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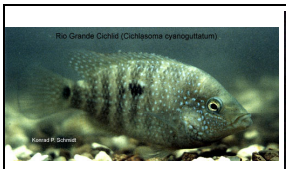



Invasive Species : 2003 COSEE Summer Institute

Center for Fisheries Research and Development
The University of Southern Mississippi
Kirsten Larsen



Slide 2

Invasive Species

- Harmful non-native plants, animals, and microorganisms that cause damage to crops, rangelands, waterways, and coastal ecosystems
- Species introduced into an environment in which they did not evolve, thus they usually have no natural enemies to limit their spread
- Damage estimated to be in the billions of dollars annually

Slide 3

Invasive Species

- Also called “biological pollutants”
  - Unlike some chemical pollutants that degrade over time, these biological pollutants have potential to persist, multiply, and spread
- Conservation biologists rank invasive species as 2nd most serious threat to endangered species after habitat destruction
- Considered one of the most serious environmental threats of the 21st century

Slide 4

Economic Impact

- Existing data on economic impact of invasive species is limited when trying to assess damage to natural ecosystems.

  These studies do not address:

  - The economic damage to an ecosystem,
  - The expected costs and benefits of alternative control measures, or
  - The impacts of continued invasions by additional species

Slide 5

Economic Impact

- The narrow scope of most economic studies limits their usefulness to decision makers who have to develop policies and allocate resources to address the problem
- Most economic studies focus on the impacts of those species that affect agriculture, forests, and fisheries
- Assessing impact on natural ecosystems very difficult

How do you quantify lost or changed ecosystem functions and aesthetic values?

Slide 6

Invasive Species…Why Do We Care?

- Significant threat to biodiversity
- Major or contributing cause to population declines for ½ of the endangered species in the U.S.
- Disrupt food chains, alter predator/prey dynamics, out compete native species for food and space
- Can be economically devastating (Formosan termite, fruit fly, zebra mussel)

Slide 7

How do they get here?

Natural Processes

- Wind
- Currents
- Territorial expansion
- Biological transport

Slide 8

How do they get here?

Anthropogenic Processes

- Ballast water
- Seawater piping systems
- Attachment to hulls of ships
- Food imports
- Intentional introduction (ornamentals, crops, aquaculture, pets)
- Release of captive non-native species into the wild

Slide 9

Control Methods for Invasive Species

- Chemical control - Pesticides
  - May negatively impact natives
- Mechanical control – Physical removal
  - Can be very expensive
- Biological control - Introduction of natural enemies
  - Can result in even greater problems with the new introduction
- Ecological control - Environmental manipulation
  - Fire and water may provide an edge to native species

Slide 10

Invasive Species Legislation

- Non-indigenous Aquatic Nuisance Prevention and Control Act (NANPCA) passed by Congress in 1990
  - Coordinated federal agency activities to address aquatic invasive species
  - Established National Aquatic Nuisance Species Taskforce (ANS) and called for development of state management plans for invasive species
  - Provided for national ballast water management program

Slide 11

Invasive Species Legislation

- NANPCA reauthorized in 1996 and became National Invasive Species Act (NISA)
  - Strengthened ballast water provisions
  - Established regional panels to provide regional priorities and to make recommendations to the ANS Taskforce

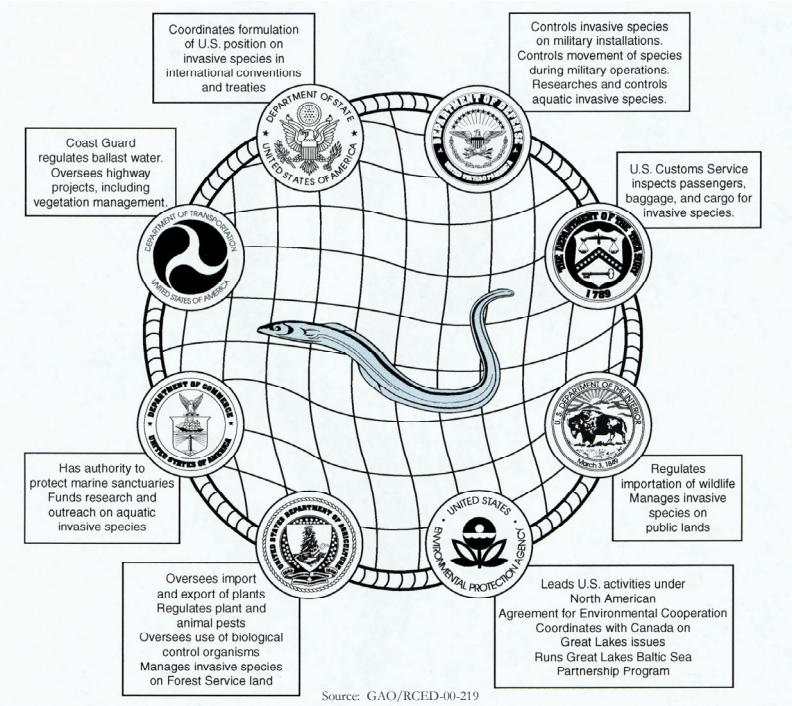
Slide 12

Invasive Species Legislation

- National Invasive Species Act (NISA) introduced for reauthorization in 2002 as National Aquatic Invasive Species Act (NAISA)
  - Funding authorizations have significantly increased
  - Funding is now being provided to develop state management plans
  - The previously voluntary ballast water management program has now been mandated

