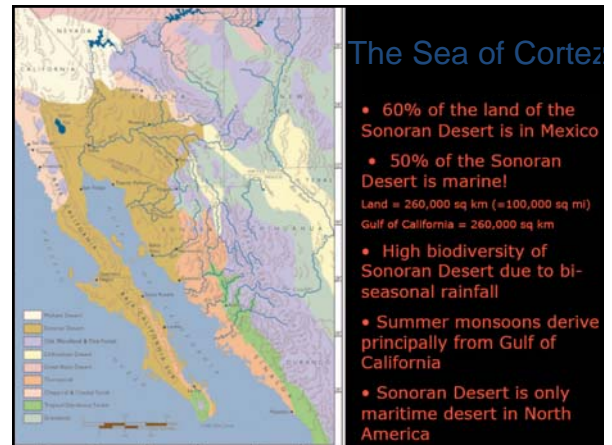


Gulf of California (Sea of Cortez)



- Field trip to Desert Museum this Saturday
- Required field trip (you lose a total of 30 out of 100 course points if you do not go!)
 - Meet at 7:45 AM on SE corner of Bioscience West (NW corner of 6th St. Parking Garage)
 - We have vans – no self driving allowed.
 - We will be gone all day (guaranteed return by 5PM).
 - Go to bed early on Friday night!
 - Bring good walking/hiking shoes, hat, water.
 - It may be chilly at 8AM – dress accordingly.
 - Wear sunscreen.

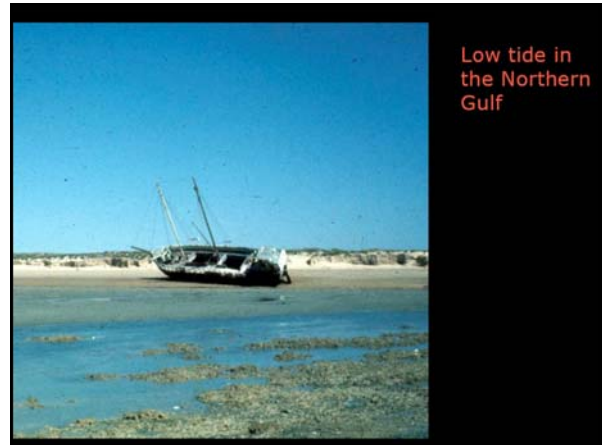
- Field trip to Desert Museum this Saturday
- If you are doing a plant collection bring your plant collection spiral notebook, tape and clippers/scissors.
 - If you are doing an insect collection bring Tupperware and maybe an insect net.
 - Reread instructions for plant an insect collections.
 - Lunch can be purchased for ~\$10 or bring your own.
 - If you own binoculars, bring them.

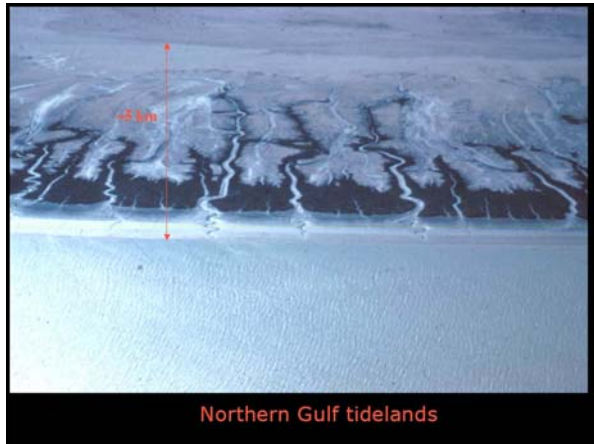


The Sea of Cortez (Gulf of California)

- Overview -- a unique sea
- Biodiversity in the Sea of Cortez
- Threats to biodiversity in the Sea of Cortez
- Protecting biodiversity







Southern Gulf

- Modest tides
- Open access to the Pacific Ocean
- Warm saline waters exit the Gulf on the surface.
- Cold bottom waters enter Gulf on bottom, carrying oxygen and nutrients that upwell in Gulf.

Cabo San Lucas

Giant sea bass (*Stereolepis gigas*)

- Rich oceanic waters support huge numbers of fish & invertebrates.
- 50% of Mexico's fisheries (60% by economic value).



“The abundance of life gives one an exuberance, a feeling of fullness and richness... where the sea swarms with life complete from plankton to porpoise” – Steinbeck and Ricketts 1941.

Faunal Biodiversity in the Sea of Cortez

- ~5,000 named species of invertebrates recorded from Gulf (~12,000 species predicted)
- 1,115 species of vertebrates
- 36 marine mammals, including 31 cetaceans (whales & porpoises) --
- more than a third of the world's cetacean diversity
- 891 fish species

Gulf of California

“The world’s aquarium” (J. Cousteau)

“Mini-Galapagos”

isolated sea, many coves, islands, islets, desert subtropical/tropical habitats

800 islands and islets

Diversity

4839 marine invertebrates (749 endemics)
 36 marine mammals (1 endemic)
 5 marine turtles
 900 fish (79 endemics)
 530 birds, 170 sea and shore birds
 626 macroalgae (62 endemics)
 ~ 10% endemics

Island land animals
 many reptiles, birds, mammals (50% endemics)

