Gulf and South Atlantic Regional Panel on Aquatic Invasive Species
October 4th-5th 2011 Meeting, Austin TX

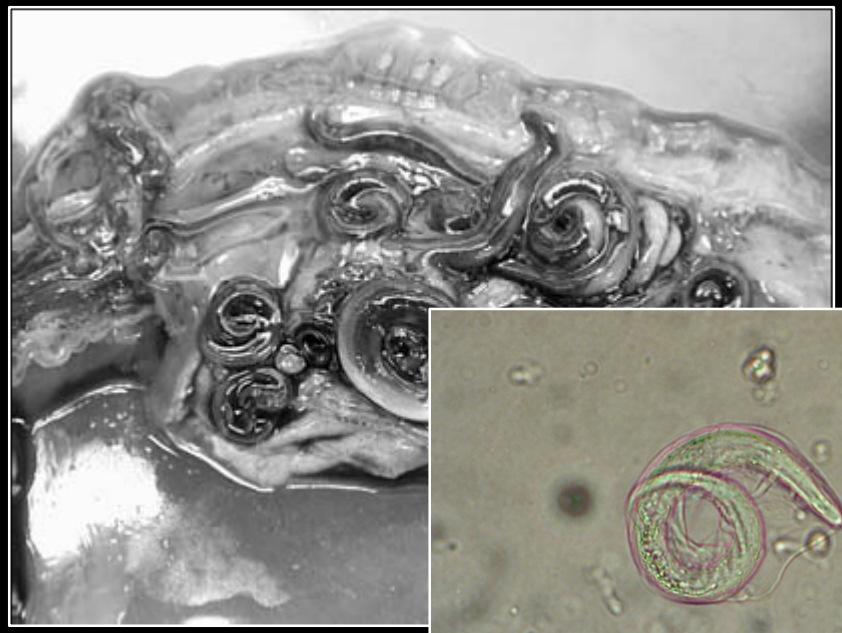
Updates on the status of invasive and non-indigenous species in South Carolina.

Peter R. Kingsley-Smith, Ph.D.
Marine Resources Research Institute (MRRI)
South Carolina Department of Natural Resources (SCDNR)
Charleston SC 29422
kingsleysmithp@dnr.sc.gov

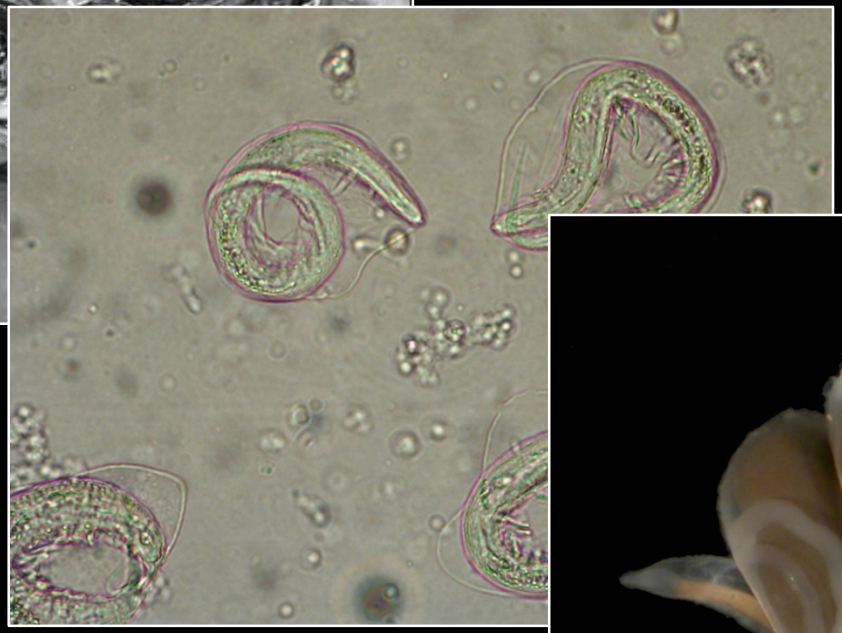
David Knott
SCDNR-MRRI Retiree
Poseidon Taxonomic Services
david.knott@why-knott.com

DNR

Infection of the invasive swim bladder nematode parasite *Anguillicoloides crassus* in South Carolina populations of the American eel *Anguilla rostrata*.



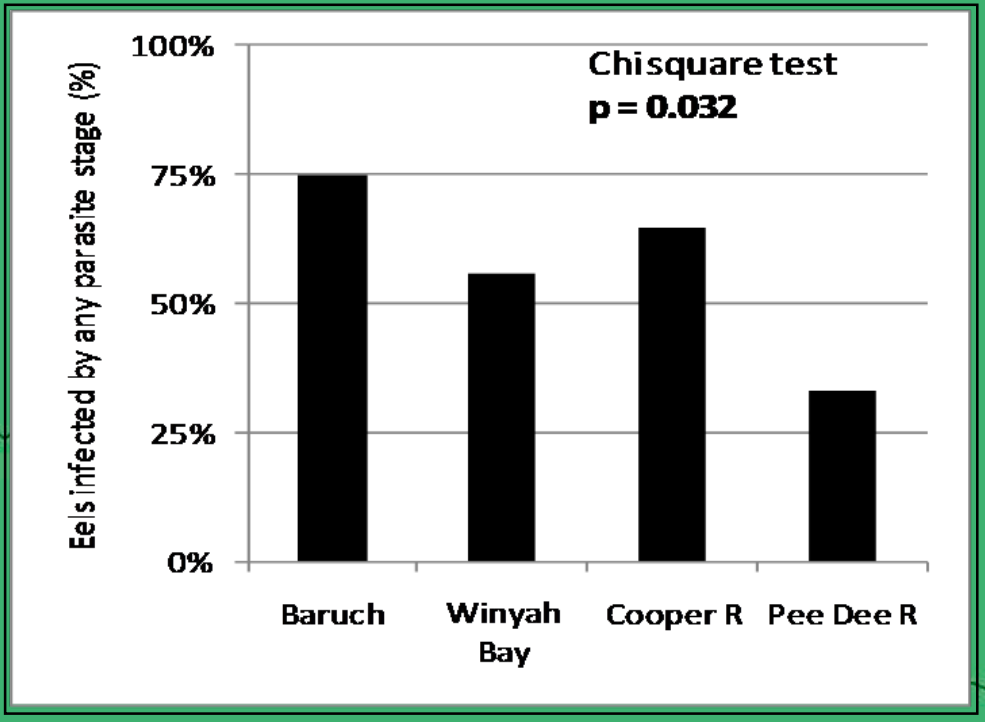
Sokowlowski & Dove 2006



Hatchlings (courtesy of D. Knott)

Adult (courtesy of D. Knott)


Juvenile parasites in eel swimbladder wall.
Photo courtesy of Jen Hein (College of Charleston).



