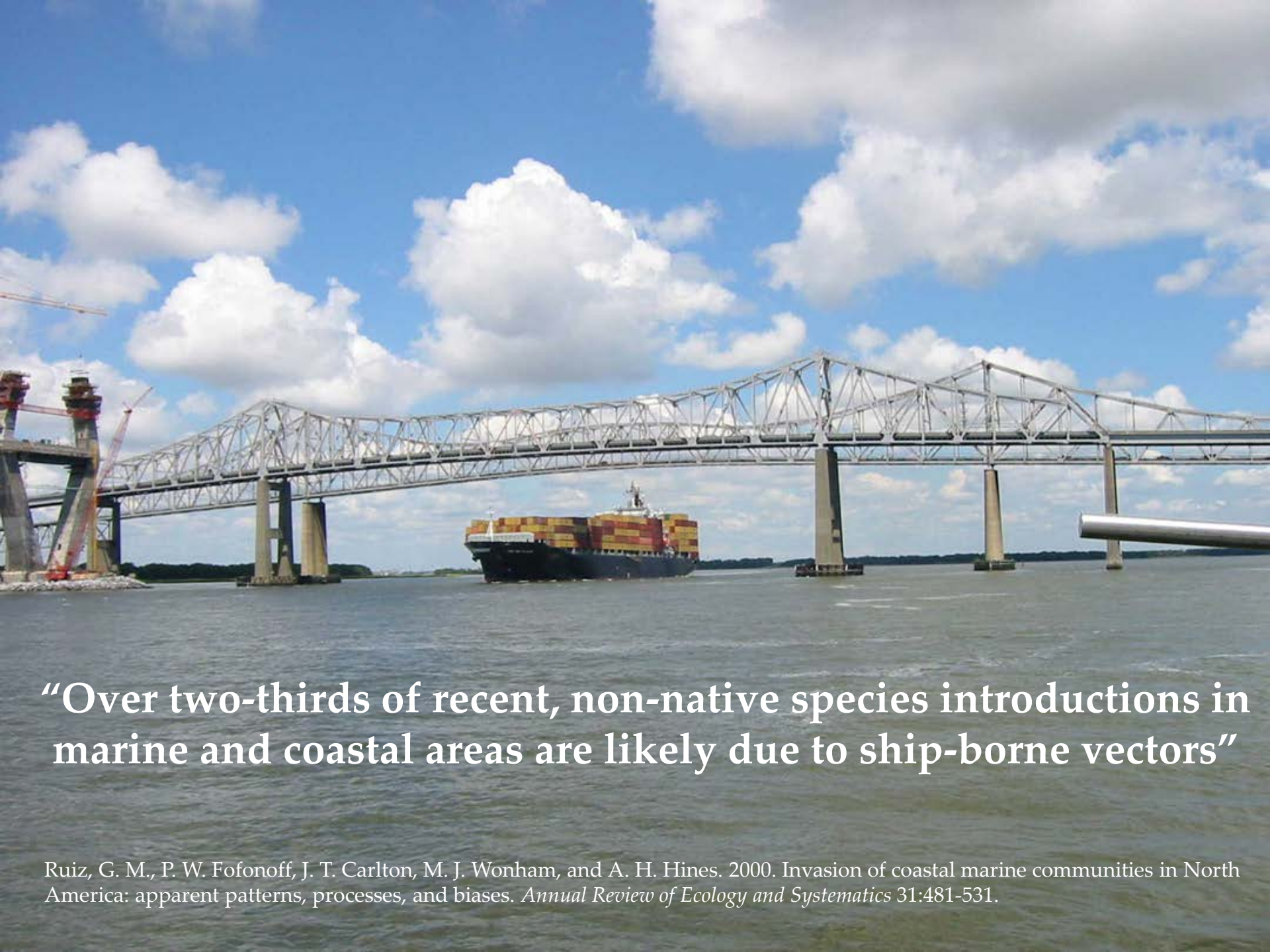
MAREX

The University of Georgia Marine Extension Service

Monitoring nonindigenous species in southeastern ports: why, how, and the lessons learned

A Unit of the Public Service & Outreach Division of the University of Georgia ● Athens ● Atlanta ● Brunswick ● Savannah ● (912) 598 2348 ● www.marex.uga.edu/shellfish ● alanpowr@uga.edu



"Over two-thirds of recent, non-native species introductions in marine and coastal areas are likely due to ship-borne vectors"

Ruiz, G. M., P. W. Fofonoff, J. T. Carlton, M. J. Wonham, and A. H. Hines. 2000. Invasion of coastal marine communities in North America: apparent patterns, processes, and biases. *Annual Review of Ecology and Systematics* 31:481-531.

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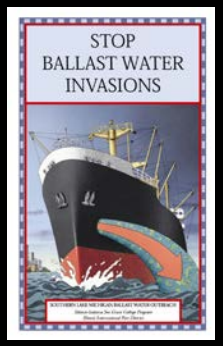
WHY