Slide 13

Federal departments and their responsibilities for invasive species



Slide 14

Invasive Species – Gulf of Mexico

- The number and diversity of invasive species in the northern Gulf of Mexico has increased
- There is a potential to affect a wide variety of fisheries and habitats

Slide 15

Gulf of Mexico Fisheries Facts

- 1.7 billion pounds of fish and shellfish landed with and ex-vessel value of $991 million in 2000
- Menhaden fishery is the largest volume fishery in Mississippi

Slide 16

Gulf of Mexico Fisheries Facts

- In dollars, 10 of the top 20 US fishing ports are located within the Gulf
- Nearly 40% of total US commercial fisheries landings are from the Gulf
- Approximately 50 species of fish or shellfish are harvested for consumption

Slide 17

Gulf of Mexico Fisheries Facts

- Gulf shrimp are the nation's second most valuable fishery
- If a species were introduced to the Gulf of Mexico that would reduce the current harvest of animals by disrupting this ecosystem, a large number of people would be affected by this loss of their livelihood

Slide 18

Invasive Species Include All Forms of Life

- Plants
- Pathogens
- Dinoflagellates
- Jellyfish
- Molluscs
- Crustaceans
- Fish
- Mammals

Slide 19

Aquatic Plants

Hydrilla verticillata
Salvinia molesta, S. minima
Eichhornia crassipes

Slide 20

Hydrilla verticillata

- Two biotypes, warm and cool
- Native to Asia, northern Europe
- First discovered in Florida, 1960

Slide 21

Hydrilla verticillata

- Grows several centimeters per day
  - Would take over 1,000 manatees to consume the standing biomass of *Hydrilla* in one Florida Bay
- High stem densities near the surface intercept most of the available light, eliminating other plants

Slide 22

Hydrilla verticillata

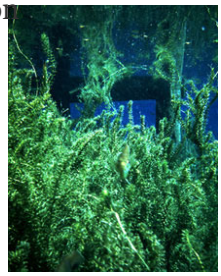
Before

After

Slide 23

Hydrilla verticillata

- Tolerates a wide range of pH
- Can photosynthesize at less than 1% sunlight
- Tubers can withstand ingestion by waterfowl and herbicides
- Causes hypoxia in summer months, reduces abundance and diversity of fish and zooplankton



Slide 24

Hydrilla verticillata

- Dominates aquatic plant community in many water bodies making them unusable for recreational purposes

- Reproduces by fragmentation, seeds, and underground tubers; spread primarily by fragments on boats and trailers

Slide 25

Salvinia molesta/S. minima
Giant Salvinia/Common Salvinia

- Introduced from Central and South America
- Brought in for aquarium and garden-pond trades

Slide 26

Salvinia molesta

- Reproduces rapidly; can double its numbers in 2-10 days

Slide 27

Salvinia molesta

- Forms dense green mats up to two feet thick
- Can cover entire surface of ponds and lakes
- Creates hypoxic conditions

Slide 28

Salvinia molesta

Tracking and monitoring *S. molesta* with remote sensing in Texas

Healthy – Arrow 1

Dying – Arrow 2

Slide 29

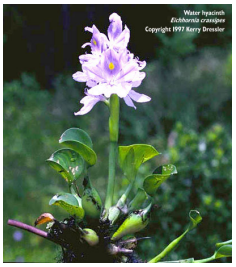
Salvinia molesta

- Experimenting with bio-control to slow growth
- *Cyrtobagous salviniae*
  - This weevil has had success in controlling *Salvinia* in other countries

Slide 30

Water Hyacinth
Eichhornia crassipes

- Introduced from Amazon River into New Orleans World Fair 1884
- Sold as an ornamental plant for pond gardens



Slide 31

Eichhornia crassipes

- Brought to Florida in 1884 from World's Fair and placed in lawn fountain near St. Johns River
- Plants rapidly multiplied and excess was discarded into the river
- By 1896 plants had spread throughout the river basin
- By 1898 plants had blocked navigation in the river
- Was an ecological and economic disaster soon after introduction

Slide 32

Eichhornia crassipes

- Most prolific plant species in Florida lakes and rivers
- Growth rates exceed dry biomass production of any land, marine, or freshwater vascular macrophyte
- Water movement can be reduced by 40 to 95%

Slide 33

Eichhornia crassipes

- Widely distributed through the Gulf coastal plain and entire states of Louisiana and Florida
- Grows under a wide range of environmental conditions
- Growth rate among the highest of any known plant
- Can double in as little as 12 days

Slide 34

Eichhornia crassipes

- Forms dense mats of free-floating vegetation
- Can form dams and increase risk of flooding

Slide 35

Eichhornia crassipes

- May cause hypoxia; one acre of water hyacinth can deposit up to 500 tons of rotting plant material on bottom of a water body
- Decreases biodiversity
- Limits recreational use in infested water bodies

Slide 36

Eichhornia crassipes Control Methods

- Herbicides have been used but are too expensive and do not keep pace with water hyacinth growth
- Mechanical controls have not proven practical on a large scale

Slide 37

Eichhornia crassipes Control Methods

- Biological controls include:
  - Weevils (*Neochetina* spp.)