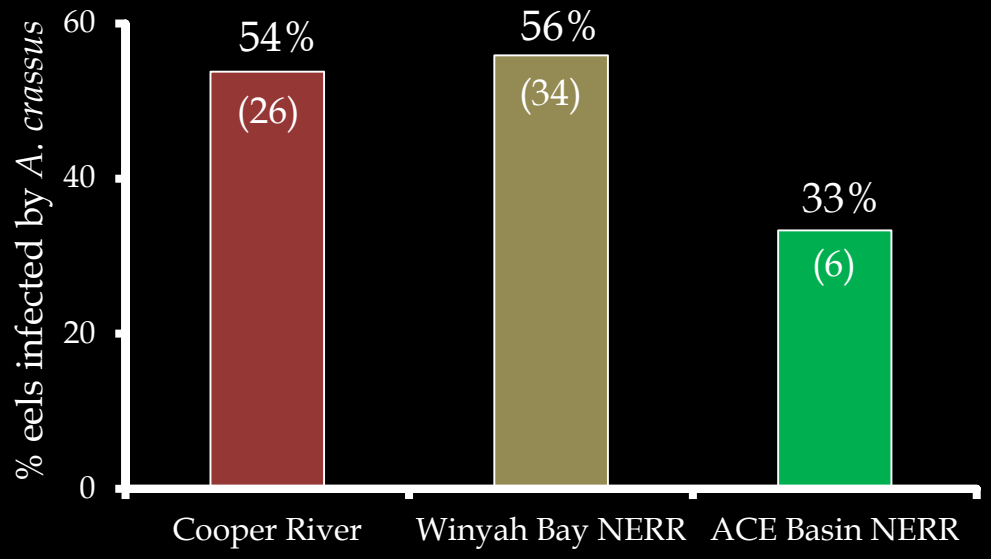
Salinity effect on *A. crassus* infection rate.

Data collected by Joyah Watkins & Aneese Williams, NSF-funded MIMES REU Program.

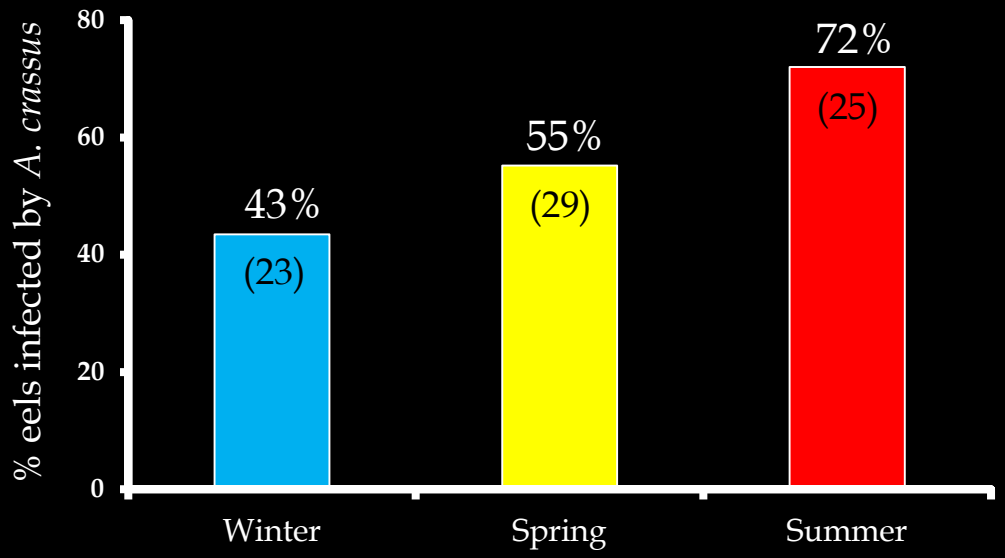
Atlantic Ocean

- Pee Dee River (0 ppt)
- Winyah Bay (5 ppt)
- Baruch (>20 ppt)
- Cooper River (5 ppt)

Site (pollution) effects on *A. crassus* infections of *A. rostrata.*



Seasonal effects on *A. crassus* infections of *A. rostrata.*



Data collected by Jen Hein, College of Charleston.

Numbers shown in parentheses are sample sizes.

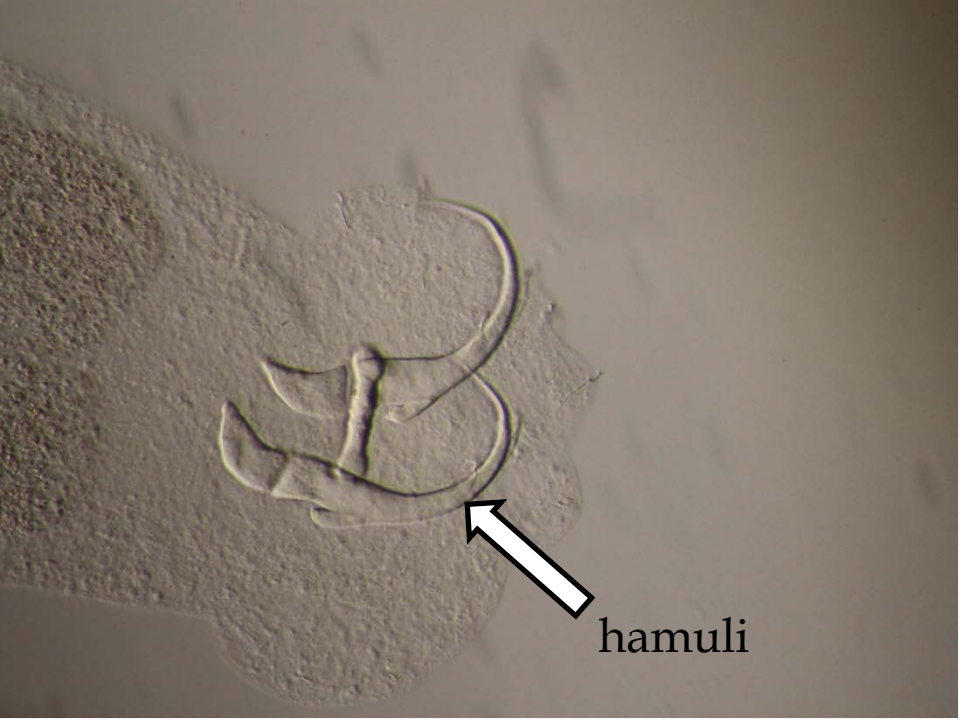
More invasive parasites for the poor old American eel, *Anguilla rostrata*…

Monogenean parasites in the genus *Pseudodactylogyrus*:

- Members of the Phylum Platyhelminthes (flatworms, lack body cavity)
- Typically small, ectoparasites of the skin and gills of fish
- Possess specialized structures for attachment (prohaptor, opisthaptor)
- Two invasive species identified from rivers in SC