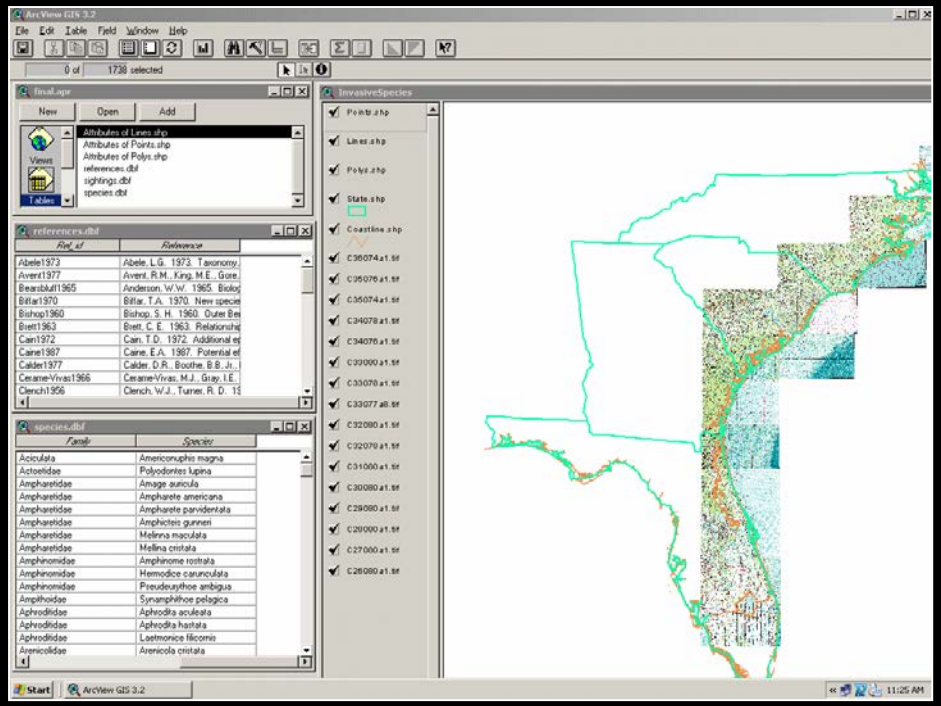


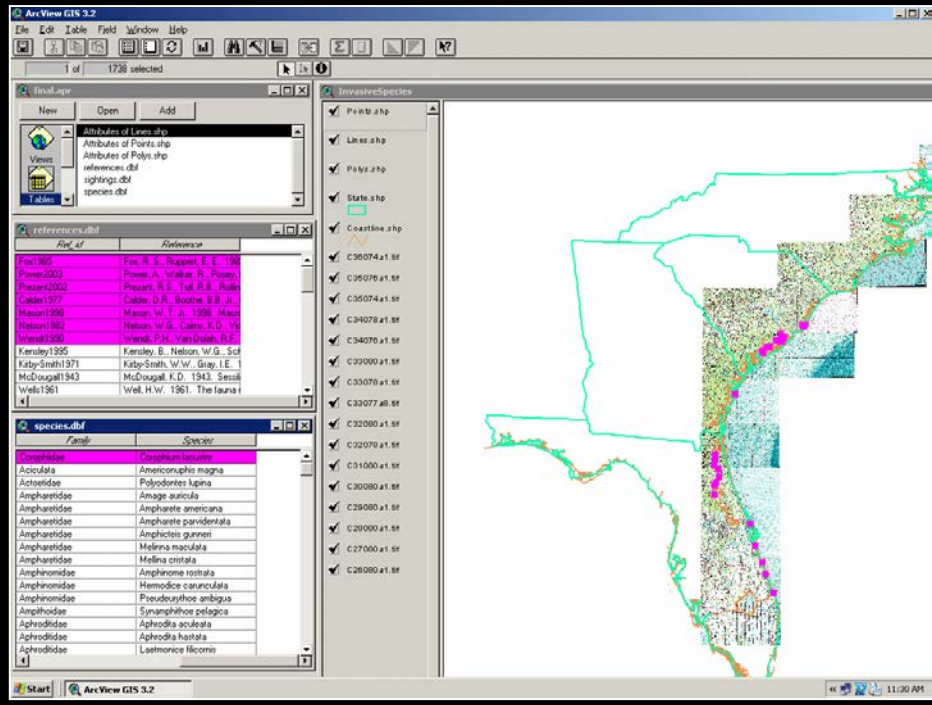
- 21 billion gallons of foreign ballast water discharged in US waters each year (Globallast).
- 7000 different species being carried in ballast tanks worldwide (Globallast).
- Many hitchhikers are also transported on the hulls of these vessels.
- Most marine nonindigenous introductions in SAB have been attributed to shipping activities.
- Commercial ports represent a main entry point for many species introductions.
- Estuarine nonindigenous species knowledge base behind those from terrestrial and freshwater systems.
- Early detection important for effective response.
- Knowledge of species distribution helps predict future spread.
- Provide reference data for future assessments of change.

HOW

1. Review literature of biotic surveys for **mollusks**, **crustaceans** and **polychaetes** in the SAB region.
2. Integrate this data with GIS.

A total of 74 survey publications were consulted to construct a GIS database detailing 36,502 mapping points for 1,738 species.

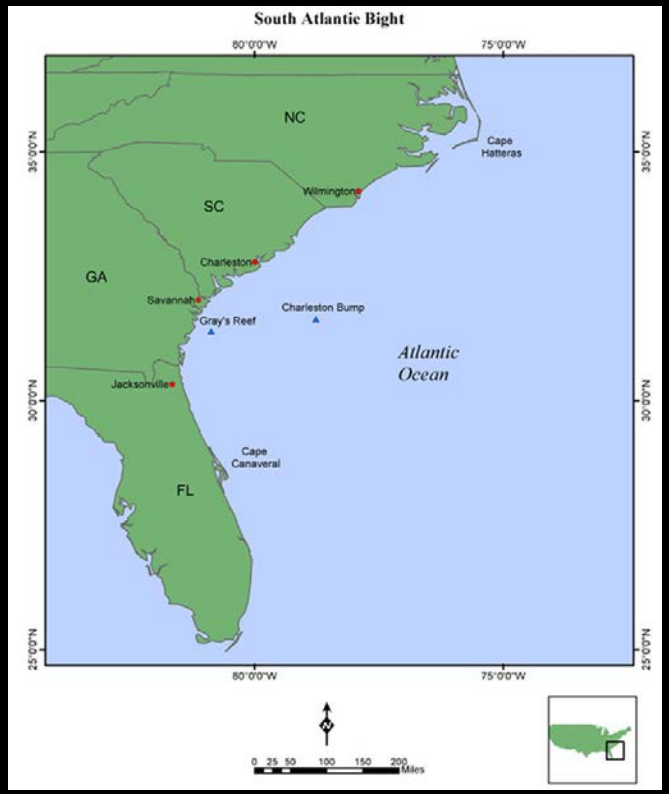




HOW

3. Describe **Wilmington**, **Charleston**, **Savannah**, and **Jacksonville** ports in terms of their history, geology, hydrography, and shipping movements.