Slide 38

Eichhornia crassipes Control Methods

- Biological controls include:
  - Argentine hyacinth moth (*Sameodes albiguttalis*)

  - Native hyacinth moth (*Bellura densa*)

Slide 39

Eichhornia crassipes Control Methods

- Biological controls include:
  - Mirid insect (*Eccritotarsus catarinensis*)
  - Used in South Africa

Slide 40

Eichhornia crassipes - Uses

- Constructed Wetland Treatment Systems
  - Establish ecosystem using aquatic plants, water snails, mosquito fish, crayfish, other micro and macro organisms to remove nutrients and clean waste water
  - San Pasqual Facility operated by City of San Diego; treats 1.2 million gallons secondary sewage wastewater daily

Slide 41

Eichhornia crassipes - Uses

- Boiled water hyacinth used in Southeast Asia as feed for pigs; requires additives
- Unsuitable for normal methods of making hay and silage; must be wilted in the shade and lacerated; molasses, sodium chloride, and urea increase nutritive value and quality
- Converts solar energy at rate of 2-3%, nearly 40% of the maximum conversion rate of solar energy. Excellent source for biogas production. One Kg of dried weed yields 174 liters of biogas containing 75% methane

Slide 42

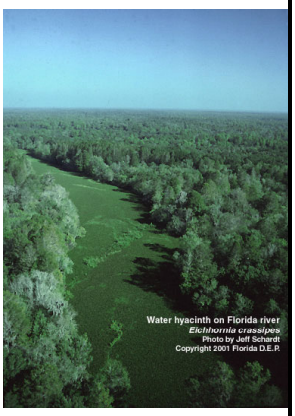
Eichhornia crassipes - Uses

- Fiber is similar to sugarcane and is used to make paper and pulpwood in India
- Used to make furniture, hats and purses

Slide 43

Eichhornia crassipes- New Worry

- Water hyacinth mats provide ideal breeding environments for mosquitoes



Slide 44

Pathogen

West Nile Virus

Slide 45

West Nile Virus

- Came to U.S. 1999 from Africa
- Spread by bite of infected mosquito
- Infects people, horses, birds
  - Over 110 species of birds are know to have been infected
  - Found in 44 states
  - 4008 verified human cases
  - 263 deaths

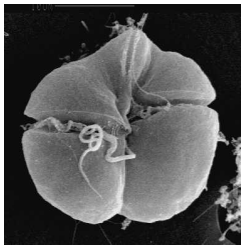
Slide 46

Dinoflagellate

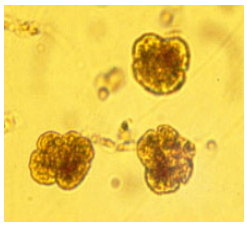
Karenia brevis
(Previously named *Gymnodinium breve)*

Slide 47

Karenia brevis



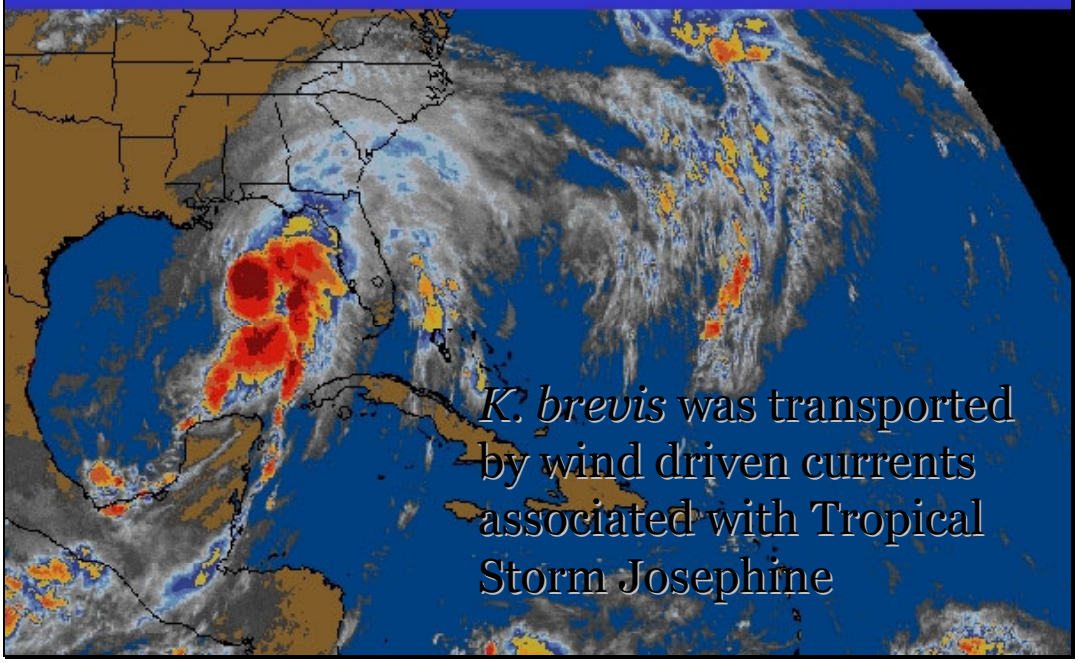
- This dinoflagellate is responsible for toxic red tides in Florida