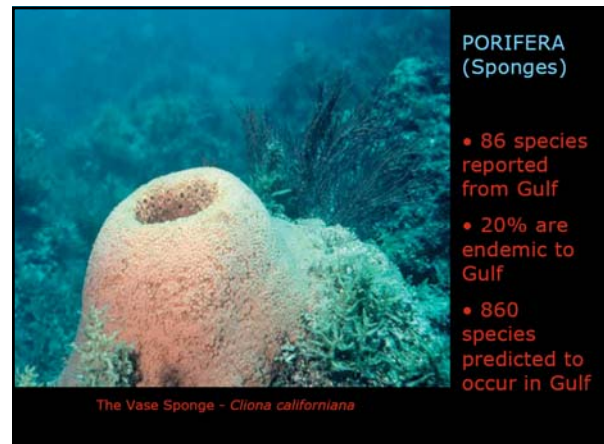
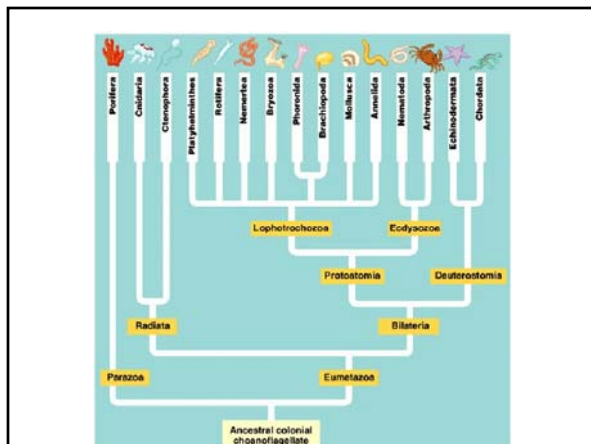
Endemic = originated in and found only in a certain region

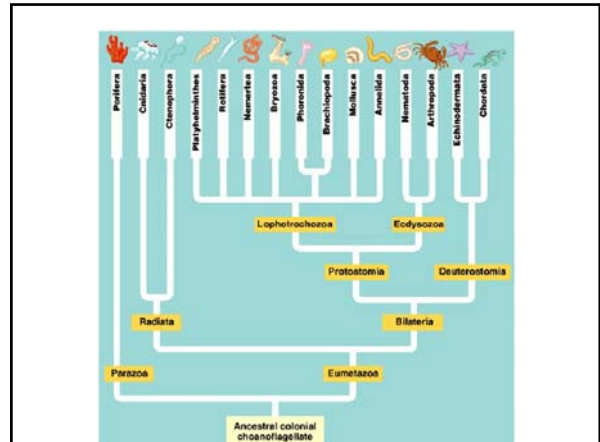
Diversity

.008% of world’s seas = Gulf of California

Diversity of fish rivals that of Bermuda and Hawaii
 Biodiversity “hot spot”

Marine invertebrates (almost 5000 species, 749 endemics)





solitary anemone

Cnidaria - Sea Anemones and their kin

- 259 species of Cnidaria known from Gulf
- 20% endemic
- 526 species predicted to occur in Gulf

Mud tube anemones

Colonial anemones



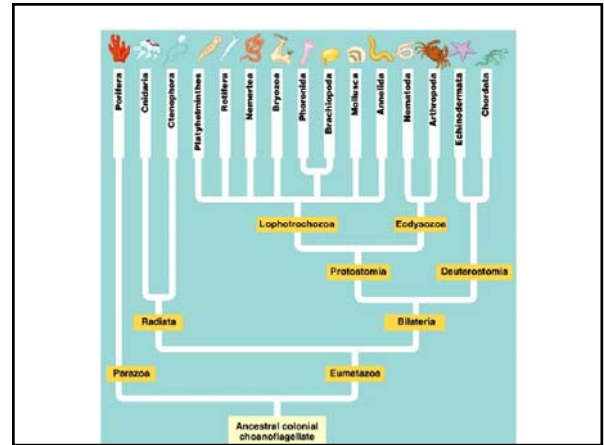
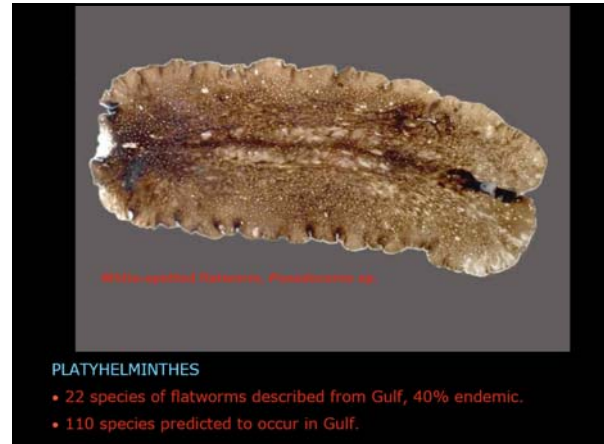
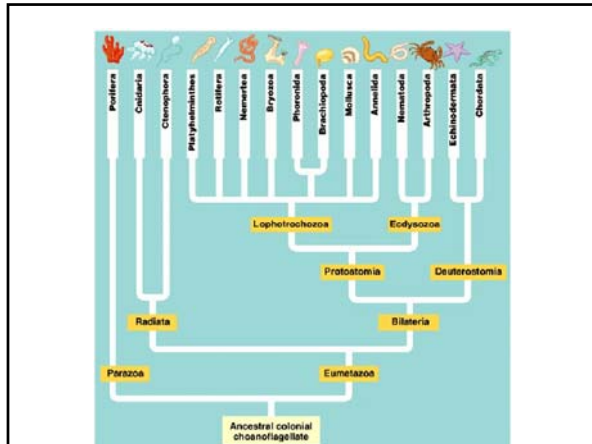
Stomolophus sp.

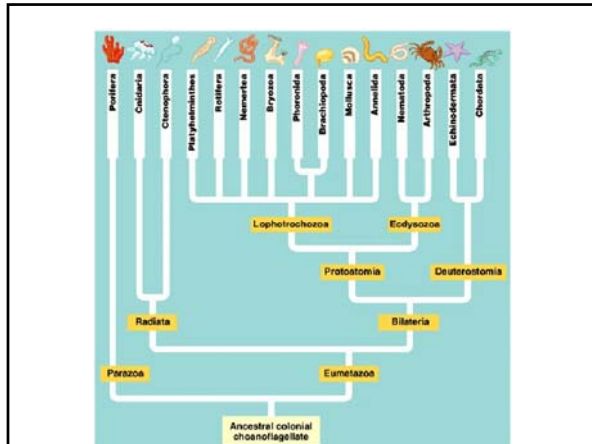
Cnidaria

- Jellyfishes (Scyphozoa)
- Only 5 species of jellyfish reported from Gulf - but at least 25 occur there.