Image credit: Southeastern Regional Taxonomic Center



American Association of Port Authorities

2005 Port Rankings (TEUs)

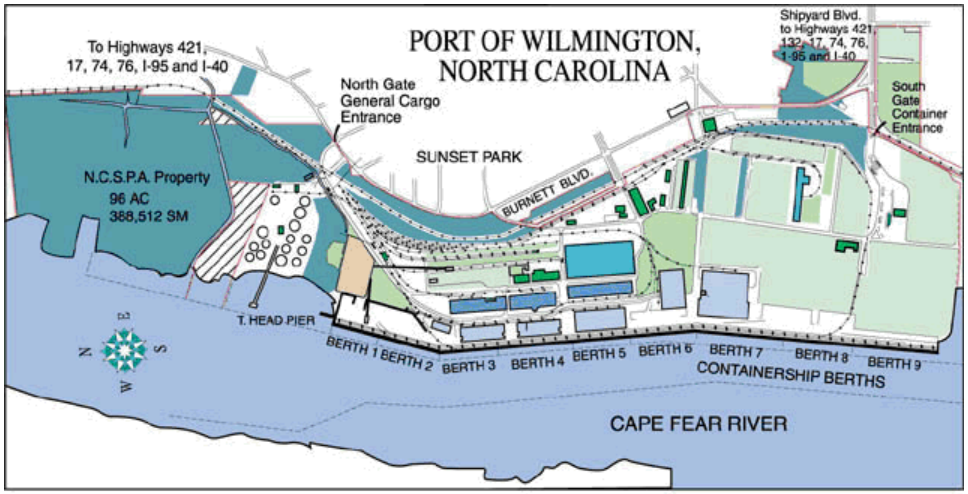
Wilmington NC 32nd

Charleston SC 7th

Savannah GA 9th

Jacksonville FL 18th

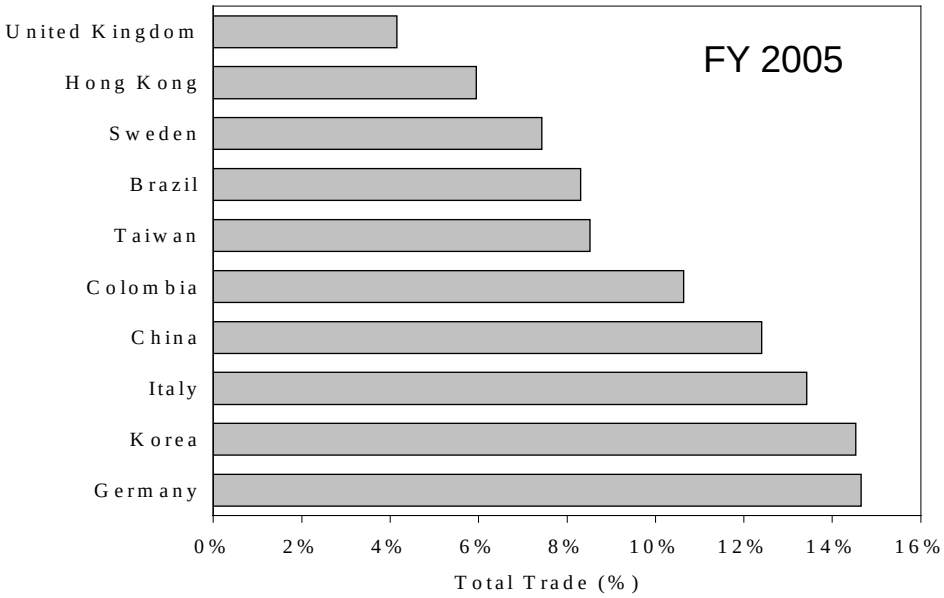
WILMINGTON, NC

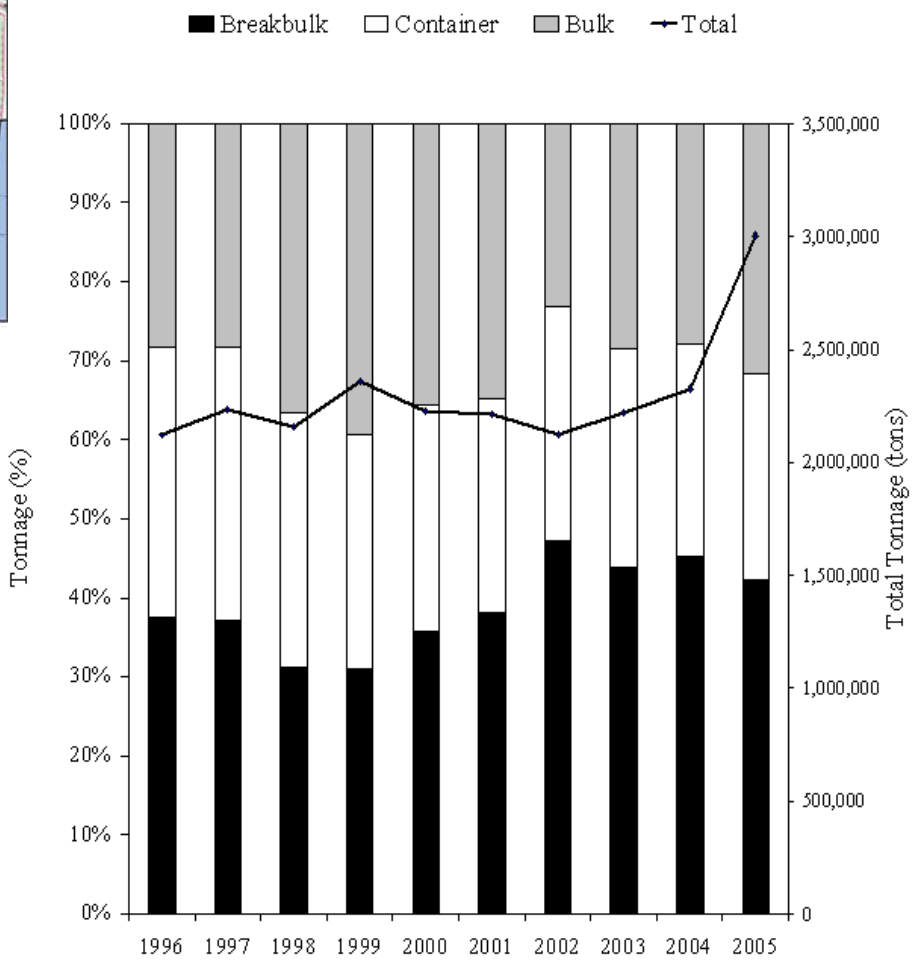


M.L.L.W. = Mean Lower Low Water
SF = Square Feet
SM = Square Meters
LF = Linear Feet
M = Meters
AC = Acres
S.I.A. = Semi-improved Area
P.C.S. = Paved Container Storage
T.O.F.C. = Trailer On Flat Car
C.O.F.C. = Container On Flat Car

Administrative/Office
Available For Development
Cargo Shelter
Containers
Open Storage

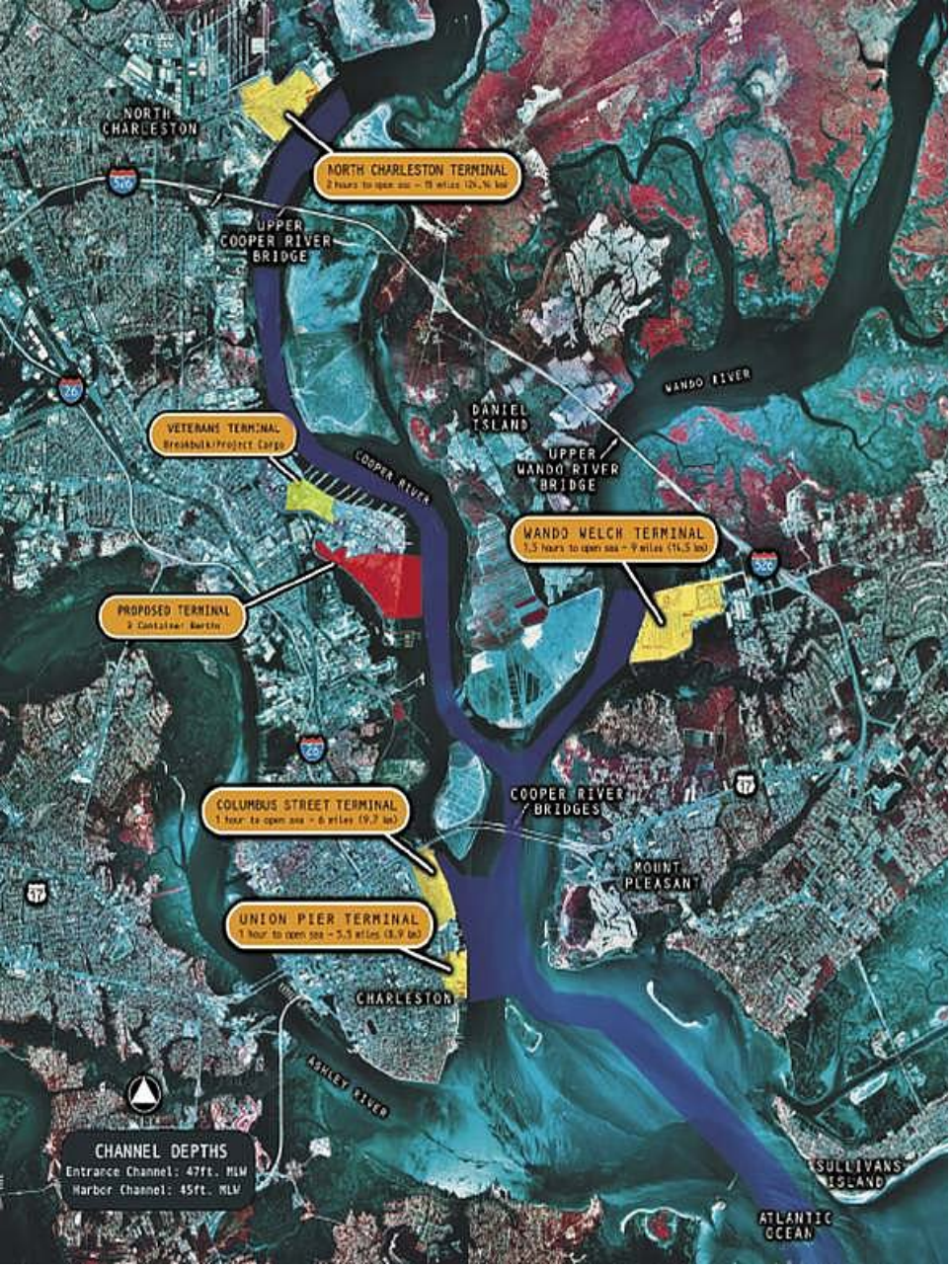
Transit Shed
Warehouse
Wood Chips Storage
NCSPA Property Line
Under Contract to N.C.S.P.A.