- The first occurrence in the northcentral Gulf was October 1996

Slide 48

Tropical Storm Josephine, 1996



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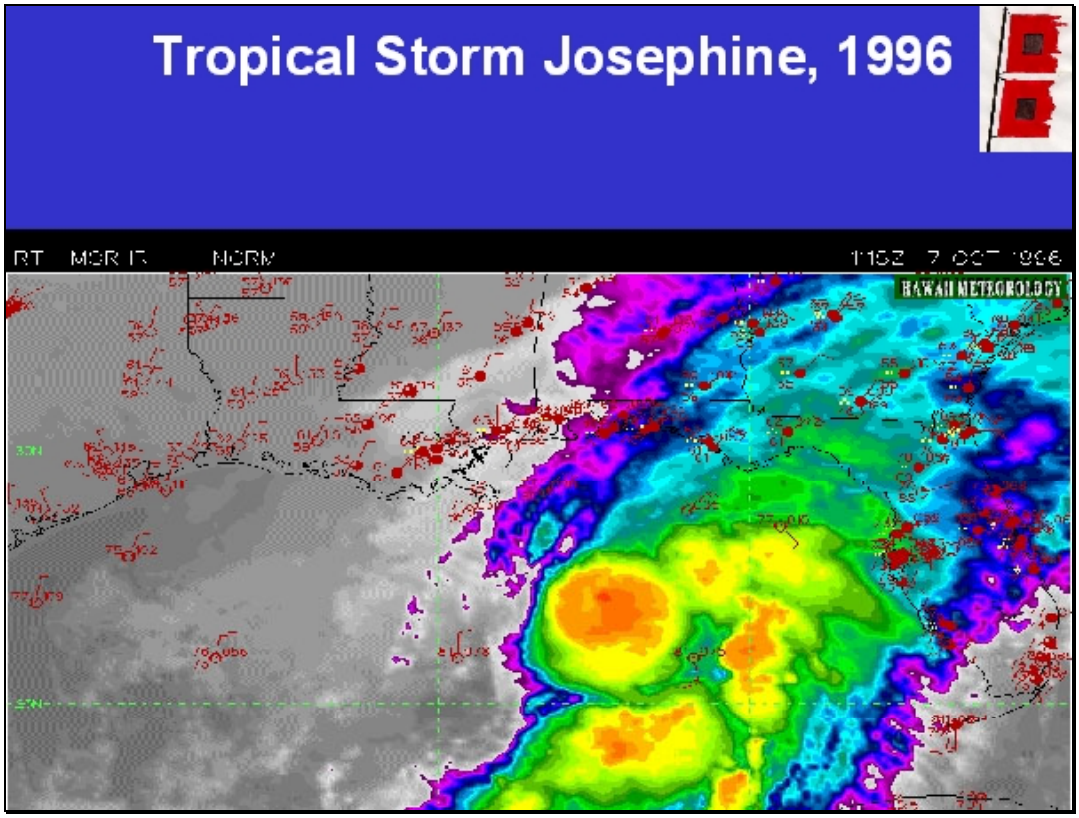


Slide 50

The 34-foot R/V Bill Demoran sits at the edge of the *K. brevis* bloom, 1996; “normal” water is off the bow of the boat

Slide 51

Karenia brevis

Harmful effects to fisheries include:

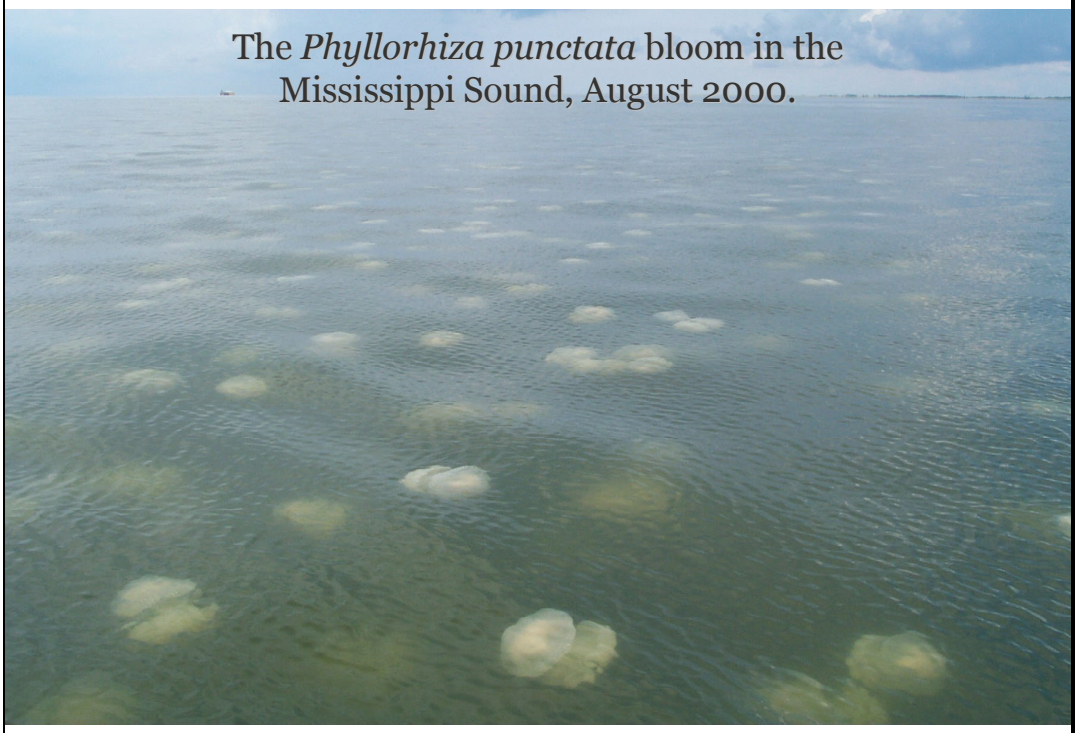
- Closure of shellfish beds
  - Oysters are capable of concentrating the toxin when they filter water containing this organism– the toxin causes severe gastrointestinal distress in humans
- Fish killed by the neurotoxins