Cnidaria True corals - 40 species in Gulf

Dendrophyllia oldroydae





ANNELIDA: POLYCHAETA
(Segmented worms)

- 716 species in Gulf, 11% endemic.
- 916 species predicted to occur in Gulf.

The worm, *Eurythoe complanata*

Golden sea mouse, *Aphrodita refulgida*

Fan worm, *Megalomma splendida*

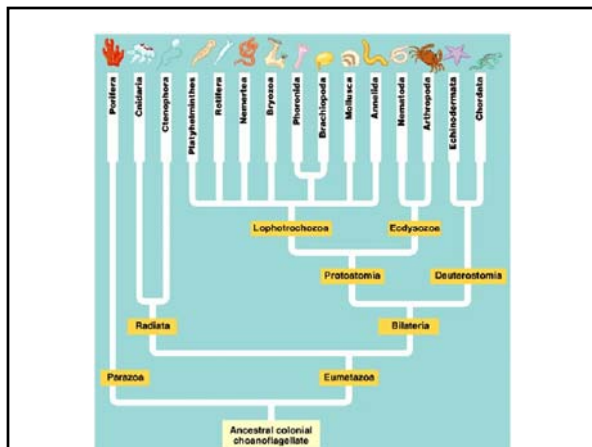
POLYCHAETA (Segmented worms)
7 species of Chaetopteridae - parchment worms

Parchment tube worm, *Mesochaetopterus mexicana*

Mantis shrimp, *Hemisquilla ensigera*

CRUSTACEA

- 1,026 species of Crustacea in Gulf, 12% endemic.
- 1,477 species predicted to occur in Gulf.

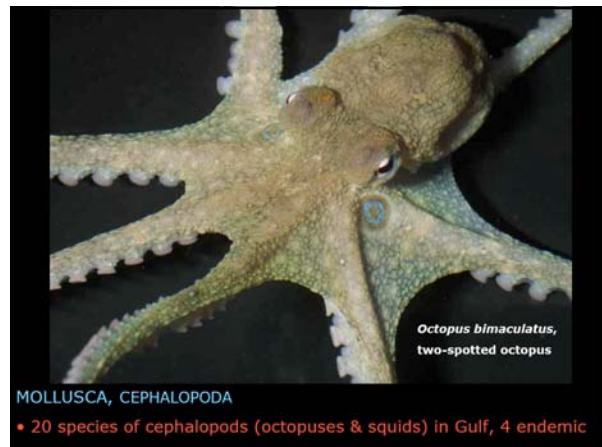
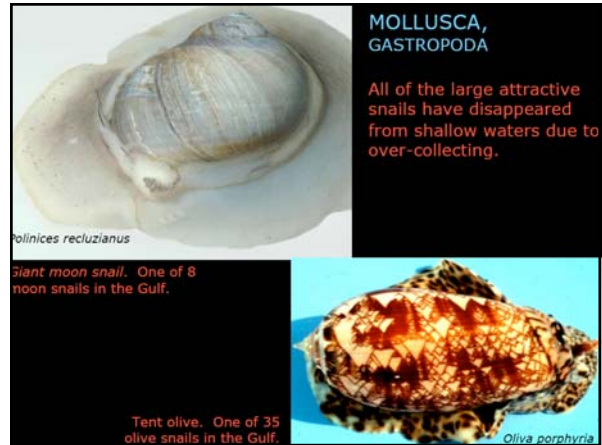
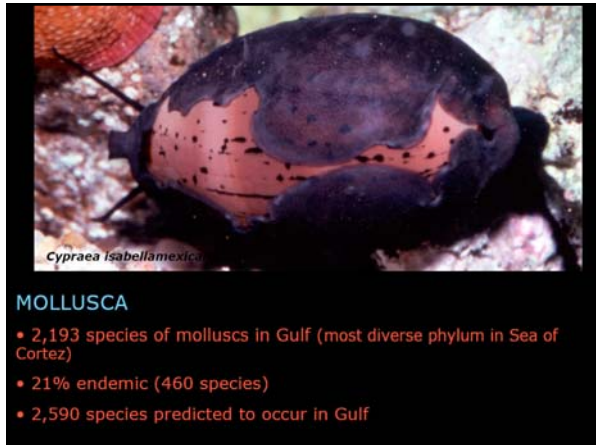
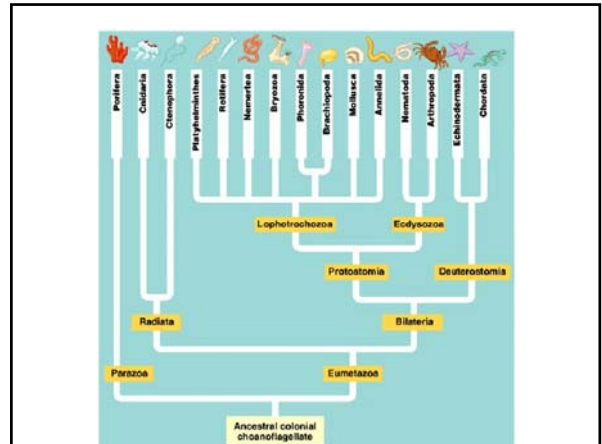