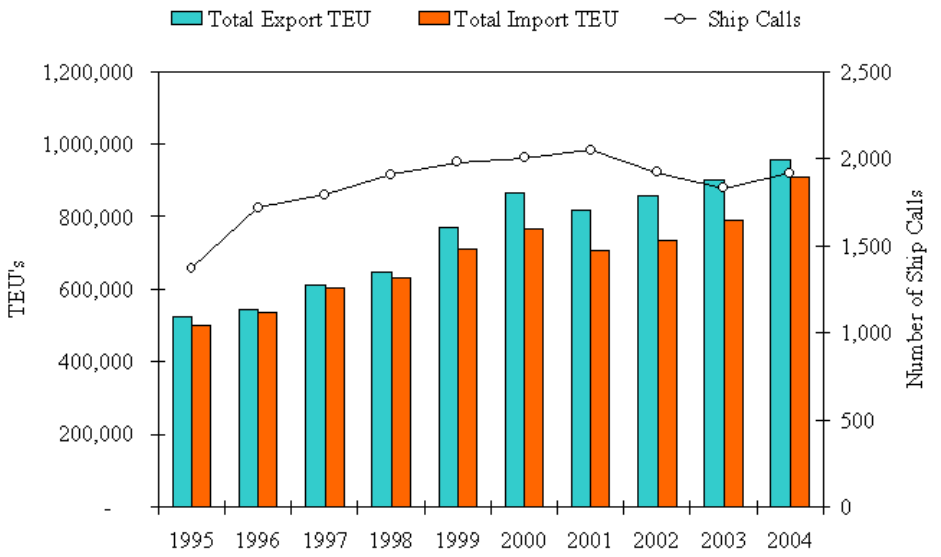


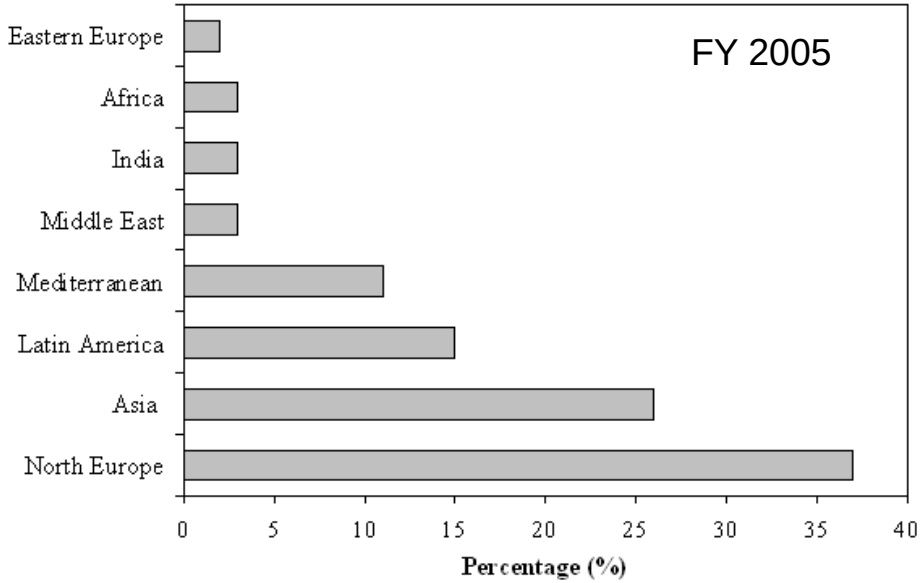


Top Imports: Chemicals

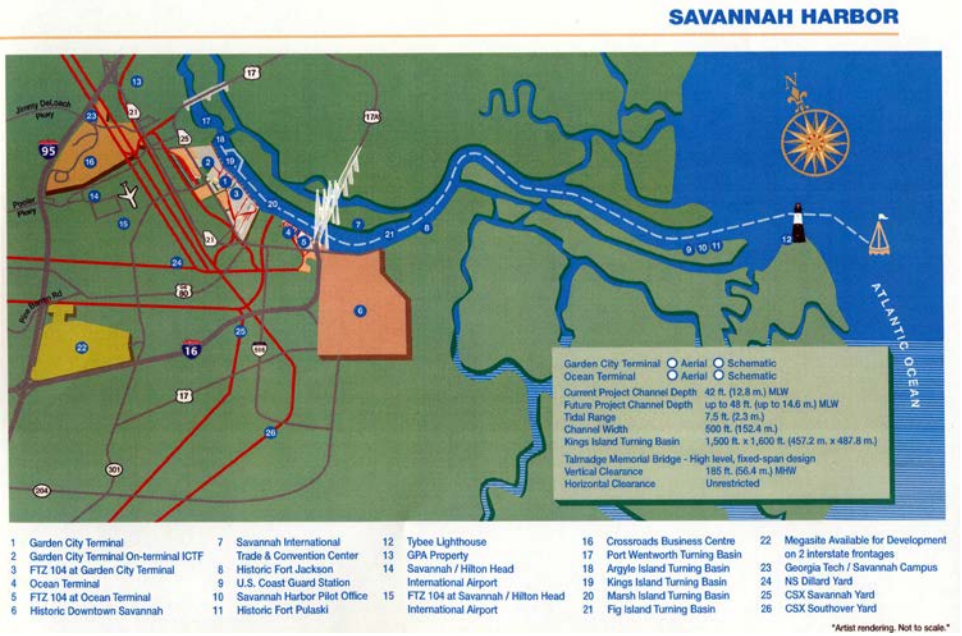
Top Exports: Wood Pulp

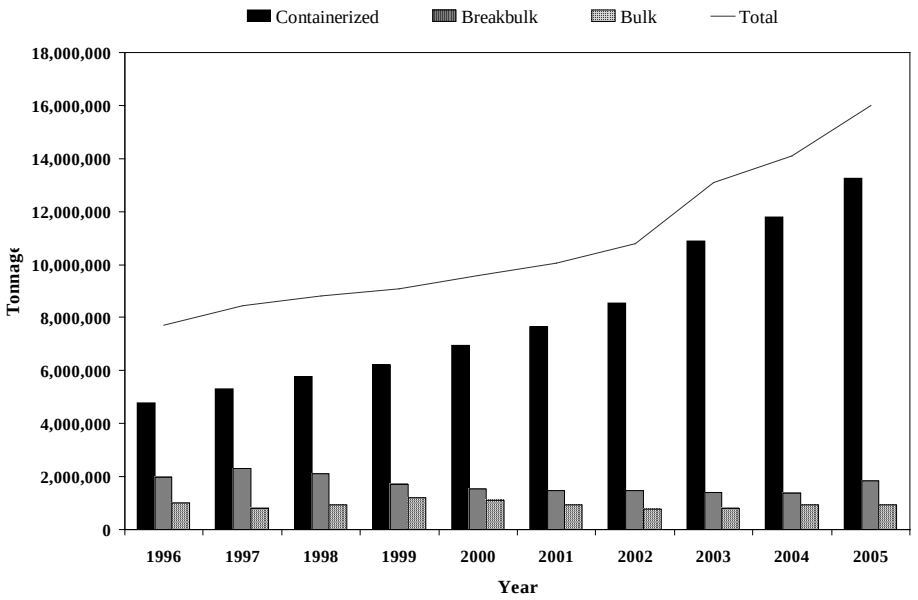




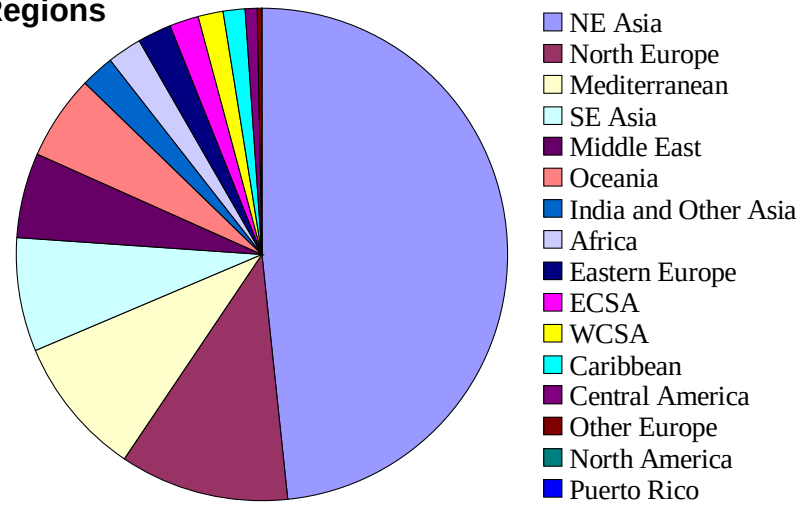


CHARLESTON, SC

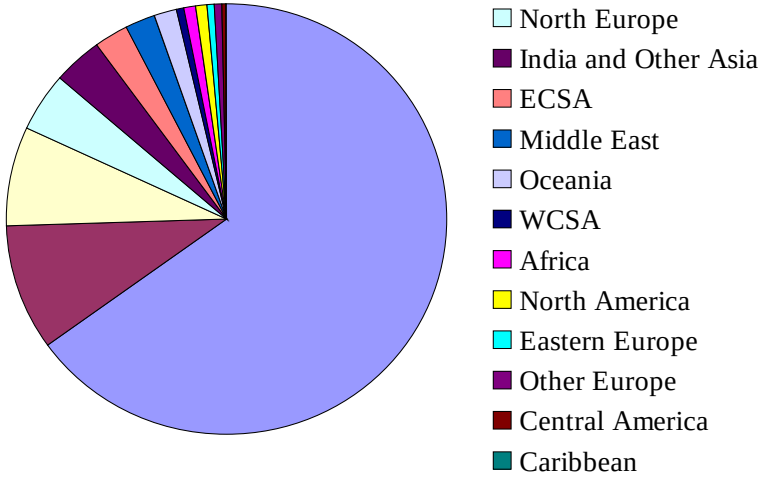




Import Regions FY 2004

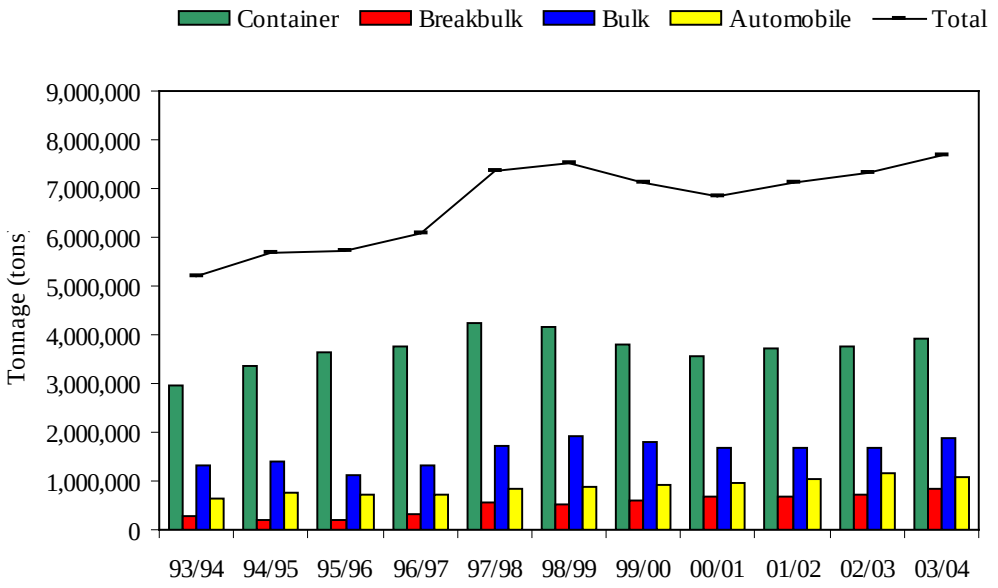


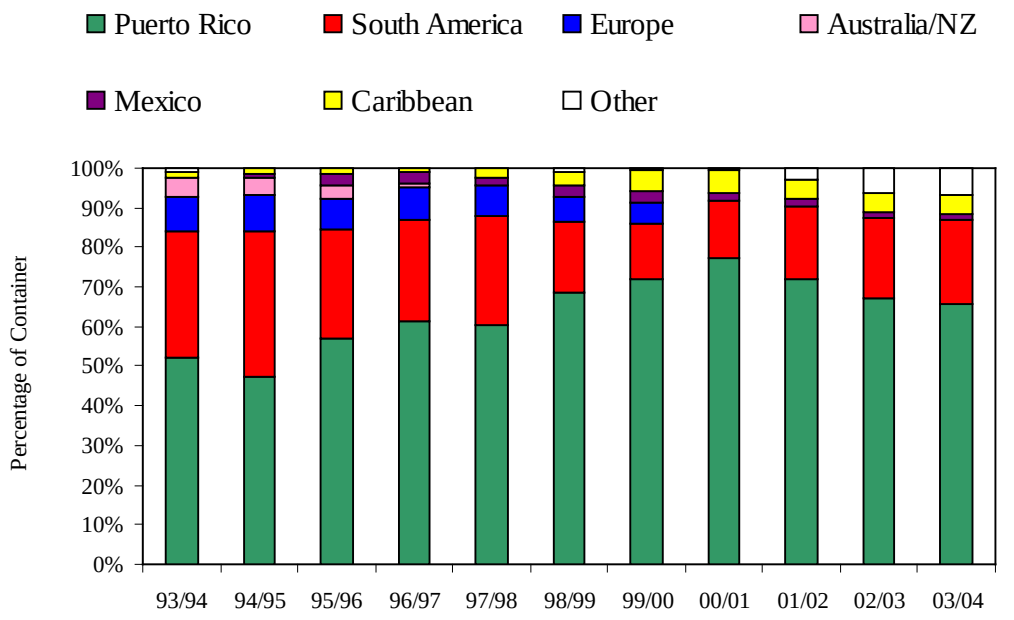
Export Regions FY 2004

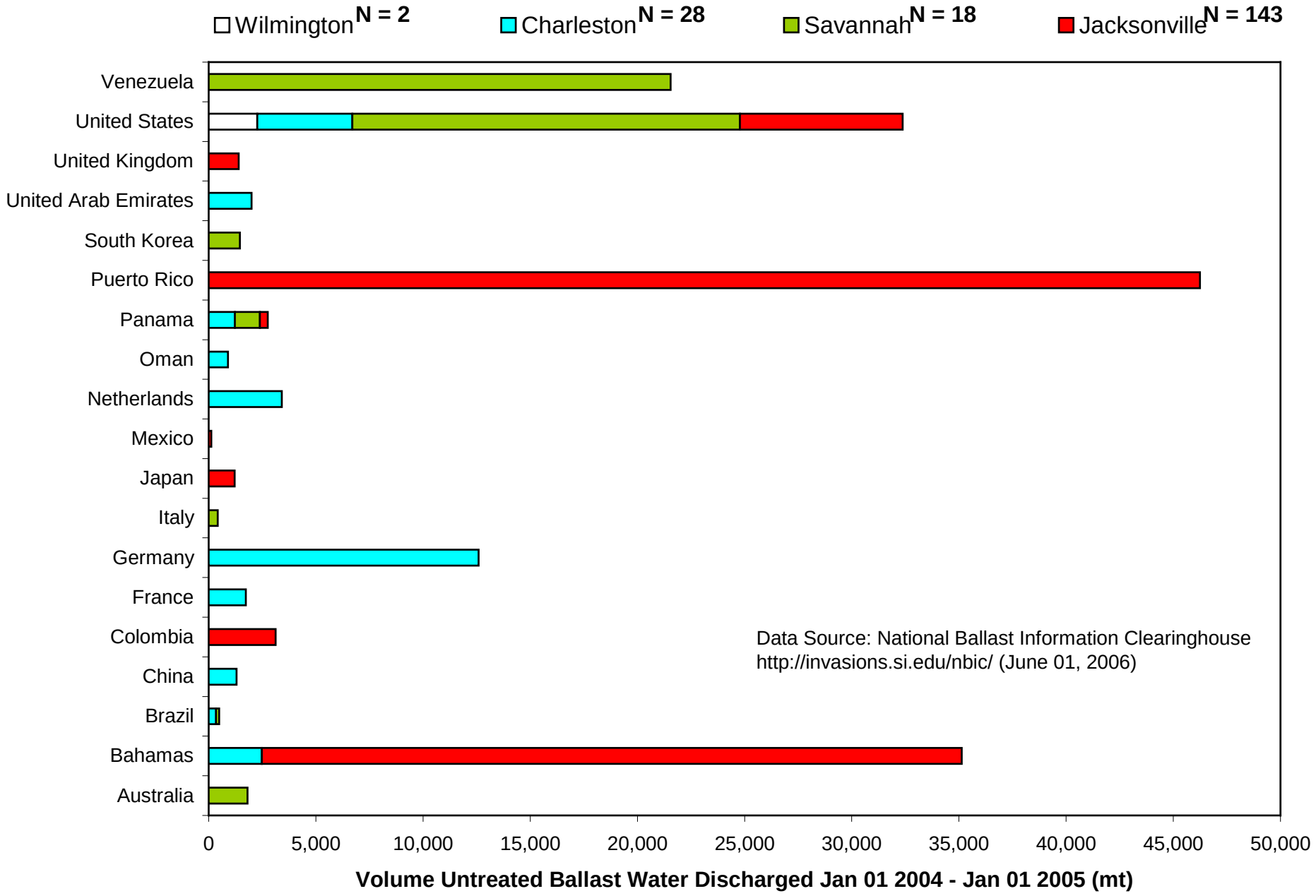


SAVANNAH, GA

JACKSONVILLE, FL







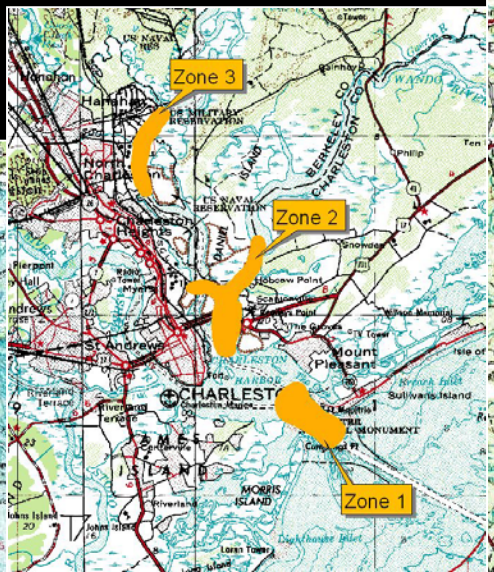
National Ballast Information Clearing House, Smithsonian Environmental Research Ctr.

HOW

4. Comprehensive searchs for molluskan, polychaete, and crustacean species in each port.

Hewitt, C.L. and R.B. Martin. 2001. Revised protocols for baseline port surveys for introduced marine species: survey design, sampling protocols and specimen handling. Centre for Research on Introduced Marine Pests. Technical Report No. 22. CSIRO Marine Research, Hobart. 46 pp.