Slide 52

Jellyfish

Phyllorhiza punctata
Drymonema dalmatinum

Slide 53



Slide 54

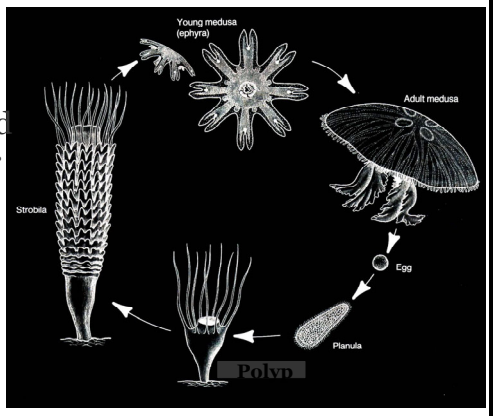
Phyllorhiza punctata

- Indigenous to Indo-Pacific
- Introduced to the western tropical Atlantic late 1960s / early 1970s
- Until recently, primary Atlantic concentration in southern Caribbean

Slide 55

Jellyfish Life Cycle

Polyp stage requires hard substrate for attachment

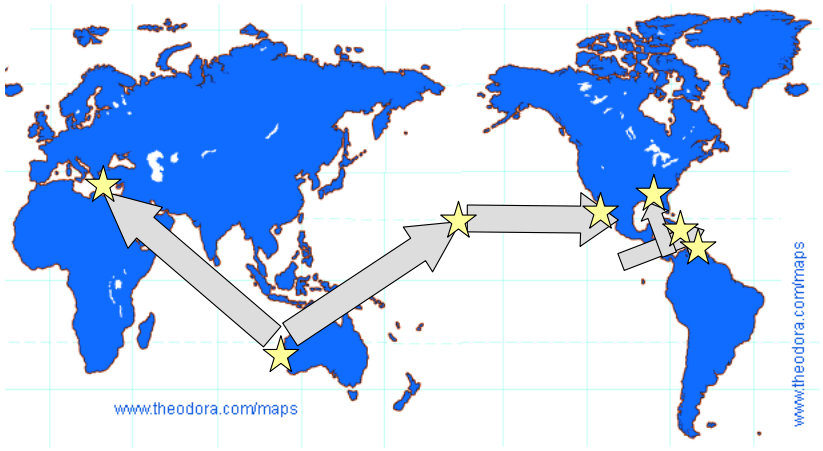


Slide 56

P. punctata was most likely transported through the Panama and Suez canals in the polyp stage, attached to the hulls of ships

Slide 57

Phyllorhiza Translocation Around the World

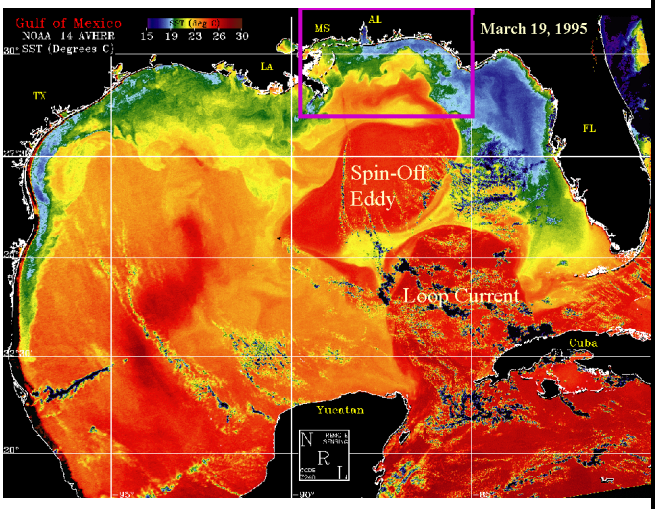


Lessepsian migration through the Suez and Panama Canals. This type of transport named for Ferdinand de Lesseps who earned the title "Great Canal Digger"

Slide 58

Probably Reached Northern Gulf via Loop Current

- The Loop Current enters the Gulf through the Yucatan Straits and exits through the Florida Straits
- Extent of intrusion is dependent on the strength of the Current as it enters the Gulf
- Can shed eddies that may move onto the northern Continental shelf



Slide 59

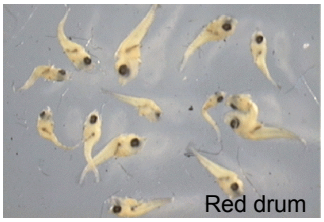
Economic Concerns

- Economic impact on trawl fisheries
  - Densities prohibited trawling in many areas
  - Large hauls of jellyfish damaged gear (ripped nets, weight pulled rigging off boats)
- Fish avoided dense aggregations of jellyfish
  - Gelatinous material in the water impaired movement, respiration, and feeding
  - In areas with large concentrations of jellies there are many free floating nematocysts that will sting fish