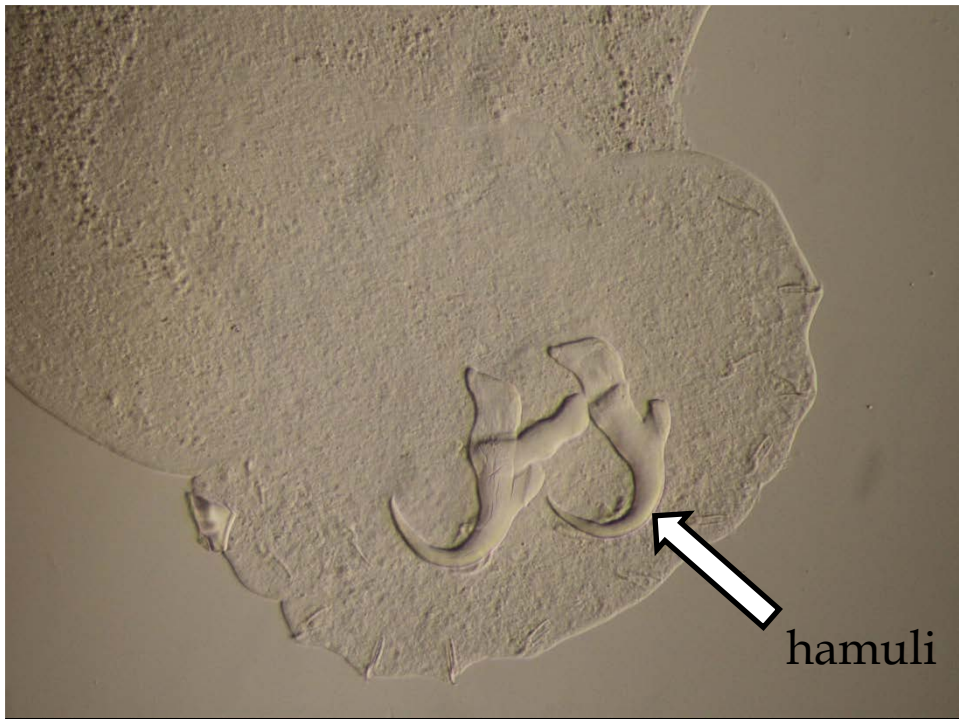
  Pseudodactylogyrus bini and *Pseudodactylogyrus anguillae*
- Larger sample sizes needed to better describe parasite distributions
- DNA sequencing for species identification verification still needed

Pseudodactylogyrus sp. on gills of elver (*Anguilla rostr*ata)



Left:
Posterior end of
Pseudodactylogyrus anguillae and
prominent hooks (hamuli) used
for attachment to gills of host.

Right:
Posterior end of
Pseudodactylogyrus bini and
prominent hooks (hamuli) used
for attachment to gills of host.



- Invasive red alga *Gracilaria vermiculophylla,* native to Eastern Asia
- Rapid proliferation of *G. vermiculophylla* over the past decade
- High salinity mudflats in Georgia and South Carolina estuaries
- Invasion of areas previously devoid of macrophytes
- Tolerant of wide temperature ranges and low light conditions
- Interactions with tube-building worm, *Diopatra cuprea* on mudflats

Gracilaria vermiculophylla
Wappoo Cut, Charleston, SC

Image courtesy of Erik Sotka, College of Charleston

Experiments to determine field growth rates of *Gracilaria vermiculophylla* (top right).

Tube-building (decoration) preferences of *Diopatra cuprea* (bottom right).

Algal consumption experiments with *Diopatra cuprea* (bottom left / below).

Tethered *Gracilaria vermiculophylla*.

Images courtesy of Wilmelie Cruz Marrero.

***Diopatra cuprea* worm tube.**

Feeding time at the *Diopatra cuprea* enclosure!

Experiments with *Diopatra cuprea* conducted for both:
1) Tube decoration preference; 2) Consumption preference

Choice

No choice

Images courtesy of Wilmelie Cruz Marrero.

Relative growth rate of *Gracilaria vermiculophylla*

Subtidal > Intertidal ($p < 0.001$)

Mean net loss within intertidal treatments during study (desiccation stress?)

Decoration of tubes by *Diopatra cuprea*

No choice experiments: *Ulva* = *Gracilaria* ($p = 0.2975$)

Choice experiments: *Ulva* > *Gracilaria* ($p = 0.0135$)

Consumption of algal species by *Diopatra cuprea*

No choice experiments: *Ulva* = *Gracilaria* ($p = 0.4677$)

Choice experiments: *Ulva* > *Gracilaria* ($p = 0.0001$)

Diopatra cuprea tubes are dominated by *Gracilaria vermiculophylla* on the Fort Johnson mudflat previously shown likely due to the scarcity of *Ulva lactuca* at this study site.

Data courtesy of Wilmelie Cruz Marrero.

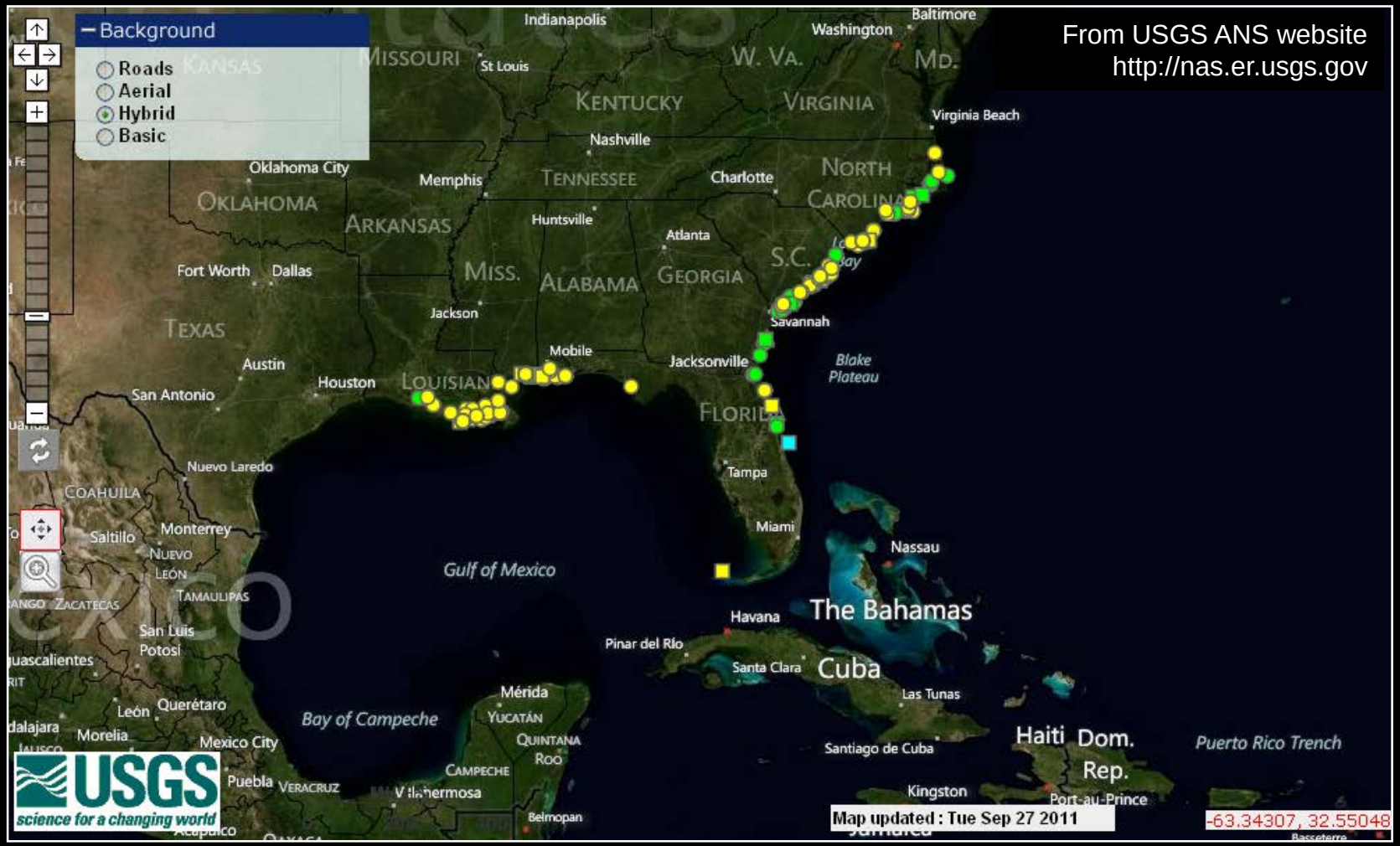
- At the previous meeting, the live collection of an Island apple snail, *Pomacea insularum* was reported.
- Return visit on August 16th 2011 to this site yielded no live snails or fresh egg masses, but did yield empty shells (mean SH= 70.9 mm ; mean SW = 65.2, n = 15).
- Consecutive cold winters may have caused mortalities.
- A more thorough investigation of these connected waterways is warranted.