- August-September 2003
- Sampling in three zones in each port
- Sampled various habitats with diverse array of sampling techniques
- 13 replicates/gear type/zone/port



Trawling

5-minute tows.

Speed less than 0.5 meters/second.

Zone below port Charleston = 68 species, highest # species for any zone with any gear.

Trawl samples returned greatest number of molluscan and crustacean species.

Trapping

- Crab traps 24x24x24″, 1.5″ mesh.
- Minnow traps 16″ long, 0.25″ mesh.
- Locally available menhaden bait.
- Overnight soak (~18 hours).
- Minnows 2nd highest # crustacean, C lowest.

- Triplicate core samples.
- 10 cm diameter, 15-cm depth.
- 1 mm sieve wash.
- Additional sample taken for organic carbon and particle size analysis.
- Highest number polychaete species.

Sediment Cores

Scrapings

- Approximately 1m2 scraped.
- Samples relaxed in $MgCl_2$ solution.
- Collected good numbers of all phyla.

Fouling Plates

- Placed in port zones only.
- Suspended from docks/ anchored and buoyed.
- 3 month deployment.
- Samples relaxed in $MgCl_2$.
- Good numbers of all phyla.

The University of Georgia Marine Extension Service

HOW

5. Provide baseline information on native biodiversity, and on the presence, distribution, relative abundance, and trophic status of identified nonindigenous species.

Molluscs: 36 species - 27 bivalve, 8 gastropod,1 cephalopod totaling 10,793 specimens.

Crustaceans: 122 species - 51 decapod, 30 amphipod, 18 isopod, 12 barnacle, 3 mysid, 3 tanaid, 2 stomatopod, 1 copepod, 1mysidacean and 1 ostracod species totaling 42, 583 specimens.

Polychaetes: 63 species totaling 2,640 specimens.

221 species, 56,016 specimens: GA Museum of Natural History and SERTC in Charleston.

Balanus trigonus

Gulf States Marine Fisheries Commission

Apocorophium lacustre

University of Illinois at Urbana-Champaign College of Agricultural, Consumer and Environmental Sciences