Slide 60

Implications for Fisheries

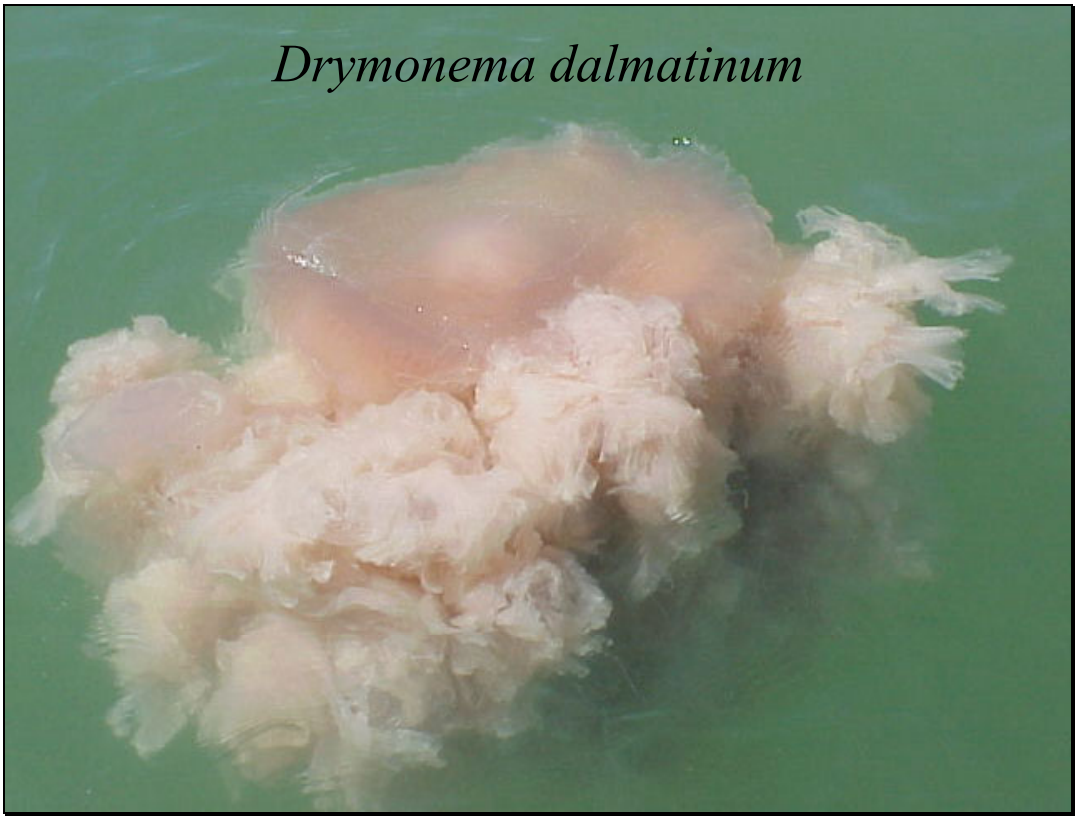
- Jellies may consume larvae of important commercial and recreational species



- Continuous feeding may reduce planktonic food supply for important commercial and recreational species

Slide 61

Slide 62



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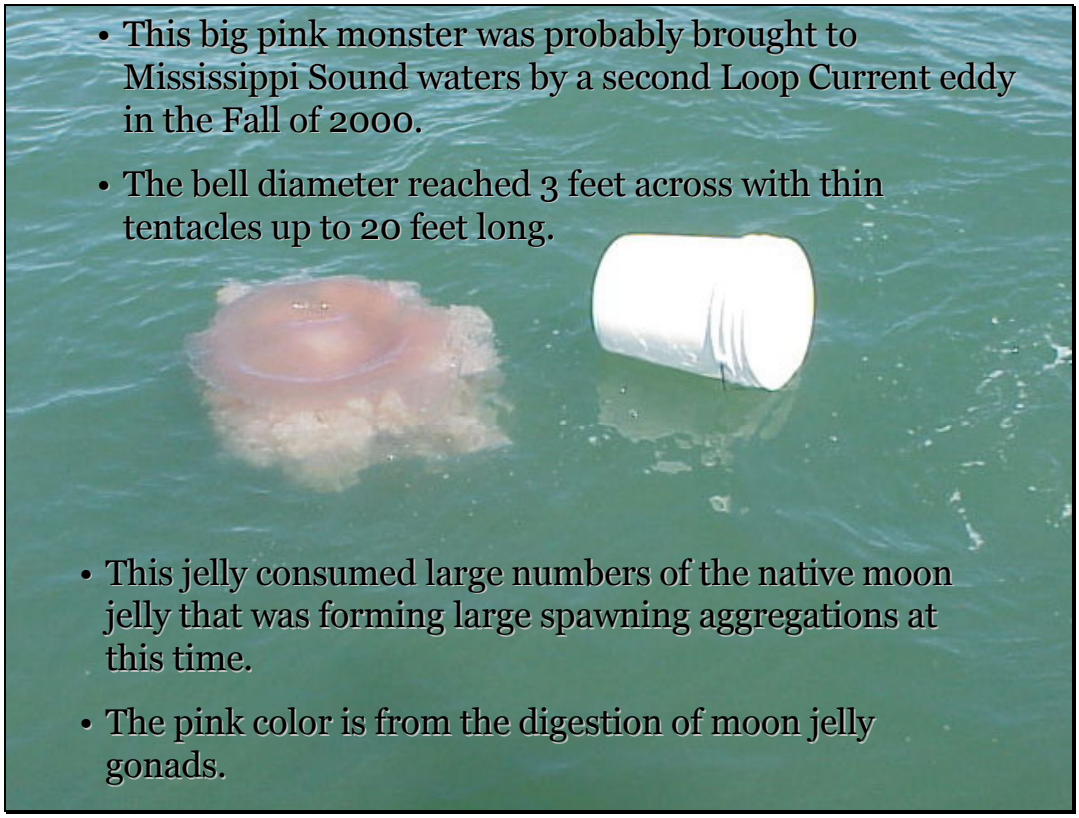