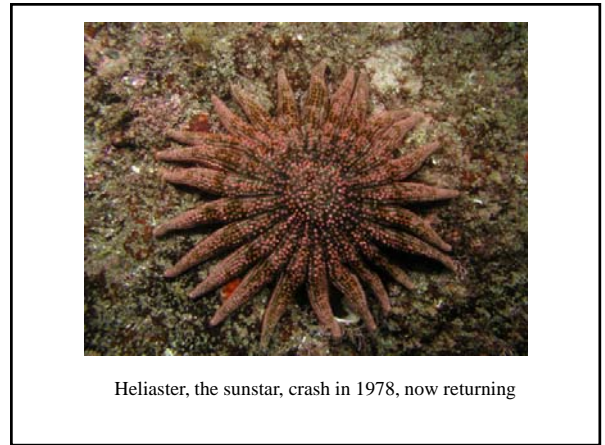
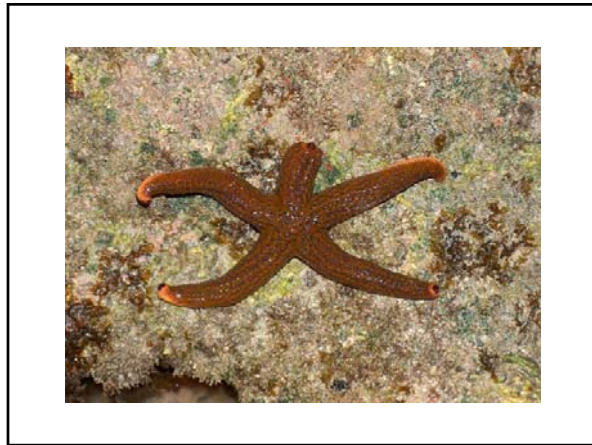
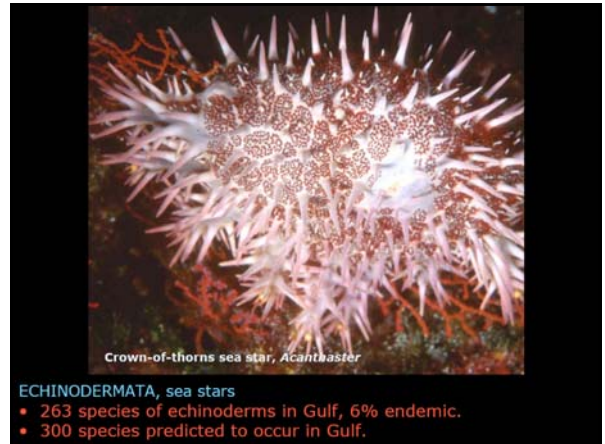
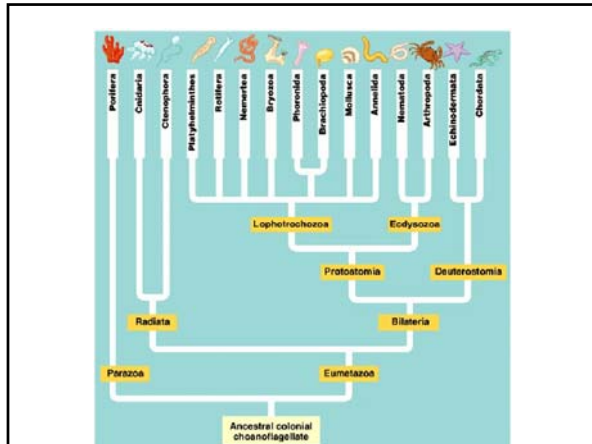

CRUSTACEA

- 300 species of true crabs in the Gulf
- 54 species of hermit crabs occur in the Gulf

Ghost crab (*Ocypode occidentalis*)

The giant Gulf hermit crab (*Petrochirus californiensis*)



Heliaster kubiniji

Endemic* to Gulf of California
Lives in intertidal zone
"Keystone" predator on the reef

Pre-1978
one individual/m² on the reef
"keystone predator" top predator
that eats many other species

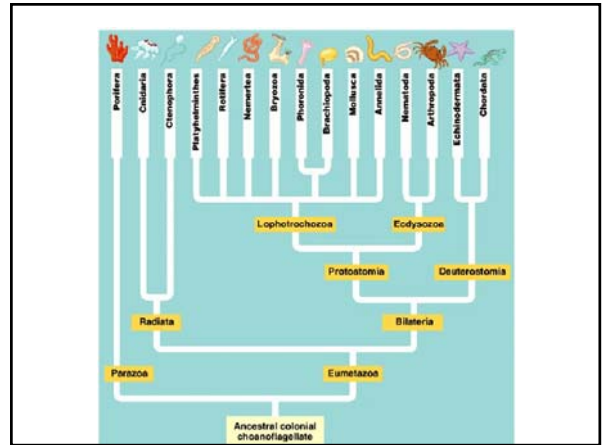
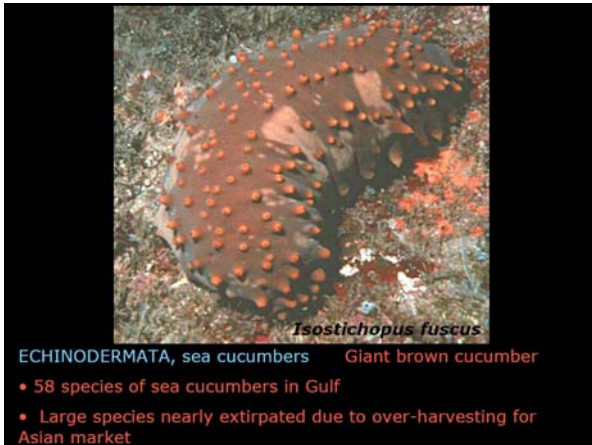
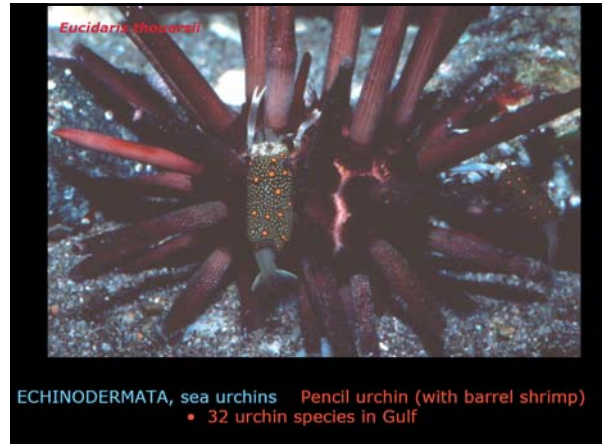
1978
population crashed
extremely rare for almost 20 yrs
still not common

endemic = where originated and currently found

Ophiocheilus

ECHINODERMATA, serpent stars

- The giant serpent star
- World's largest serpent star (arm span to 20").
- All large echinoderms are now rare on mainland shores due to over-collecting (by tourists).