Ligia exotica

Balanus amphitrite

San Francisco Guide to Exotic Species of San Francisco Bay

Petrolisthes armatus

Southeastern Regional Taxonomic Center

5 Nonindigenous Crustaceans

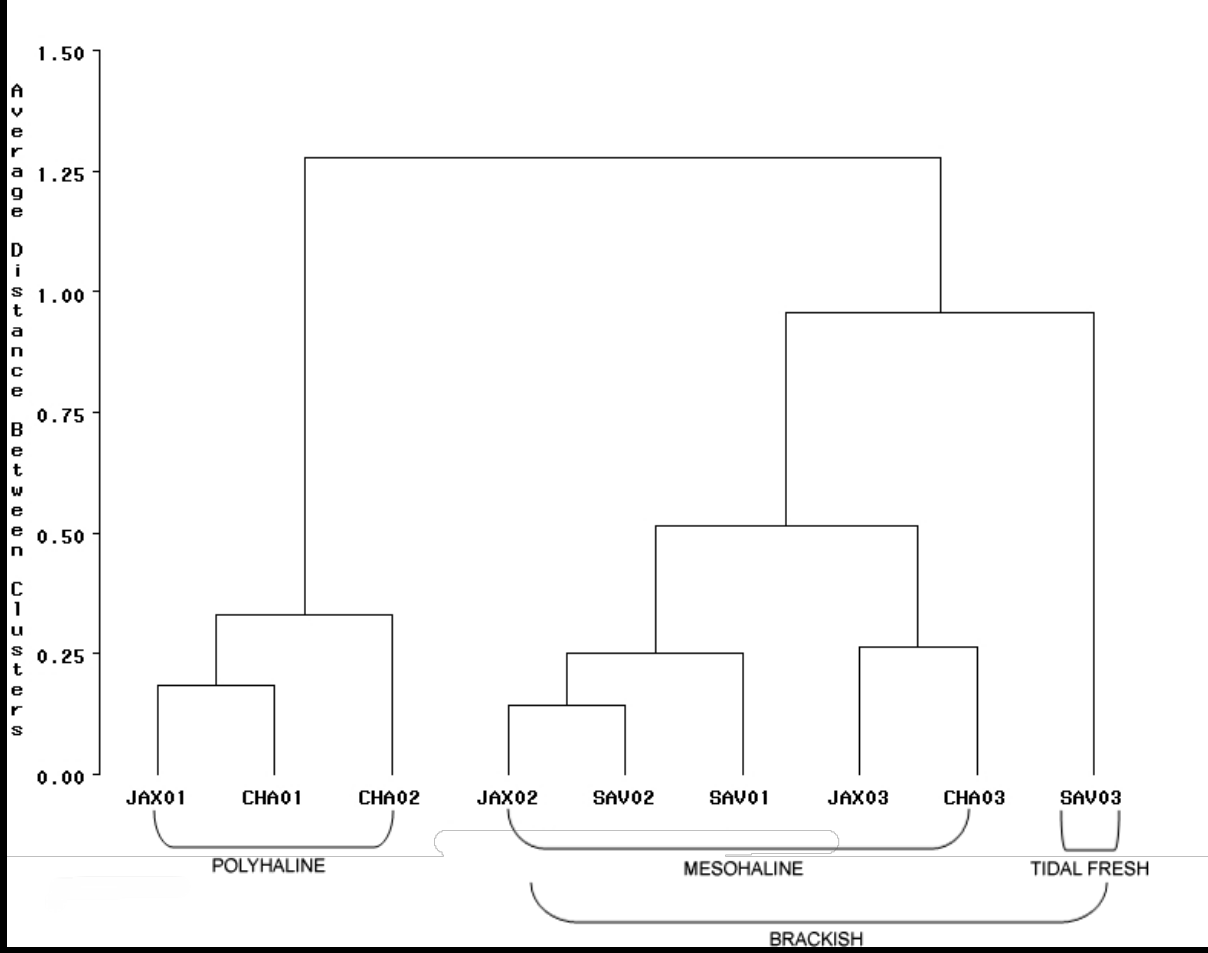
HOW

6. Determine community structure, sediment size, and water quality at ports.

Wilm - lowest diversity & evenness.

Diversity indices higher below ports.

Cluster analysis - 2 groupings – marine and brackish water - within brackish sites further split into mesohaline & tidal fresh.



Annual water temperatures in the ports range from 8 to 30 °C.

Predominantly poorly sorted fine-medium sand substrates with low-intermediate organic matter.

Varying distances port facilities are from open sea (5.5 to 26 miles) present a range in salinity regimes (0 ppt to 35.45 ppt).

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The University of Georgia Marine Extension Service

LESSONS LEARNED

- **Coordination & Permitting:** Marine Patrol, Coast Guard, port authorities, Department of Natural Resources, and Corps of Engineers. This was sometimes difficult, particularly out of state. Different states had different requirements. Security concerns. Convincing ports that project was beneficial was sometimes difficult. SC required Coast Guard be present for all sampling activities. Florida sampling permit had special conditions and required additional time to acquire.

LOTS OF COMMUNICATION NECESSARY

SUBMIT APPLICATION FOR ALL PERMITS AT BEGINNING OF PROJECT

GET PARTNERS FOR EACH STATE BEING SURVEYED

GET PORT AUTHORITIES ON BOARD

LESSONS LEARNED

2. **Sampling Conditions:**

Weather: Aug and Sep hot, humid, thunderstorms - sampling difficult.

Tides: Very large tidal range - strong currents which may have contributed to lost fouling plates, and also made taking scraping samples difficult from a small boat. We were also dependent upon low tides during daylight hours to collect intertidal scraping and core samples.

Sediment: Soft muds difficult to move in making made hand coring difficult.

COLLECT SCRAPINGS AT SLACK WATER

DO AS MUCH AS POSSIBLE IN EARLY MORNING

SCHEDULE CORING TO BEGIN WHILE TIDE GOING OUT TO ALLOW TIME

REPLACE HAND CORES WITH GRAB SAMPLER FROM BOAT

LESSONS LEARNED

3. **Sampling Techniques:**

Trawling: Large quantities of bottom debris in port areas resulted in numerous net snags slowing down the sampling process and causing extensive net damage. Different regulations in Florida meant our nets there had to be pulled equipped with a Turtle Excluder Device which was not consistent with other locations. Trawling during the day will miss all those that bury up.

Fouling Plates: Difficult to always find suitable site to hang plates. Lost several. No permission in Jacksonville and Charleston ports. Lost many of those we anchored and floated. Distance from sites prevented routine checking. Plates may have been lost due to currents, lines being cut by oyster shells, or may have been interfered with.

HAVE MANY BACK UP TRAWL NETS

ASK LOCALS AND USE MAPS TO ID HEAVY DEBRIS AREAS

DEPLOY MORE PLATES THAN NEED & USE LOCAL PARTNERS TO MONITOR

CONDUCT ONE SET OF 13 TRAWLS DURING DAY AND ANOTHER AT NIGHT

LESSONS LEARNED

3. **Sampling Techniques:**

Scrapings: Strong currents, made it difficult to safely approach and remain at pilings by boat. Dense oyster growth on the pilings required the use of hammers as opposed to scrapers to collect the samples, often resulting in damaged specimens. It was also difficult to scrape a consistently sized area.

INSTEAD OF SCRAPING EXACT AREA FILL A BUCKET TO A SET LEVEL

IF SURFACE UNAVAILABLE TAKE OYSTER REEF CLUMPS FROM SHORE

SAMPLE AT SLACK WATER

TIE OFF OR HAVE FEW HOLD BOAT STEADY WHILE OTHERS COLLECT

HAVE SOMETHING OBVIOUS THAT IDENTIFIES YOUR BOAT AS RESEARCH

METHOD DOES NOT SAMPLE SUBTIDAL FOULING COMMUNITIES

FLOATING DOCK WOULD BE IDEAL FOR SUBTIDAL COMMUNITIES

4. **Sampling Adequacy:**
Our surveys only detected a fraction of the species we know are in the region from lit review. However these are diverse systems and sample processing is labor and time intensive.

BUMP UP NUMBER OF REPLICATE SAMPLES TO 15 PER ZONE PER GEAR

PORTS WITH TERMINALS SPREAD OUT NEED MORE SAMPLES IN THIS ZONE

PLACE SUFFICIENT PLATES OUT TO ALLOW FOR SIGNIFICANT LOSSES

INCLUDE SHALLOW WATER SEINING & TRAWLING

CONDUCT SEASONALLY

CONDUCT ANNUALLY

TIE INTO OTHER MONITORING PROGRAMS

REDESIGN AS RAPID ASSESSMENT TYPE SURVEY IF HAVE EXPERTS & RESOURCES AVAILABLE

NEED BETTER TAXONOMIC KEYS FOR REGION

NEED ACCESS TO GLOBAL LIST OF EXPERTS FOR DIFFERENT PHYLA

We did not include several taxonomic groups that were collected, specifically fish, echinoderms, cnidarians, oligochaetes and other arthropod subphyla. Given the effort involved in collection it was wasteful that we did not have the resources to include them. These specimens were however retained and we are currently identifying them as part of another funded project. We are also targeting shallow water environments using seine nets and a small otter trawl.