Slide 64

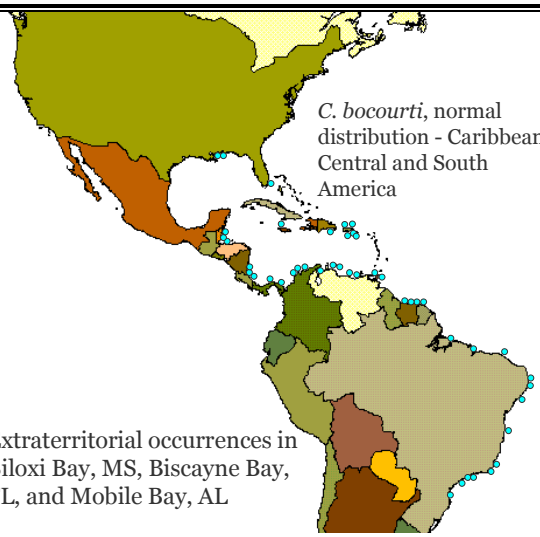
Crustaceans

Callinectes bocourti
Cardisoma guanhumi
Macrobrachium rosenbergii

Slide 65

Callinectes bocourti

Slide 66



Slide 67

Callinectes bocourti

- Related to the common blue crab, *Callinectes sapidus*
- Co-habitates with *C. sapidus* in some areas
- Tolerant of stagnant, polluted conditions
- Most aspects of life history similar to *C. sapidus*
- Average size smaller than *C. sapidus*
- Fisheries exist in Surinam and Venezuela

C. bocourti has two color phases, green and brown

Slide 68

Callinectes bocourti

- Transport mechanism probably ballast water during megalopal stage
- Highly active banana trade between Central / South America and northern Gulf ports

Slide 69

C. bocourti Local Occurrences

- 1971, November – Biloxi Back Bay
- 1990, Fall – Biloxi Back Bay
- 1997, Fall – Davis Bayou, Ocean Springs
- 1998, November – Biloxi Bay bridge
- 1999, November – Biloxi Back Bay
- 2000, Mobile Bay juvenile

Slide 70

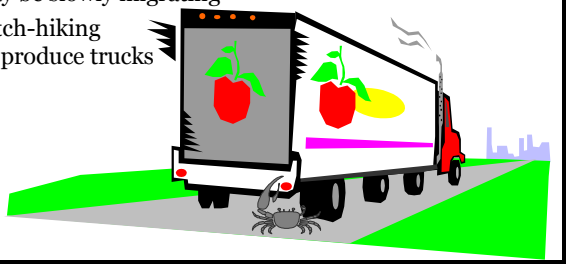
Cardisoma guanhumi

- Tropical species
- Range extends from southern Florida to Brazil; reported from Mississippi and Louisiana
- Abundant in the Caribbean Basin
- Highly prized as food

Slide 71

Cardisoma guanhumi

- In south Florida, up to 7500 burrows/acre
- Agricultural pest, feeds on crops
- Extending range northward
  - May be slowly migrating
  - Hitch-hiking on produce trucks



Slide 72

Malaysian Prawn
Macrobrachium rosenbergii

Native to
Southeast Asia

Aquaculture releases
in various Gulf states

Slide 73

Molluscs

Mytilus edulis
Brachidontes domingensis
Dreissena polymorpha
Corbicula fluminea

Slide 74

Mytilus edulis

- Wide distribution
- Non-indigenous to Gulf of Mexico
- First discovered in northcentral Gulf in June 2001
- Infestation in firemain system of U.S. Navy vessel in dry dock

Slide 75

Brachidontes domingensis

- Native to south Florida and the Caribbean
- First discovered in northcentral Gulf in June 2001
- Infestation in firemain system of U.S. Navy vessel

Slide 76

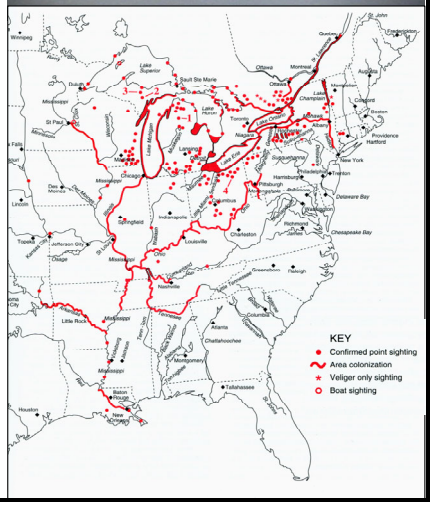
Potential Implications for Fisheries

- Mussels may out-compete indigenous species
- *M. edulis* commercially fished in many areas – if established it may support a new fishery

Slide 77

Zebra Mussel
Dreissena polymorpha

- Freshwater mussel from Europe
- First introduced to Great Lakes in 1988
- Has migrated down the Mississippi River
- First discovered in Mississippi Sound February 2002