31 species of cetaceans (whales & dolphins) inhabit the Gulf -- 34% of all the world's marine cetacean species!

Some migratory have given up migrating due to the abundance of food in Gulf (e.g., fin whales, sperm whales).

Fin whale

Gray whale

Common dolphin

Long-beaked common dolphin (*Delphinus capensis*) and bottlenose dolphin (*Tursiops truncatus*)

Gulf of California, Bahia de los Angeles,

<http://www-cs-students.stanford.edu/~robles/bc/bajacalif.html>

California sea lion (*Zalophus californianus*)



<http://www.oceanoasis.org/fieldguide/zalo-cal.html>

Fin whale *Balaenoptera physalus*



<http://www.exzoobrance.com/virtual%20zoo/they%20swim/fin%20whale/Fin%20Whale%20314040.jpg>

Gray whale *Eschrichtius robustus*



<http://www.exzoobrance.com/virtual%20zoo/they%20swim/fin%20whale/Fin%20Whale%20314040.jpg>

Baja, Loreto, Gray whale calving ground




Gray whale migration, 10,000 miles rt



Gray whale movies


http://www.arkive.org/species/GES/mammals/Eschrichtius_robustus/more_moving_images.html





Vaquita
Phocoena sinus


The marine mammal with the "most-est"



Vaquita "little cow"
Phocoena sinus


The marine mammal with the "most-est"

Smallest
Most restricted range
Most secretive
Most endangered
"critically endangered"
250 left



Vaquita, the harbor porpoise, *Phocoena sinus*


Size: 120 lbs (55 kg), less than 5 feet long (1.5m)
Color: gray back, pale belly, dark eye ring and lips in adults, babies uniformly gray
Shape: relatively tall dorsal fin and long pectoral fins for a porpoise
Behavior: alone or small groups (2, 4, or 10 max). Shy.
Endemic to Northern Gulf of California



Vaquita, the harbor porpoise, *Phocoena sinus*

Threats:

- 40-60 killed each year in gillnets (fishing boats) and trawling nets (shrimp boats)
- habitat loss due to damming of Colorado River



Vaquita

WWF-Mexico proposes the following milestone to save the vaquita:
By 2009, bycatch of vaquita in the Gulf of California be reduced to no more than one animal per year. To achieve this, they suggest:

- a wildlife refuge covering the distribution area of the vaquita that falls outside of the Upper Gulf of California Biosphere Reserve.
- Eliminate the use of gillnets and shrimp trawls in vaquita habitat
- Make progress on alternative gears and other sustainable economic alternatives for local fishermen and communities



BIOSPHERE RESERVE

MEXICO

El Golfo de Santa Clara

Puerto Peñasco

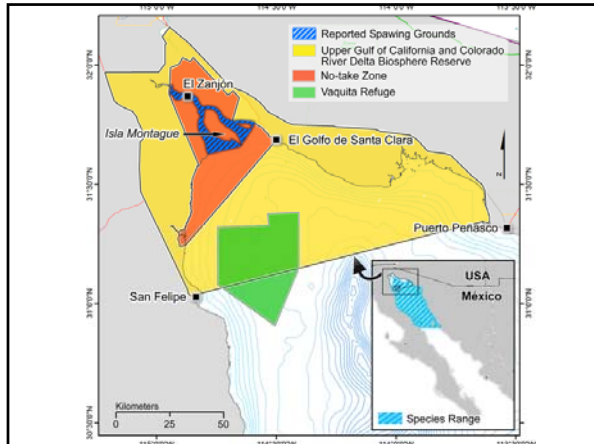
San Felipe

Vaquita Refuge

Vaquita Range

GULF OF CALIFORNIA

40 miles



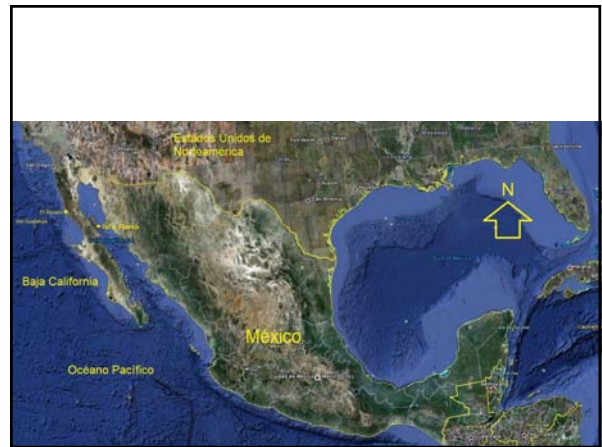
Blue whale, minke whale, humpback whale...

34 species of marine mammal in the Gulf of California

- 181 aquatic bird species in Gulf.
- Entire breeding populations of some sea birds (e.g. Elegant Tern, Heerman's Gull, Yellow-footed Gull) occur within the Sea of Cortez.

Elegant terns on Isla Rasa

- Isla Rasa protected in 1964 through efforts of the Desert Museum



Isla Raza

<http://www.oceanoasis.org/fieldguide/islarasa.html>

Isla Raza

Heermans's Gull
Nest on Isla Raza & Little Cardenoza, summer
150,000-300,000 pairs
Migrate to B.C.