Live adult *Pomacea insularum*

Pomacea insularum egg masses

Image courtesy of Michelle Sempsrott, FL FWCC

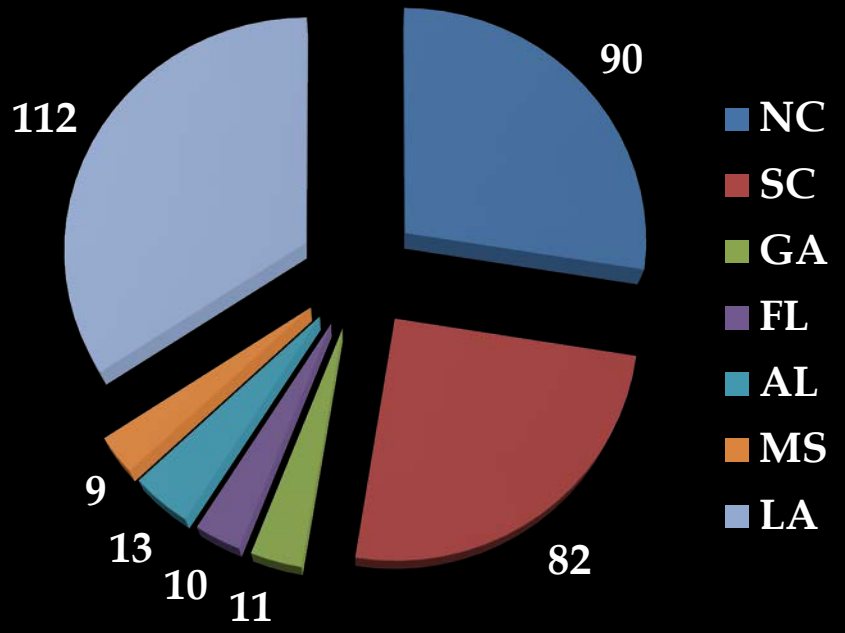
Updates to the Status of Asian Tiger Shrimp, *Penaeus monodon*, along the southeastern U.S. coastline.



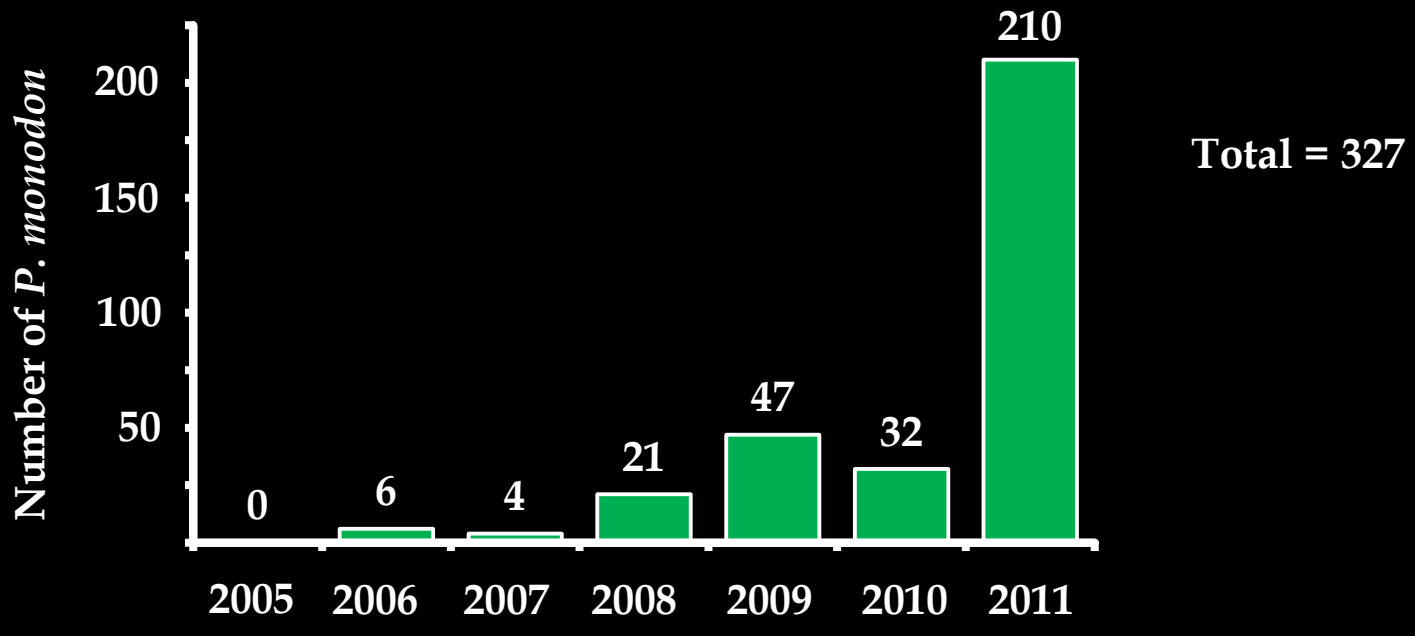
Updated numbers for Asian tiger shrimp, *Penaeus monodon* collections.

