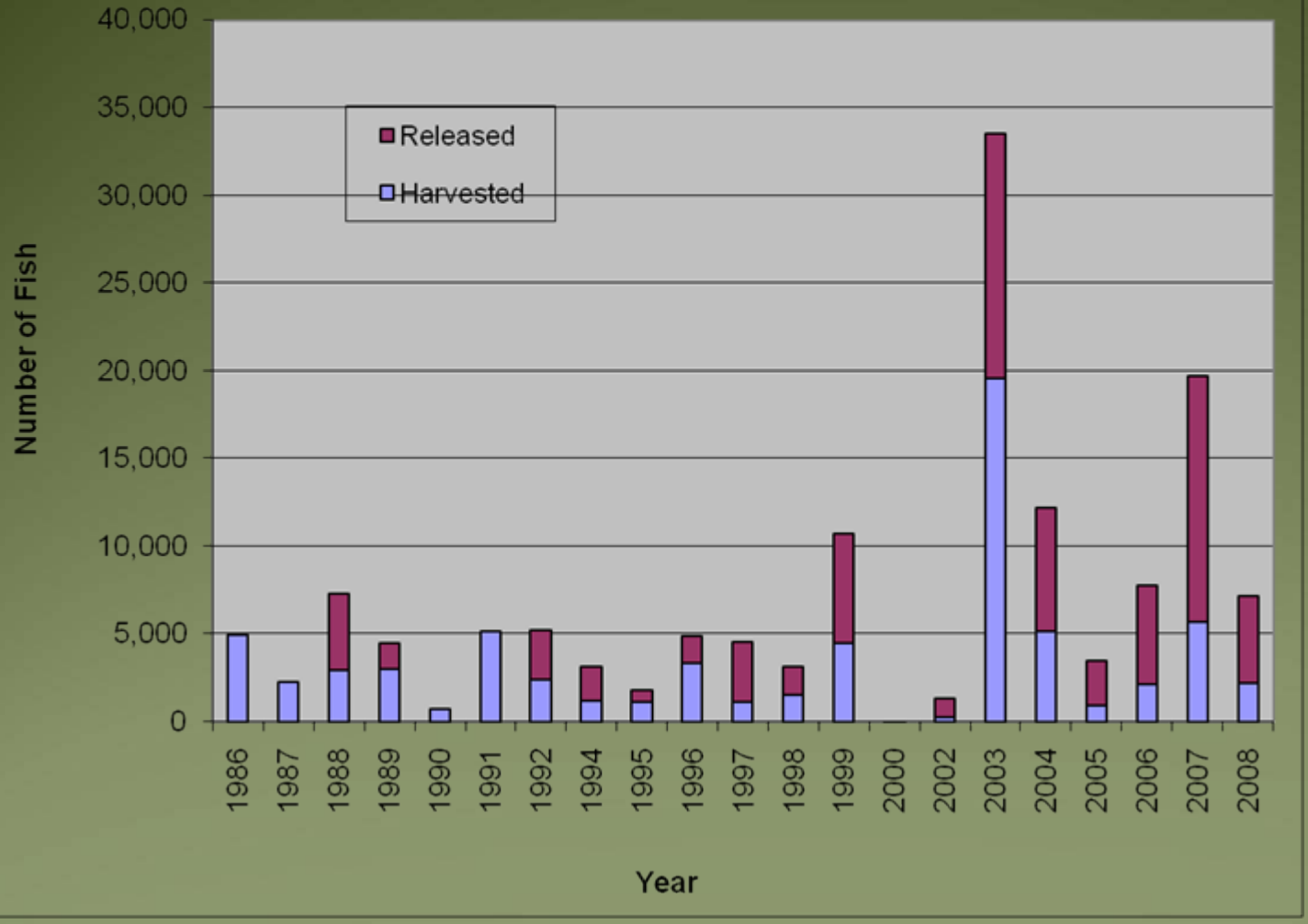
Current management

- South Atlantic and Gulf of Mexico Fishery Management Council (considered one stock)
  - Coastal Pelagics Fishery Management Plan
- Limit of 2 fish/person/day
- Minimum fork length = 33 in (~84 cm)
  - Maturity
    - Females—80 cm, 2 years (near min. FL)
    - Males—60 cm, 1-2 years

SC Cobia Harvest 1997-2008 (commercial and charter boats)