<http://www.oceanoasis.org/fieldguide/islarasa.html>



Heerman's gulls and Elegant terns breed on Isla Raza

Isla Raza

Sterna elegans, Elegant tern
90% of world population nest on Isla Raza



<http://www.oceanosis.org/fieldguide/islarasa.html>

[videos](#)

Isla Raza



Sterna elegans, Elegant Tern
22,500 pairs on Isla Raza, 2000
Other nests elsewhere (eg, San Diego)

- 1940, 1 million birds on Raza
- 1960s, 25,000 birds
- 1973, 5000 birds
- 1993/4, rat eradication program
- 1993, 350,000 hermann's gulls
- 1994, 45,000 elegant terns

1964, declared a legal bird sanctuary

Threats: egg collecting, rats, fishing camps, 300 ecotourists per year

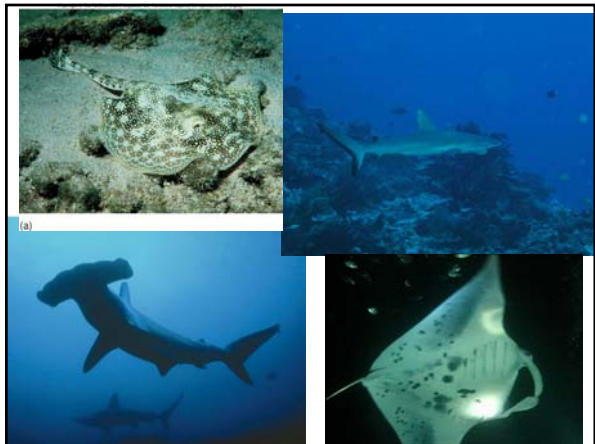
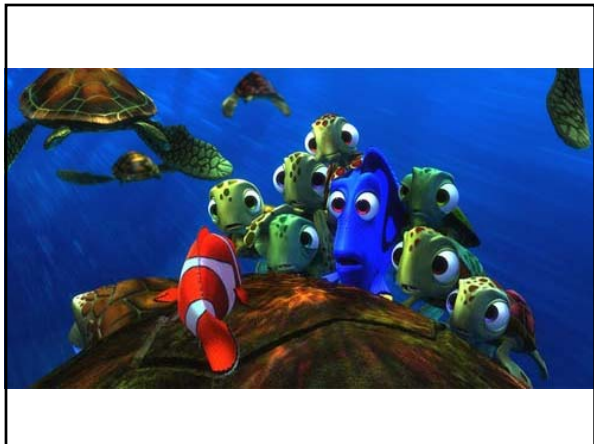
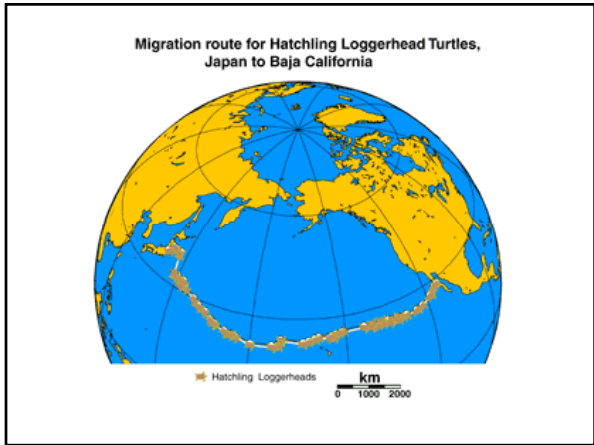
More noisy than royal tern
<http://www.oceanosis.org/fieldguide/islarasa.html>

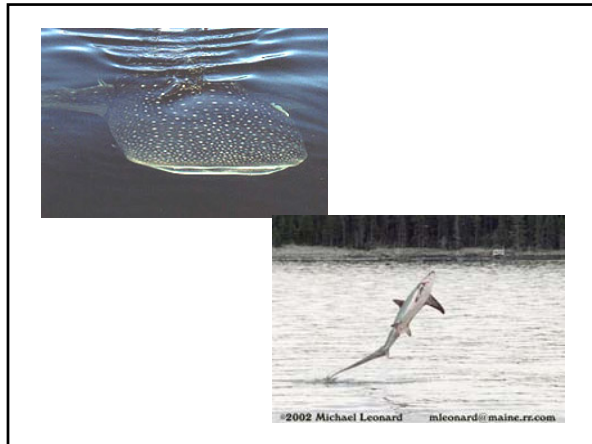


- Sea turtles of Baja**
- Green turtle (aka black turtle)
 - Loggerhead
 - Olive Ridley
 - Hawksbill
 - Leatherback



Pair of black sea turtles





New shark species from the Gulf of California, 2003



Mustelus hacat,
1 m long, lives at 250 m

http://news.nationalgeographic.com/news/2006/03/0313_060313_shark.html

Pacific Seahorse



Garden Eel

- Eels and seahorses are fish.
- Garden eel:



Threats to Biodiversity

Death of the Colorado River

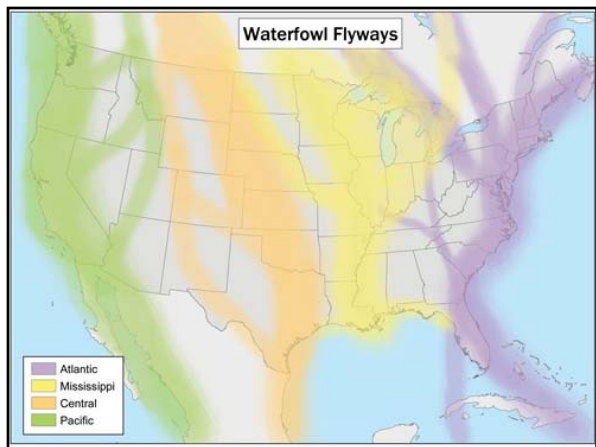
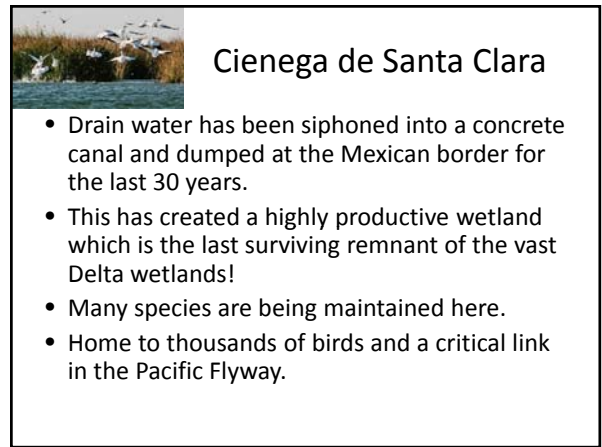
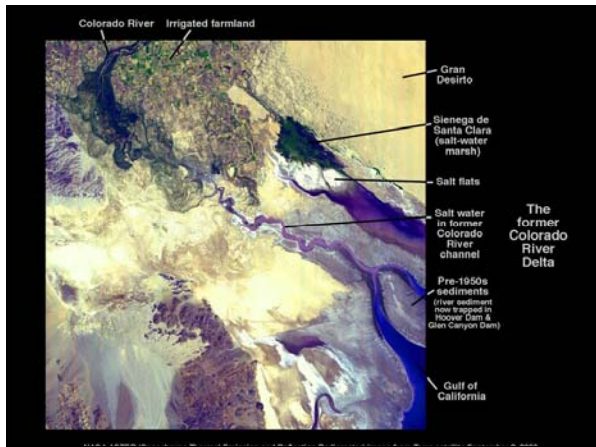


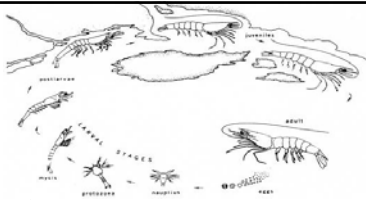
- 20 dams & thousands of kilometers of canals have converted the Colorado River into a totally controlled plumbing system.
- Prior to Hoover Dam (1935), ~15 maf/year of river water reached the upper Gulf annually.
- 100 years ago, river boats steamed from the Gulf into the Colorado/Gila River system -- major steamship port in Yuma.



Today:

- Almost no river water reaches the Gulf, except during "flood years."
- The Delta has switched from a depositional basin to an erosional basin, as tides now remove ancient sediments.
- The Delta and its marshes are disappearing into the deep basins of the Gulf
- Spawning & nursery grounds for commercial species of fish and shrimp are being lost.





- The Gulf Shrimp that we eat start their lives as free-floating larvae out in the sea.
- They move into shallow marshes and estuaries with brackish water
- When they reach a subadult stage they go back out in the sea.
- Loss of the Colorado delta and other estuaries has reduced shrimp numbers.

The fabled Totoaba

- Found in the northern Sea of Cortez.
- Formerly abundant and intensely fished.
- Now rare and endangered.
- Predatory fish, lives up to 15 years, matures at 6-7 years.
- **Spawn in Colorado delta, where the larval and juvenile stages live in brackish water.**
- Adults live out in the open sea only returning to the delta once a year in springtime to spawn



The fabled Totoaba

- It could be a big fish!



The fabled Totoaba

- Fishing started in the 1920's reaching 2,000 metric tons in 1943.
- By 1975 down to only 50 tons.
- Mexico banned fishing.
- Now stabilized at a low level.
- Bladders - a Chinese soup – *Seen Kow*
- still worth about \$100 each on the black market.



The fabled Totoaba

- **Double trouble:**
- Requires the old Colorado River delta conditions for reproduction.
- Recovers slowly from fishing, due to long life and delayed maturity.



Threats to Biodiversity



Extraction of sea life for tourist trade.



Curio shops, Puerto Peñasco

Threats to Biodiversity: Over Fishing

Nearly every fishery in the Gulf is over-fished.

- Bottom trawlers (shrimp boats)
- Purse seiners (anchovy/sardine boats)
- Gill nets
- Long lines
- Artisanal (family) fishing (~25,000 pangas in Gulf)



- More than 1,000 shrimp trawlers operate in the Gulf.

- A bottom area of sea floor equivalent to 2X the total size of the Gulf is dragged annually.



- Trawlers continually disrupt bottom communities.
- Completely remove seafloor life -- then rain dead animals ("by-catch") back to the sea floor, creating "dead zones" of hypoxia.
- Capture up to 40 kg of by-catch for every 1 kg of shrimp caught -- most inefficient fishery on earth -- 95% waste
- Catch per unit effort has been declining since the 1970s.
- Federal government subsidizes over-harvesting and over-capacity of fishing fleets (cheap diesel fuel, prop up fishing cooperatives, etc).

Bycatch

Non-target fishes caught accidentally in fishing gear

Photos courtesy Monterey Bay Aquarium

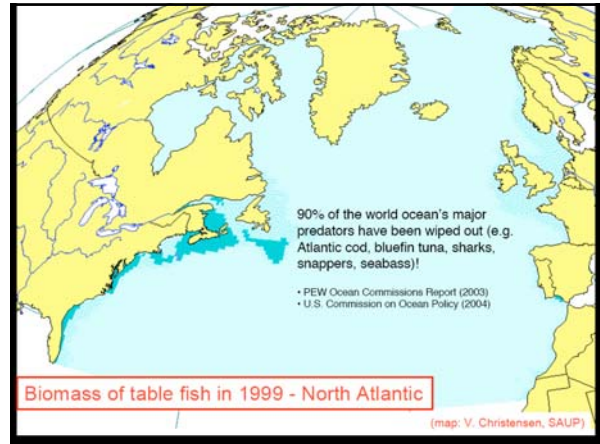
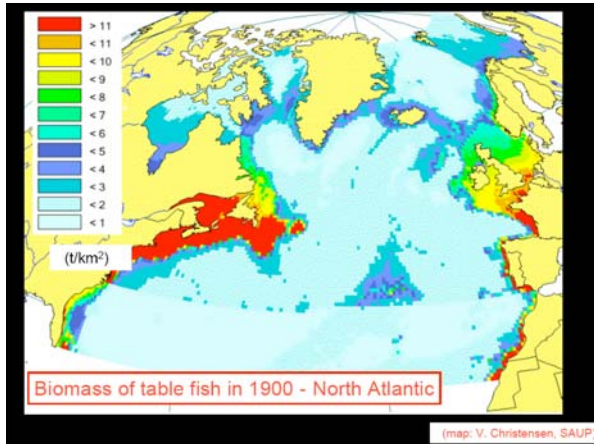
Damage by Bottom Trawling

