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ENVIRONMENTAL SYSTEMS AND SOCIETIES
STANDARD LEVEL
PAPER 2

Monday 7 November 2011 (morning)

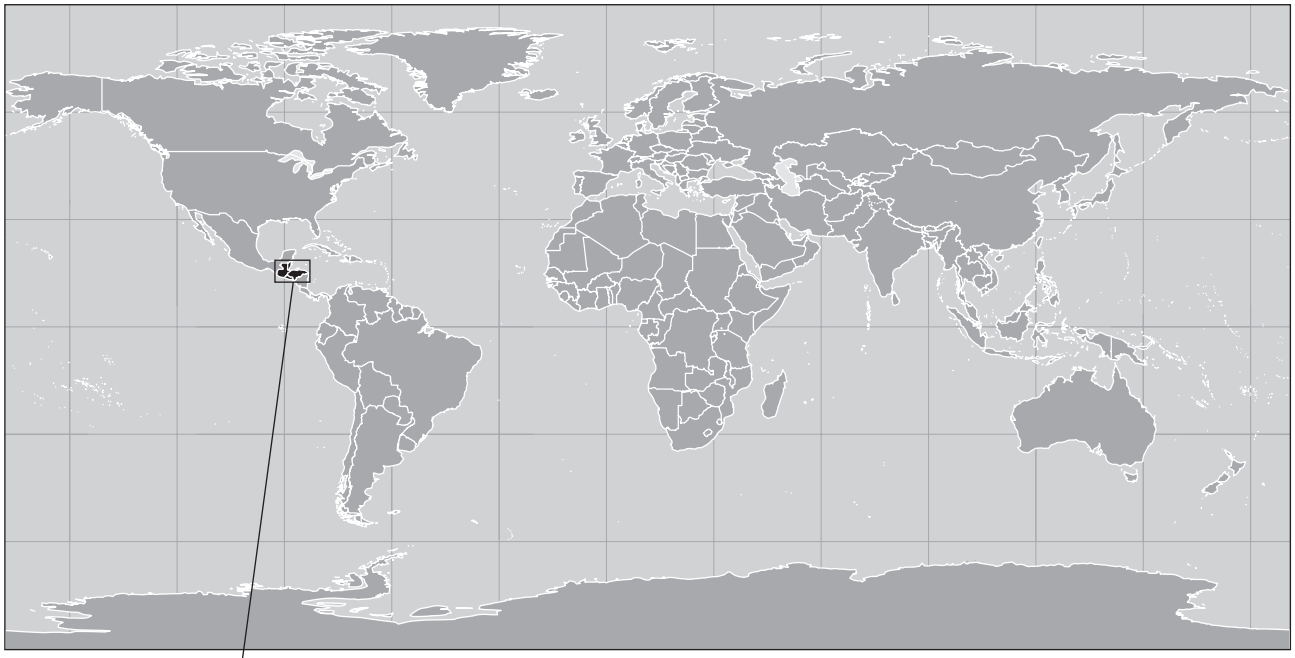
2 hours

RESOURCE BOOKLET

INSTRUCTIONS TO CANDIDATES

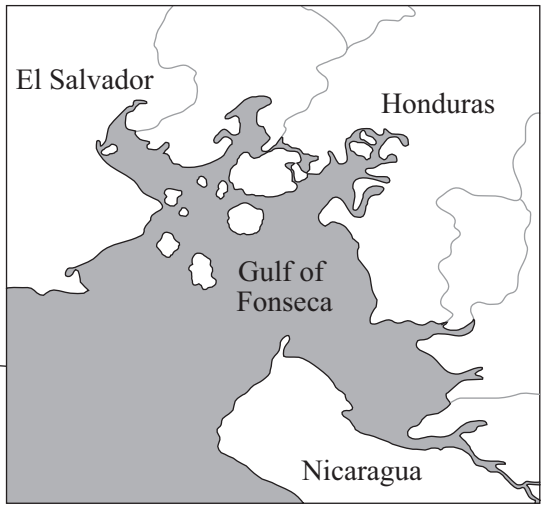
- Do not open this booklet until instructed to do so.
- This booklet contains **all** of the resources required to answer question 1.

Figure 1 World map showing the location of the Gulf of Fonseca



[Source: world map adapted from www.un.org/depts/cartographic/map/profile/world.pdf]

[Source: www.cia.gov/library/
publications/the-world-factbook]



[Source: www.worldatlas.com/aatlas/
infopage/fonsecag.gif. Used with permission]

Figure 2 Fact file on the Gulf of Fonseca

- A gulf is a large body of water usually surrounded on three sides by land; the Gulf of Fonseca is surrounded by El Salvador, Honduras, and Nicaragua.
- The gulf covers an area of approximately 3200 km^2 and has a coastline of 261 km.
- The coastal ecosystem is dominated by various species of mangrove. Mangroves are evergreen trees found in the inter-tidal zone in tropical and subtropical latitudes.
- Bananas, coffee and beef are three of the main exports from the Gulf of Fonseca countries.
- Shrimp farming is an important area of economic growth in the countries enclosing the Gulf of Fonseca.