Slide 78

Zebra mussel

- Encrusts on hulls of boats and buoys; shells of native mussel species
- Has ability to coat any available surface
- Clogs water intake pipes

Slide 79

Zebra mussel

- Reproduce quickly; females can release 5 million eggs per year
- Bureau of Oceans and International Environmental and Scientific Affairs estimates that zebra mussel invasions will reduce native mussel species by 50% in the next decade and will cause extinction of 140 species
- Total economic impact over the next ten years - $3.1 billion

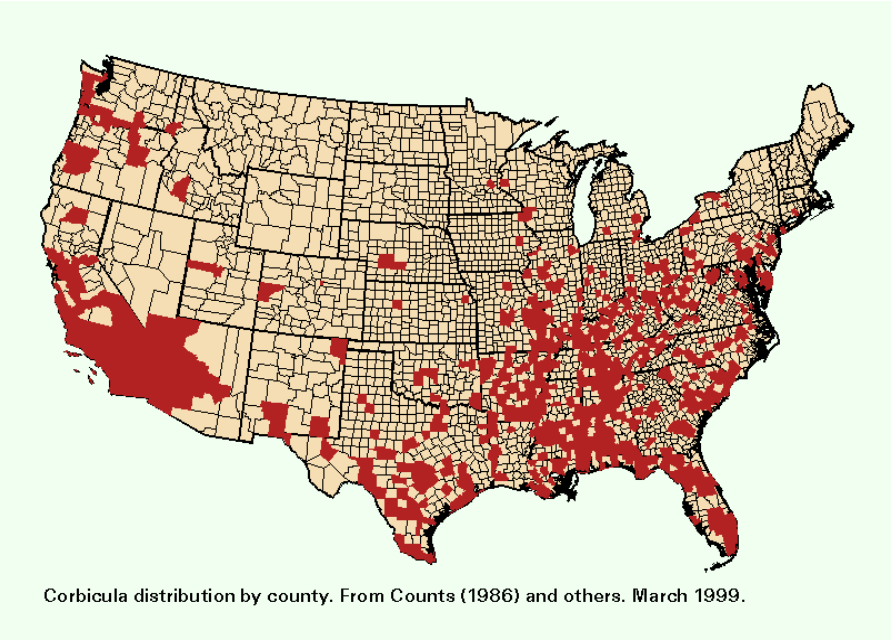
Slide 80

Asian Clam
Corbicula fluminea

- First collected in U.S. 1938 in the Columbia River, Washington State
- Means of introduction to U.S. thought to be as a food item for Chinese immigrants
- Means of introduction to the Gulf of Mexico unknown

Slide 81

Asian Clam
Corbicula fluminea



Corbicula distribution by county. From Counts (1986) and others. March 1999.

Slide 82

Fish

Cichlasoma cyanoguttatum
Oreochromis niloticus

Slide 83

Rio Grande Cichlid
Cichlasoma cyanoguttatum

- Only cichlid native to the United States
- Natural range extends from VeraCruz, Mexico into southern Texas
- Introduced into other Texas waters and into Florida as a food fish; accidental releases from fish farms

Slide 84

Rio Grande Cichlid
Cichlasoma cyanoguttatum

- Introduced into Lake Pontchartrain in early 1990s as aquarium release
- Very abundant, aggressive; competes with centrarchids (blue gills and sunfishes) for nesting areas; rapidly displacing other fish species in Lake Pontchartrain

Slide 85

Nile Tilapia
Oreochromis niloticus

- Originally from Africa, has been distributed worldwide for aquaculture
- Introduced through accidental release from aquaculture ponds
- Although a warm climate, freshwater fish, the tilapia is capable of tolerating moderate salinities and colder temperatures than first thought.

Slide 86

Nile Tilapia
Oreochromis niloticus

- Grows quickly; is capable of reproducing at less than 2.5 inches; holds eggs and young in mouth for protection

- Competes with centrarchids (blue gills and sunfishes) for nesting areas; has the potential to displace other fish species

Slide 87

Mammals

Myocastor coypus

Slide 88

Nutria
Myocastor coypus

- Aquatic South American rodent found in fresh, brackish and salt waters
- Introduced into New Orleans early 1930s for fur and were marketed as the next “mink” to gullible buyers
- Breeding pairs were sold for as much as $2,500

Slide 89

Nutria

- Nutria also released by state and federal agencies to control water hyacinth and alligator weed
- By late 1950s estimated 20 million nutria in coastal Louisiana
- Officials estimate that removal of 400,000 nutria per year for 5 years would reduce acreage impacted by these animals 25-49% or 25,000 to 49,000 acres

Slide 90

Nutria

- Fast growing, may reach sexual maturity in 4 months, usually 8; Produce 1 to 11 (normally 4-6) young; multiple broods/year

- Feed on almost any terrestrial or aquatic plant, eat roots; consume up to 25% of body weight in plants per day

Slide 91

Nutria Eat-Out

- Prodigious breeding prowess and enormous appetite have led to massive “eat-outs”
- Over 100,000 acres of coastal wetlands have been affected

Slide 92

Nutria

- Control measures have generally failed; little public interest in fur products or nutria cuisine

Nutria coat

Nutria hat

Slide 93

Nutria

- Other attempts to rid Louisiana of these "swamp rats" included target practice for sheriff's deputies and recreational nutria hunts
- Most recent attempt is the Nutria Control Program: $4 bounty per nutria tail