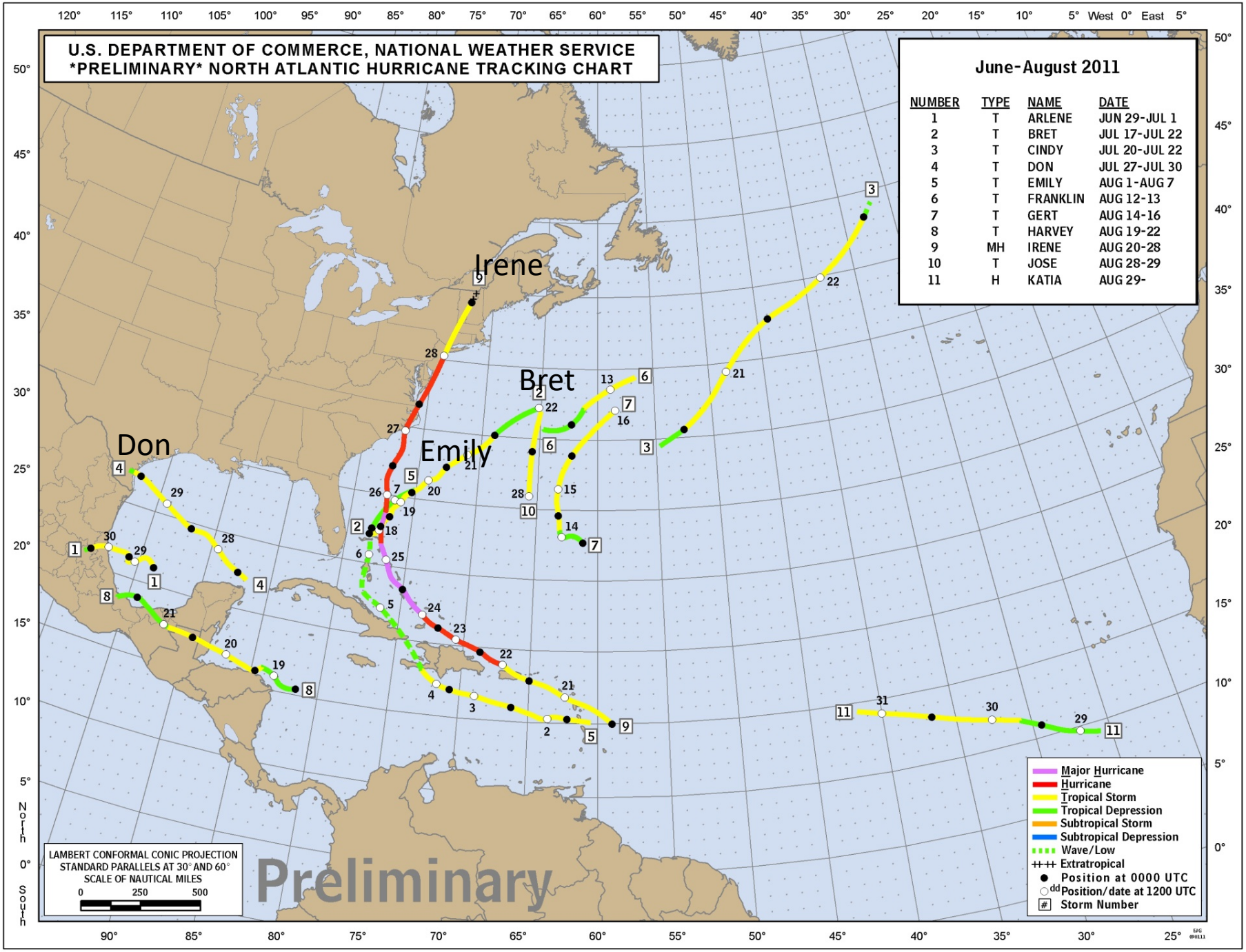
	NC	SC	GA	FL	MS	LA	AL	TOTAL
2010 Season	2	20	1	2	0	7	0	**32**
2011 Season (updated 10/5/2011)	58	40	3	4	5	100	7	**210**
Grand totals to date	90	82	11	10	9	112	13	**327**

Contribution to *P. monodon* catches by state (totals to date).



Collections of *P. monodon* in South Atlantic and Gulf coast states




U.S. DEPARTMENT OF COMMERCE, NATIONAL WEATHER SERVICE
PRELIMINARY NORTH ATLANTIC HURRICANE TRACKING CHART
June-August 2011
NUMBER TYPE NAME DATE
1 T ARLENE JUN 29-JUL 1
2 T BRET JUL 17-JUL 22
3 T CINDY JUL 20-JUL 22
4 T DON JUL 27-JUL 30
5 T EMILY AUG 1-AUG 7
6 T FRANKLIN AUG 12-13
7 T GERT AUG 14-16
8 T HARVEY AUG 19-22
9 MH IRENE AUG 20-28
10 T JOSE AUG 28-29
11 H KATIA AUG 29-
Irene
Bret
Emily
Don
Major Hurricane
Hurricane
Tropical Storm
Tropical Depression
Subtropical Storm
Subtropical Depression
Wave/Low
Extratropical
Position at 0000 UTC
Position/date at 1200 UTC
Storm Number
LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS AT 30° AND 60°
SCALE OF NAUTICAL MILES
0 250 500
Preliminary