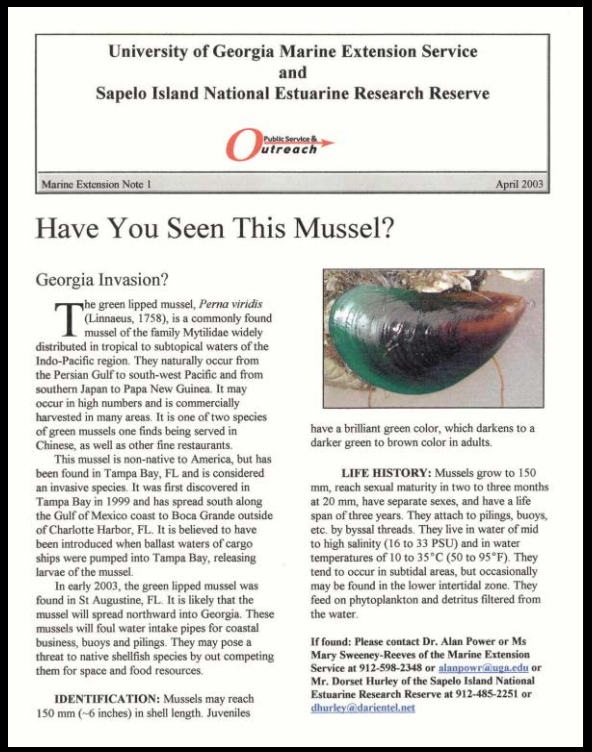
PRESERVE ALL SPECIMENS, MAY GET OPPORTUNITY TO ID LATER

CAREFUL OF METAL DEBRIS, STINGRAYS, ALLIGATORS, CATFISH, etc

HAVE PLENTY OF BACK UP NETS WHEN TEAR ON SNAGS

PUBLIC AWARENESS IS CRITICAL

USE VOLUNTEERS TO MONITOR SPREAD OR WATCH FOR LIKELY INVADERS



University of Georgia Marine Extension Service
and
Sapelo Island National Estuarine Research Reserve

Public Service & Outreach

Marine Extension Note 1 — April 2003

Have You Seen This Mussel?

Georgia Invasion?

The green lipped mussel, *Perna viridis* (Linnaeus, 1758), is a commonly found mussel of the family Mytilidae widely distributed in tropical to subtopical waters of the Indo-Pacific region. They naturally occur from the Persian Gulf to south-west Pacific and from southern Japan to Papa New Guinea. It may occur in high numbers and is commercially harvested in many areas. It is one of two species of green mussels one finds being served in Chinese, as well as other fine restaurants.

This mussel is non-native to America, but has been found in Tampa Bay, FL and is considered an invasive species. It was first discovered in Tampa Bay in 1999 and has spread south along the Gulf of Mexico coast to Boca Grande outside of Charlotte Harbor, FL. It is believed to have been introduced when ballast waters of cargo ships were pumped into Tampa Bay, releasing larvae of the mussel.

In early 2003, the green lipped mussel was found in St Augustine, FL. It is likely that the mussel will spread northward into Georgia. These mussels will foul water intake pipes for coastal business, buoys and pilings. They may pose a threat to native shellfish species by out competing them for space and food resources.

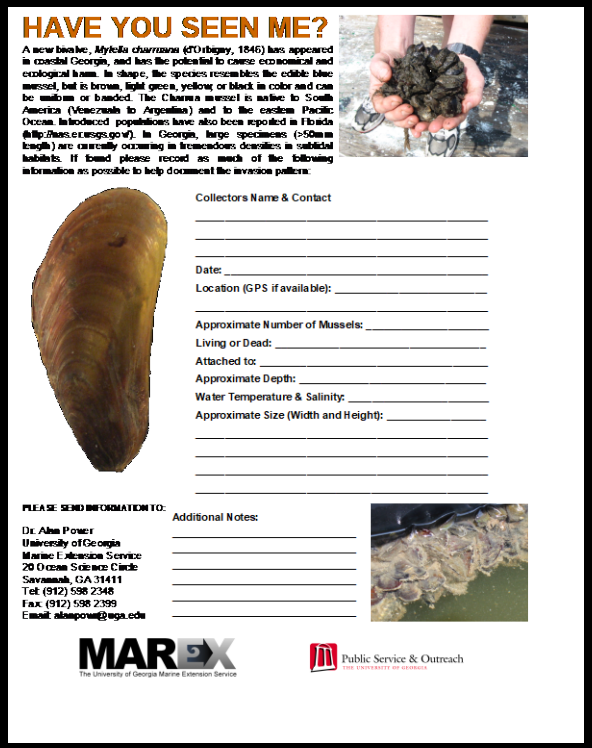
IDENTIFICATION: Mussels may reach 150 mm (~6 inches) in shell length. Juveniles have a brilliant green color, which darkens to a darker green to brown color in adults.

LIFE HISTORY: Mussels grow to 150 mm, reach sexual maturity in two to three months at 20 mm, have separate sexes, and have a life span of three years. They attach to pilings, buoys, etc. by byssal threads. They live in water of mid to high salinity (16 to 33 PSU) and in water temperatures of 10 to 35°C (50 to 95°F). They tend to occur in subtidal areas, but occasionally may be found in the lower intertidal zone. They feed on phytoplankton and detritus filtered from the water.

If found: Please contact Dr. Alan Power or Ms Mary Sweeney-Reeves of the Marine Extension Service at 912-598-2348 or alanpowr@uga.edu or Mr. Dorset Hurley of the Sapelo Island National Estuarine Research Reserve at 912-485-2251 or dhurley@darientel.net

Green Mussel

Perna viridis



HAVE YOU SEEN ME?

A new bivalve, *Mytella charruana* (d'Orbigny, 1846) has appeared in coastal Georgia, and has the potential to cause economical and ecological harm. In shape, the species resembles the edible blue mussel, but is brown, light green, yellow or black in color and can be uniform or banded. The Charrua mussel is native to South America (Venezuela to Argentina) and to the eastern Pacific Ocean. Introduced populations have also been reported in Florida (http://nas.er.usgs.gov/). In Georgia, large specimens (>50mm length) are currently occurring in tremendous densities in subtidal habitats. If found please record as much of the following information as possible to help document the invasion pattern.

Collectors Name & Contact

_____
_____
_____

Date: _____

Location (GPS if available): _____
_____

Approximate Number of Mussels: _____
Living or Dead: _____
Attached to: _____
Approximate Depth: _____
Water Temperature & Salinity: _____
Approximate Size (Width and Height): _____
_____
_____
_____
_____

PLEASE SEND INFORMATION TO:

Dr. Alan Power
University of Georgia
Marine Extension Service
20 Ocean Science Circle
Savannah, GA 31411
Tel: (912) 598 2348
Fax: (912) 598 2399
Email: alanpowr@uga.edu

Additional Notes:
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Public Service & Outreach
THE UNIVERSITY OF GEORGIA

Charrua Mussel

Mytella charruana

HAVE YOU SEEN ME?

A new acorn barnacle, *Megabalanus coccopoma* (Darwin, 1854) has been introduced to coastal Georgia, and has the potential to cause economical and ecological harm. The species has a conspicuous pink color and can grow quite large (>50 mm in diameter and height). This is originally a Pacific species ranging from California to Ecuador. In recent years it has been reported from Brazil and from Texas and Louisiana in the Gulf of Mexico. If found please record as much of the following information as possible to help document the invasion pattern:

Images Courtesy Fran Lapolla

Collectors Name & Contact

_____
_____
_____

Date: _____

Location (GPS if available): _____
_____

Approximate Number of Barnacles: _____
Living or Dead: _____
Attached to: _____
Approximate Depth: _____
Water Temperature & Salinity: _____
Approximate Size (Width and Height): _____
_____
_____
_____
_____

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Additional Notes:
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Public Service & Outreach
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Pink Barnacle

Megabalanus coccopoma

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The University of Georgia Marine Extension Service

Acknowledgements

NOAA's National Sea Grant Aquatic Nuisance Species Program, University of Georgia Marine Extension Service, University of North Carolina at Wilmington, Georgia and North Carolina Ports Authorities, Coast Guard, Georgia, South Carolina, North Carolina and Florida Department of Natural Resources, Army Corps of Engineers, Marine Patrol, Southeastern Regional Taxonomic Center, United States Geological Survey, University of Florida, Jacksonville Shell Club, Skidaway Institute of Oceanography, Guana Tolomato Matanzas National Estuarine Research Reserve, American Museum of Natural History, Sapelo Island National Estuarine Research Reserve, Nature Conservancy

UNCW CENTER FOR MARINE SCIENCE

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Sea Grant Georgia

DNR

http://www.shellfish.uga.edu/researchinvasiveport.htm