*equivalent of clear cutting forests

Photos courtesy Monterey Bay Aquarium

A healthy middle-shelf bottom habitat

Before Dredging After Dredging



Is Aquaculture the Answer?

Threats to Biodiversity: Aquaculture

- Conversion of estuaries to shrimp farms.
- Destruction of mangroves.
- No government regulation of runoff (food, wastes, drugs, exotic disease organisms, etc).

Former mangrove lagoon in Gulf

Former mangrove lagoon near Guaymas

95% of the mangrove lagoons in Sonora have been developed as shrimp ponds.

Destruction of coastal mangrove lagoons eliminate habitat for hundreds of species, including critical nursery grounds for nearly all commercially important shellfish and finfish in the Gulf.

It takes >3 lbs of wild-caught fish to raise 1 pound of shrimp or salmon!

These products result in a net loss of fish from the sea.

Environmental Risks of Marine Aquaculture

Antibiotics, pesticides, and other chemicals used in aquaculture can harm wild fish and marine life.

Excess feed and waste can pollute the water and harm the environment.

Overcrowding can lead to disease outbreaks that spread to wild fish.

Escapes of farmed fish can compete with wild fish for food and space.

Genetic pollution can occur if farmed fish breed with wild fish.

Physical damage to the seabed can occur from anchors and other equipment.

© John Yarnon & Pew Ocean Commission

ASDM's Sustainable Seafoods Program

Learn more

Visit www.seafoodwatch.org for

- More detailed information on these recommendations
- Seafood recommendations for other species
- The latest version of this and other regional guides
- Information on seafood and your health and much more...

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MONTEREY BAY AQUARIUM

Seafood WATCH

RED: OCEAN

Gulf of California Seafood Guide 2006

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BEST CHOICES	GOOD ALTERNATIVES	AVOID	Use This Guide to Make Choices for Healthy Oceans
<ul style="list-style-type: none"> California US farmed Chum (farmed) Coast Pacific farmed (except open sea) Crab (Dungeness, snow, Canadian, Stone Harbor, Pacific) Herring, Alaska/Sardines Lobster (spiny urchin caught from Pacific Basin) Mussels (farmed) Oysters (farmed) Rockfish (wild-caught from Alaska) Salmon (wild-caught from Alaska) Scallops (farmed) Sardines, Chile (farmed) Squid, US farmed Trawl (wild-caught US farmed) Tuna (Alaska, Bay, Yellowfin) Wild-caught 	<ul style="list-style-type: none"> Oysters (wild-caught) Quahog (wild-caught) Seafood (wild-caught) Shrimp (wild-caught) Shrimp (US farmed or wild-caught) Squid (wild-caught) Scallops (wild-caught) Shrimp (US farmed or wild-caught) Squid (wild-caught) Shrimp (US farmed or wild-caught) Squid (wild-caught) Shrimp (US farmed or wild-caught) Squid (wild-caught) Shrimp (US farmed or wild-caught) Squid (wild-caught) 	<ul style="list-style-type: none"> Chum (wild-caught) Coast Pacific farmed (except open sea) Crab (Dungeness, snow, Canadian, Stone Harbor, Pacific) Herring, Alaska/Sardines Lobster (spiny urchin caught from Pacific Basin) Mussels (farmed) Oysters (farmed) Rockfish (wild-caught from Alaska) Salmon (wild-caught from Alaska) Scallops (farmed) Sardines, Chile (farmed) Squid, US farmed Trawl (wild-caught US farmed) Tuna (Alaska, Bay, Yellowfin) Wild-caught 	<p>Best Choices These are your best seafood choices! Their fish are abundant, well managed and caught or farmed in environmentally friendly ways.</p> <p>Good Alternatives These are good alternatives to the best choices. However, there are concerns with how they're caught or farmed or with the health of the habitat due to other human impacts.</p> <p>Avoid Avoid these fish, or look for more. They come from sources that are overfished and/or caught or farmed in ways that harm other marine life or the environment.</p> <p>Seafood may appear in more than one category.</p>

Seafood Watch

Salmon

Coho, Chum, Keta, King, Pink, Red, Silver, Sockeye, Sake

Best Choice

Alaska / Wild-caught

Fishery management is especially important for salmon as these fish require freshwater and ocean habitats to survive. Wild-caught salmon from Alaska is considered a "Best Choice" and is certified as sustainable to the standard of the Marine Stewardship Council (MSC).

Seafood Recommendations +

Conservation Note +

Find This Nearby +

THE GULF OF CALIFORNIA

Good News: Many New Marine Reserves and Parks in the Gulf

- 40% of Mexico's conservation areas are now in the Sonoran Desert region - almost all designated in past 15 years.
- There are now 17 federally designated parks and reserves in the Gulf region.
- The Desert Museum has played important roles in the designation & management of many of these.

"The abundance of life gives one an exuberance, a feeling of fullness and richness... where the sea swarms with life... complete from plankton to porpoise" – Steinbeck and Ricketts 1941.

The Sea of Cortez is “exhausted but not yet dead”. NYTimes 2002.