www.sea-ex.com/
recreational1/brag.html

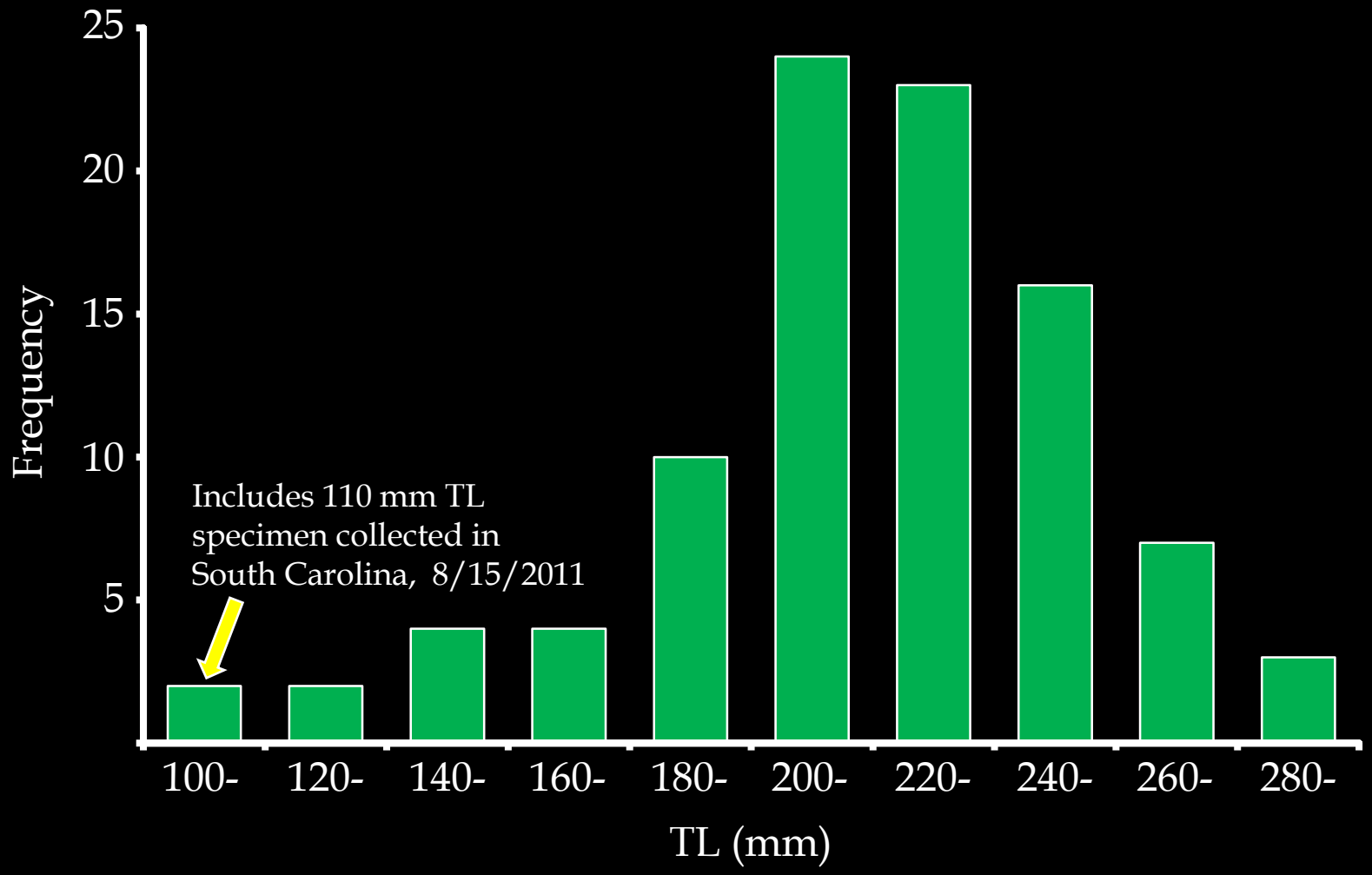
Penaeus monodon, undetermined sex, TL ~105 mm.
Collected by private citizen on 8/29/2010
~12 km from New Smyrna Beach on FL ICWW.
Specimen donated to FL FWRI staff.

Mean total length (mm) of *Penaeus monodon* collected along the southeast Atlantic US and Gulf coasts (through September 14th 2011)

Year	2006	2007	2008	2009	2010	2011	All Years
Male	221 (1)	224 (2)	206 (4)	204 (7)	192 (6)	209 (18)	206 (38)
							8.1 in
Female	–	237 (1)	213 (3)	236 (9)	–	234 (12)	232 (25)
							9.1 in
Sex undeter.	181 (1)	207 (1)	259 (3)	231 (15)	225 (4)	209 (24)	220 (48)
							8.7 in
All	201 (2)	223 (4)	224 (10)	226 (31)	205 (10)	214 (54)	218 (111)
							8.6 in

Numbers shown in parentheses are sample sizes

Size-frequency distribution of *P. monodon* collected and measured between July 2009 and September 2011 (n=95).
Data shown are total lengths in mm.



Female *P. monodon* collected from the estuary behind Hilton Head Island on 8/15/2011 (TL = 110 mm, 8.2 gm)

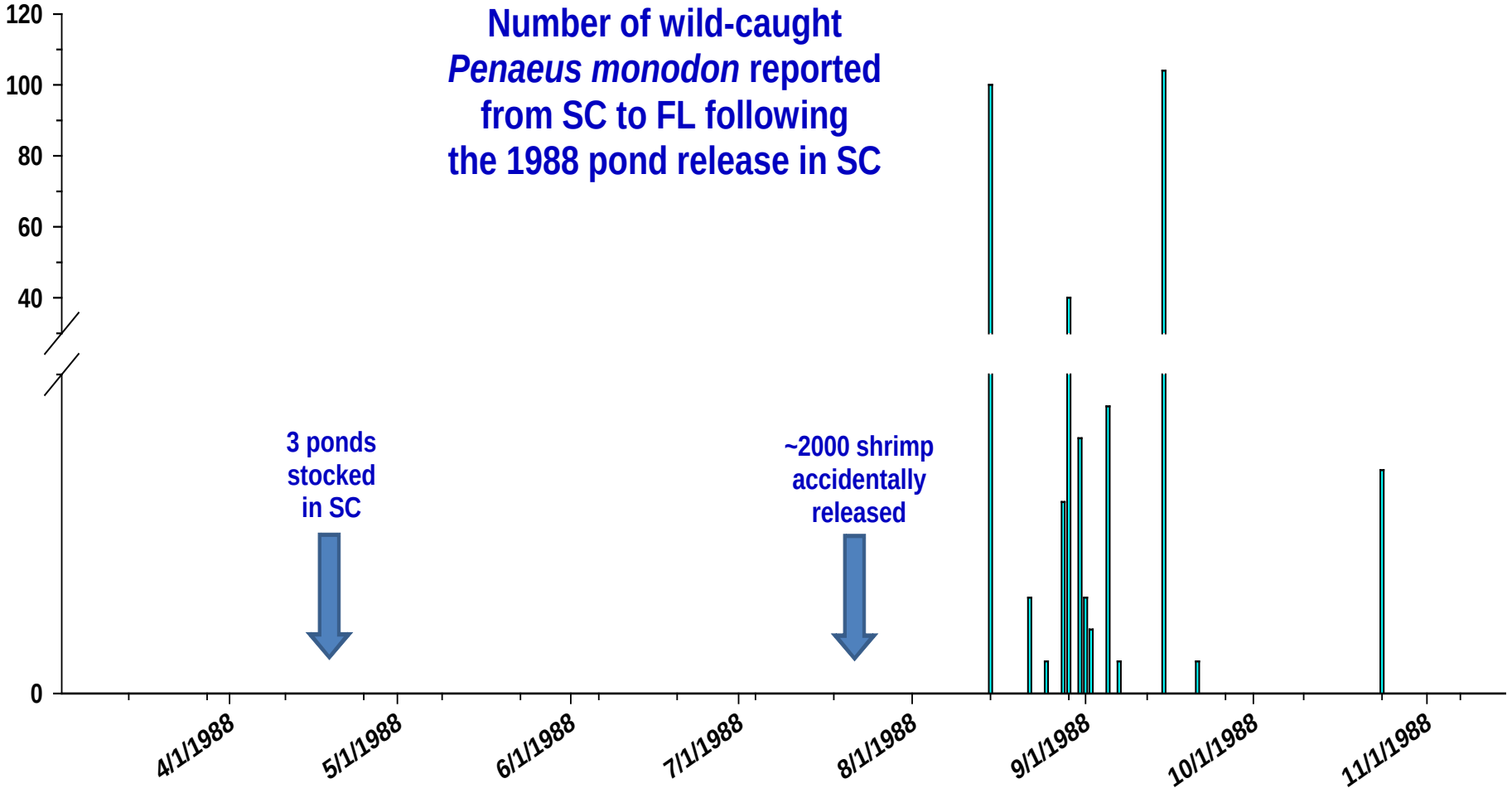
White spot syndrome virus (WSSV)?