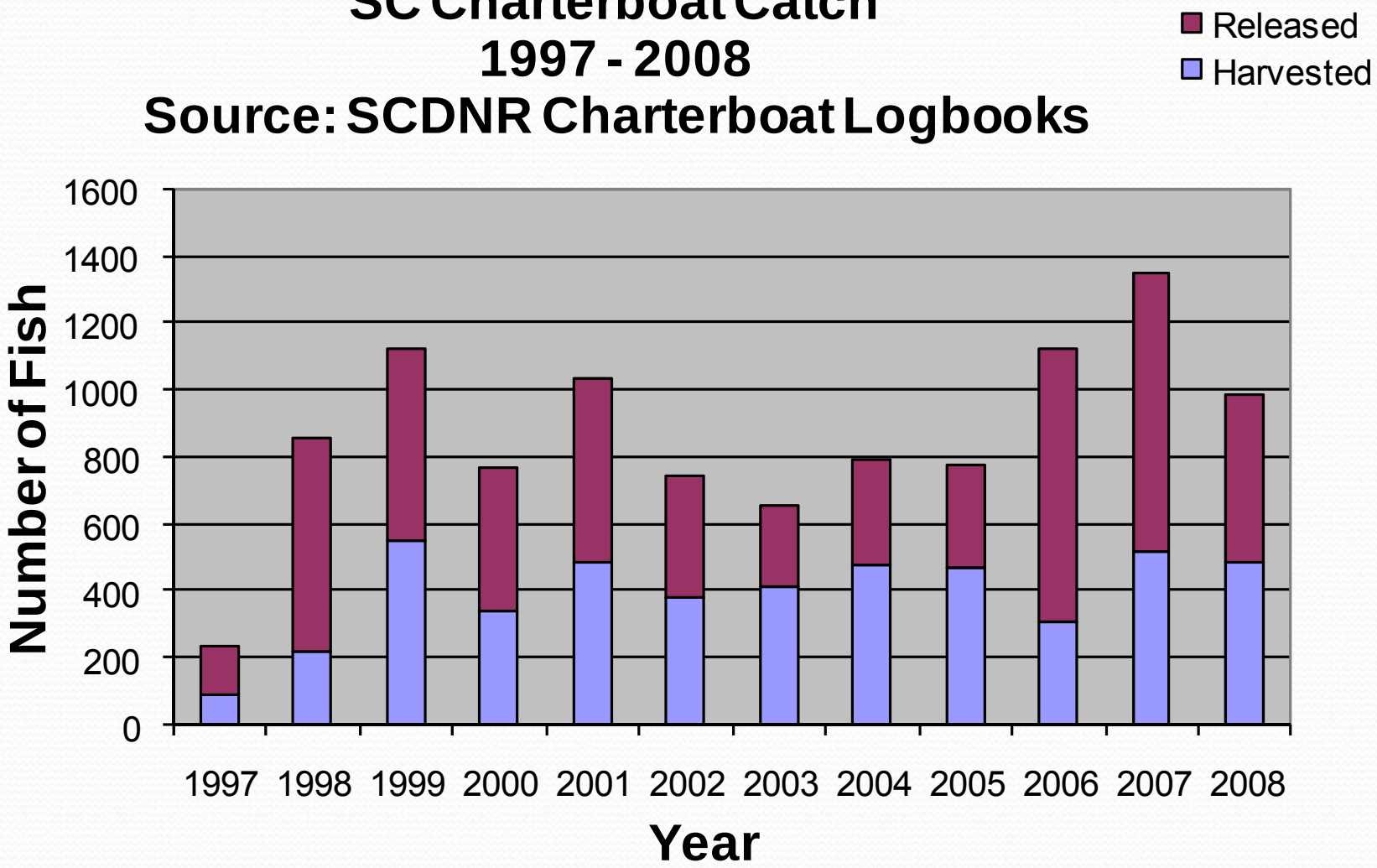


SC Recreational Cobia Catch
1986 - 2008
Source: MRFSS

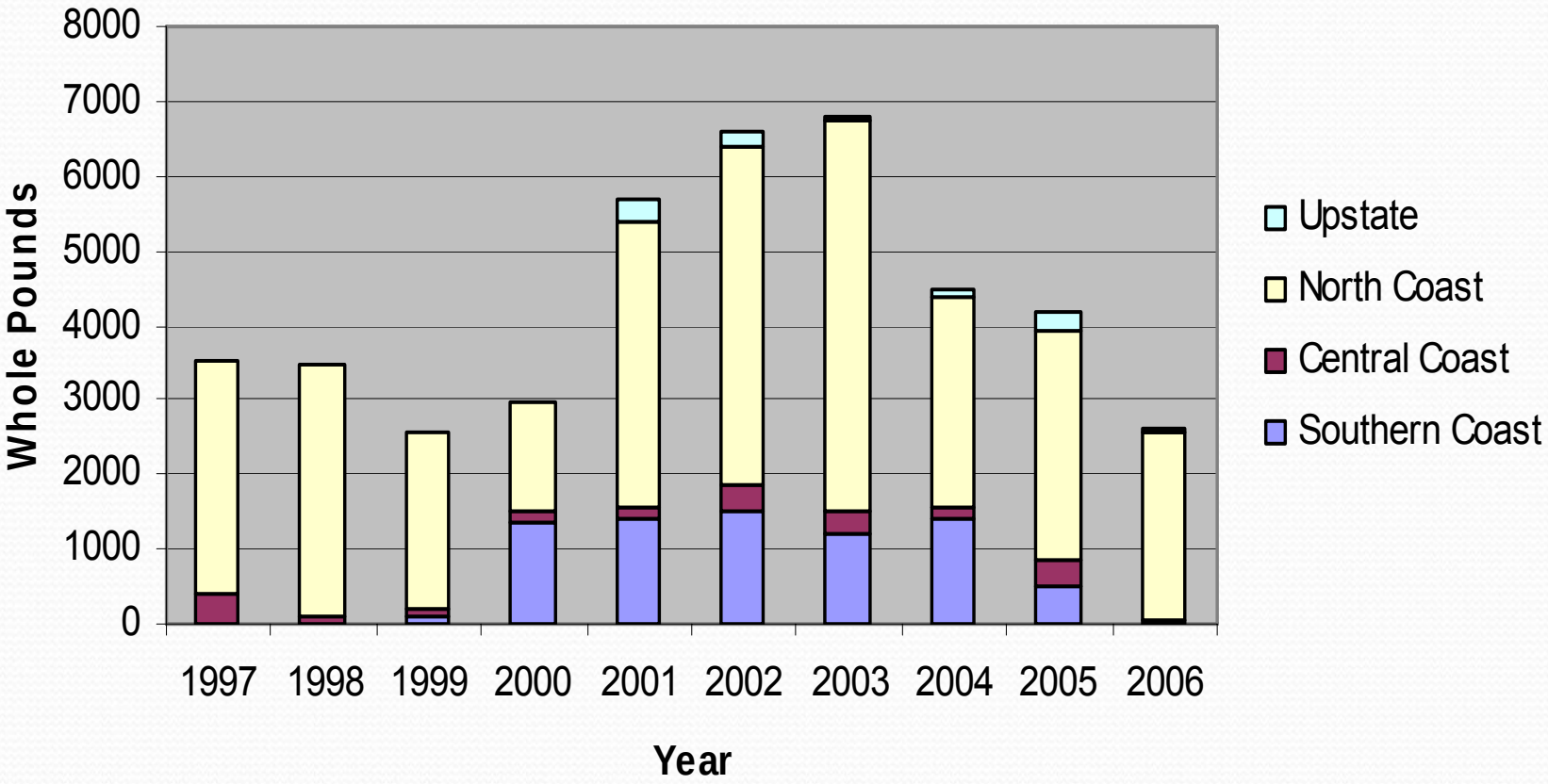


Year	PSE
1986	47
1987	100
1988	31.9
1989	31.4
1990	43.7
1991	56.6
1992	43.3
1993	No Data
1994	58.7
1995	63.4
1996	25.2
1997	43.1
1998	37.2
1999	32
2000	53.2
2001	No Data
2002	61
2003	31.4
2004	35.4
2005	46.1
2006	44.5
2007	34.3
2008	42.9

SC Charterboat Catch
1997 - 2008
Source: SCDNR Charterboat Logbooks



SC Commercial Cobia Landings by Region
1997-2006
Source: SCDNR Dealer Reporting



Commercial Cobia Landings in SC (2004-2008)