Is *P. monodon* a potential vector for this pathogen for its transmission to native penaeid shrimp species?

Potential sources of *P. monodon* in the U.S.

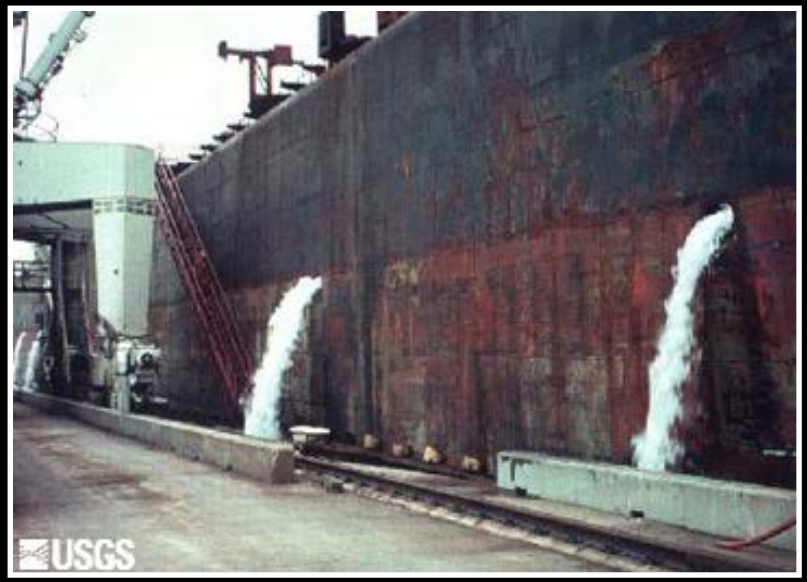
- escapement from U.S. aquaculture operations?
- continuous ballast transport and delivery?
- escapement from Caribbean aquaculture operations?
- migration from wild Caribbean or African populations?
- established breeding populations somewhere along the U.S. coast?

Potential sources of *P. monodon* in the U.S.
– *escapement from U.S. aquaculture operations?*



Potential sources of *P. monodon* in the U.S.

– *continuous ballast transport and delivery?*



Potential sources of *P. monodon* in the U.S.
– *escapement from Caribbean aquaculture operations?*

2006, one year before TS Noel

2007, one week after TS Noel

Baharona, Dominican Republic, 2002

Baharona, Dominican Republic, 2010


Baharona, Dominican Republic, 2010
La Canoa
Bombita
© 2011 Google
Image © 2011 GeoEye
© 2011 Europa Technologies
Image © 2011 TerraMetrics
©2010 Google
Imagery Date: 1/23/2010
lat 18.313300° lon -71.103193° elev 5 m
Eye alt 4.02 km

Potential sources of *P. monodon* in the U.S.

– *migration from wild Caribbean or African populations?*

Exploring Economic Opportunities in Sustainable Shrimp Farming in West Africa: Focus on South-South Cooperation

Regional Roundtable

Conakry (Guinea), 6 - 8 June 2006

Sahel and West Africa Club/OECD

Development Perspectives Unit

Shrimp seed: Shrimp farming requires a reliable supply of quality disease free hatchery seed. *Penaeus monodon*, is a non-indigenous species widely found in Asia, but has localized and is now found wild along the west coast of Africa, probably the result of an earlier introduction. This resource provides the potential for the development of a *P. monodon* hatchery system based on local resources, avoiding the need to introduce shrimp from other regions, and risks of importing disease. The advantage of *P. monodon* is that hatchery technology is readily available in Asia and eastern Africa and sufficiently well-understood and thus, it is amenable to adaptation for aquaculture in West Africa. Two hatcheries already exist in West Africa, although only the hatchery currently functioning is The Gambian farm "*West African Aquaculture*".

Potential sources of *P. monodon* in the U.S.

– *migration from wild Caribbean or African populations?*

Exploring Economic Opportunities in Sustainable Shrimp Farming in West Africa: Focus on South-South Cooperation

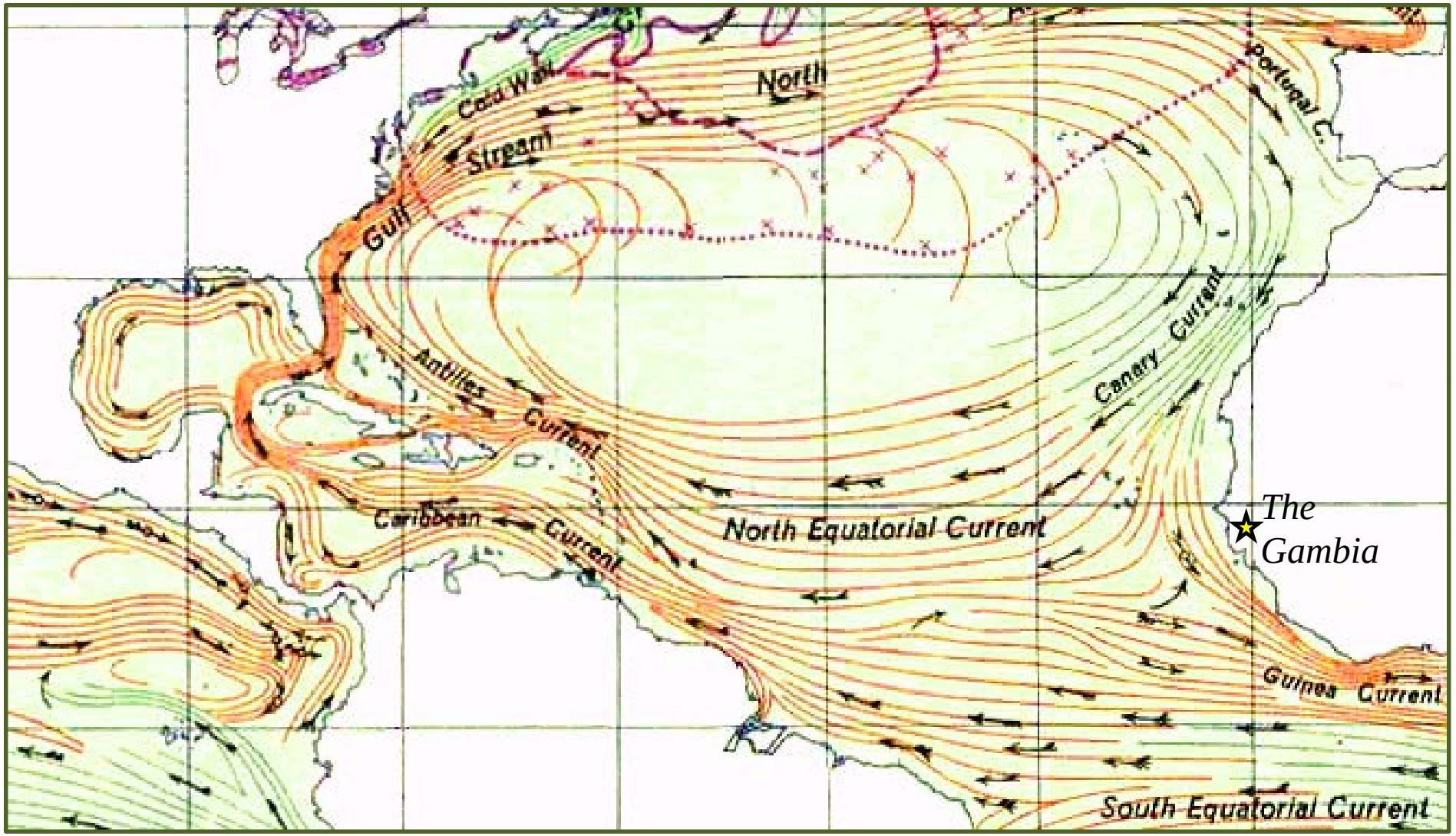
Regional Roundtable

Conakry (Guinea), 6 - 8 June 2006

Sahel and West Africa Club/OECD

Development Perspectives Unit

Shrimp seed: Shrimp farming requires a reliable supply of quality disease free hatchery seed. *Penaeus monodon*, is a non-indigenous species widely found in Asia, but has localized and is now found wild along the west coast of Africa, probably the result of an earlier introduction. This resource provides the potential for the development of a *P. monodon* hatchery system based on local resources, avoiding the need to introduce shrimp from other regions, and risks of importing disease. The advantage of *P. monodon* is that hatchery technology is readily available in Asia and eastern Africa and sufficiently well-understood and thus, it is amenable to adaptation for aquaculture in West Africa. Two hatcheries already exist in West Africa, although only the hatchery currently functioning is The Gambian farm "*West African Aquaculture*".



Hypothetic mechanism for transport of *P. monodon* to U.S. East Coast.

- Entrainment of individuals from established populations in The Gambia in trans-Atlantic (North Equatorial) currents.
- Consistent with reports of *P. monodon* in southeastern region since 2006.


The Gambia, W. Africa, 2009
2978 ft
© 2009 Google
Image © 2009 GeoEye
©2009 Google
Imagery Date: Mar 19, 2009
lat 13.282081° lon -16.524833° elev 8 ft
Eye alt 10408 ft


The Gambia, W. Africa, 2009
© 2009 Google
Image © 2009 GeoEye
©2009 Google
471 ft
Imagery Date: Mar 19, 2009
lat 13.290710° lon -16.518830° elev 5 ft
Eye alt 1631 ft

Potential sources of *P. monodon* in the U.S.

– *established breeding populations somewhere along the U.S. coast???*

Current efforts and future needs:

- recognition flyer to docks
- more systematic data collection and reporting (to USGS and to DMK)
- more size/weight/sex data for reported specimens
- data recording cards to biologists

TIGER SHRIMP DATA CARD

Reporter Name:
Date of Report:
Captain/Fisherman Name:
Vessel Name:
Dock Location/Sfd Company:
Date of Capture:
Location of Capture (detailed description-GPS) _____ N_____ °_____._____' W_____ °_____._____'
Depth Range of Capture: □Feet □Meters
Number caught at this location (all tows):

TIGER SHRIMP DATA CARD

Reporter Name:
Date of Report:
Captain/Fisherman Name:
Vessel Name:
Dock Location/Sfd Company:
Date of Capture:
Location of Capture (detailed description-GPS) _____ N_____ °_____._____' W_____ °_____._____'
Depth Range of Capture: □Feet □Meters
Number caught at this location (all tows):

TIGER SHRIMP DATA CARD

Reporter Name:
Date of Report:
Captain/Fisherman Name:
Vessel Name:
Dock Location/Sfd Company:
Date of Capture:
Location of Capture (detailed description-GPS) _____ N_____ °_____._____' W_____ °_____._____'
Depth Range of Capture: □Feet □Meters
Number caught at this location (all tows):

TIGER SHRIMP DATA CARD

Reporter Name:
Date of Report:
Captain/Fisherman Name:
Vessel Name:
Dock Location/Sfd Company:
Date of Capture:
Location of Capture (detailed description-GPS) _____ N_____ °_____._____' W_____ °_____._____'
Depth Range of Capture: □Feet □Meters
Number caught at this location (all tows):

Sp #	TL		Weight		Sex		
	□mm	□inches	□ grams	□ounces	Male	Female	Undet
1					□	□	□
2					□	□	□
3					□	□	□
4					□	□	□
5					□	□	□
6					□	□	□
7					□	□	□
8					□	□	□
9					□	□	□
10					□	□	□

Sp #	TL		Weight		Sex		
	□mm	□inches	□ grams	□ounces	Male	Female	Undet
1					□	□	□
2					□	□	□
3					□	□	□
4					□	□	□
5					□	□	□
6					□	□	□
7					□	□	□
8					□	□	□
9					□	□	□
10					□	□	□

Sp #	TL		Weight		Sex		
	□mm	□inches	□ grams	□ounces	Male	Female	Undet
1					□	□	□
2					□	□	□
3					□	□	□
4					□	□	□
5					□	□	□
6					□	□	□
7					□	□	□
8					□	□	□
9					□	□	□
10					□	□	□

Sp #	TL		Weight		Sex		
	□mm	□inches	□ grams	□ounces	Male	Female	Undet
1					□	□	□
2					□	□	□
3					□	□	□
4					□	□	□
5					□	□	□
6					□	□	□
7					□	□	□
8					□	□	□
9					□	□	□
10					□	□	□

Potential sources of *P. monodon* in the U.S.

– *established breeding populations somewhere along the U.S. coast???*

Current efforts and future needs:

- recognition flyer to docks
- more systematic data collection and reporting (to USGS and to DMK)
- more size/weight/sex data for reported specimens
- data recording cards to biologists
- tissue collection, DNA sequencing and analysis

Potential sources of *P. monodon* in the U.S.

– *established breeding populations somewhere along the U.S. coast???*

Current efforts and future needs:

- recognition flyer to docks
- more systematic data collection and reporting (to USGS and to DMK)
- more size/weight/sex data for reported specimens
- data recording cards to biologists
- tissue collection, DNA sequencing and analysis
- reproductive staging
- cold tolerance experiments
- update USGS NAS *P. monodon* fact sheet
- NOAA integrated assessment?