Figure 3 The mangrove ecosystem

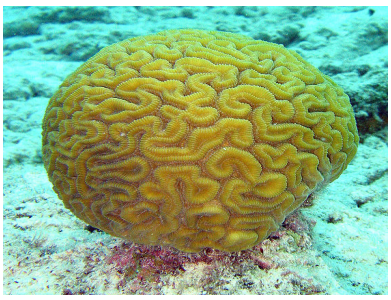
- Mangrove trees are found in estuaries where fresh water enters the sea; they are therefore able to survive in varying levels of salinity and nutrient availability.
- Mangrove trees have specialized aerial roots that are adapted to low oxygen concentration and varying water levels.
- Mangrove ecosystems are important nursery grounds for fish and crustaceans (shrimp and crabs) *e.g.* Blue Striped Grunt and Mangrove Crab.
- Mangrove ecosystems provide habitats for many creatures, including migratory and non-migratory birds *e.g.* Mangrove Warbler and Jabiru Stork.
- Mangrove ecosystems provide important resources for local people in the form of wood, plant extracts, and subsistence harvesting of crabs and snails.
- Removal of mangroves impacts on soil erosion rates and nutrient cycles affecting the shoreline, seagrass beds and coral reef.

Mangrove
(*Rhizophora mangle*)

[Source: http://en.wikipedia.org/wiki/File:Mangrove.jpg
Created by Muriel Gottrop.]

Seagrass
(*Halophila sp.*)

[Source: http://en.wikipedia.org/wiki/File:Floridian_seagrass_bed.jpg
Created by Wikipedia user: Menchi.]

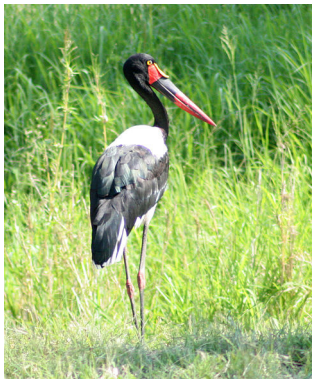


Brain Coral
(Family Faviidae – multiple species)

[Source: http://en.wikipedia.org/wiki/File:Brain_coral.jpg
Photo taken by Jan Derk.]

Mangrove Warbler
(migratory)
(*Dendroica petechia*)

[Source: www.stevenanz.com/Main_Directory/Recent%20Photos/2007/070411_Yucatan/original/mangrove_warbler6527.jpg]
© Steve Nanz. Used with permission.



Jabiru Stork
(non-migratory)

(*Jabiru mycteria*)
[Source: http://en.wikipedia.org/wiki/File:Jabiru_mycteria_-Parque_das_Aves,Foz_do_Iguacu,_Brazil-back-8a.jpg
Created by Chad Bordes.]

Mangrove Crab
(*Ucides cordatus*)

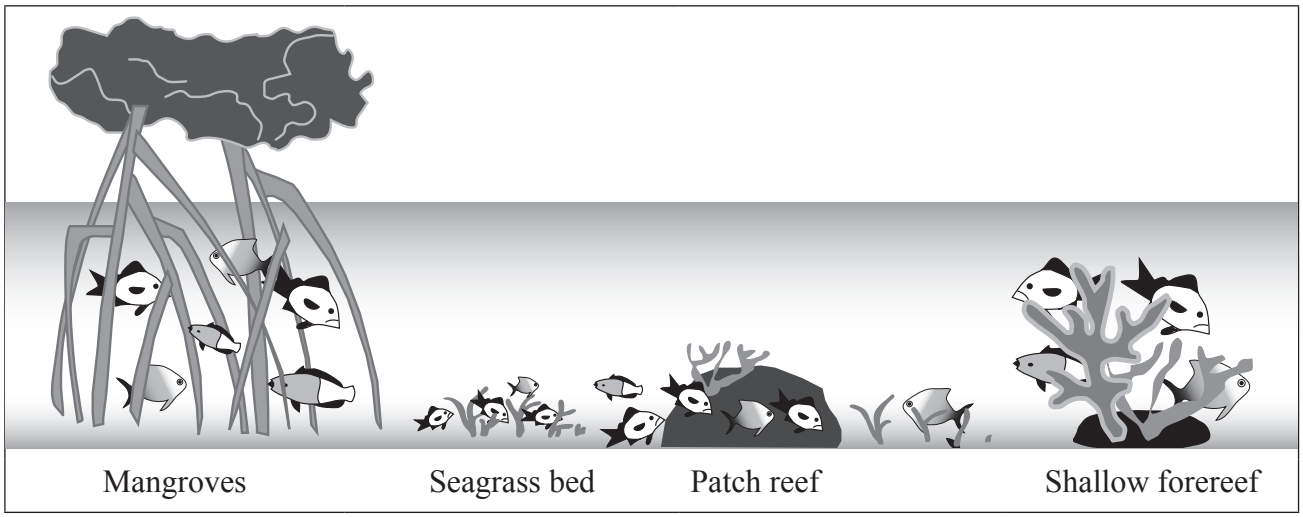
[Source: http://en.wikipedia.org/wiki/File:Nokogirigazami1.JPG Created by Wikipedia user Sakanayaman.]

Blue Striped Grunt
(*Haemulon sciurus*)

[Source: http://en.wikipedia.org/wiki/File:Blue_Stripe_Grunt._Haemulon_sciurus.jpg
Created by: Brian Gratwicke.]

Figure 4 Mangrove ecosystems as nurseries for coral reef fish

(a) Mangroves present



(b) Mangroves absent

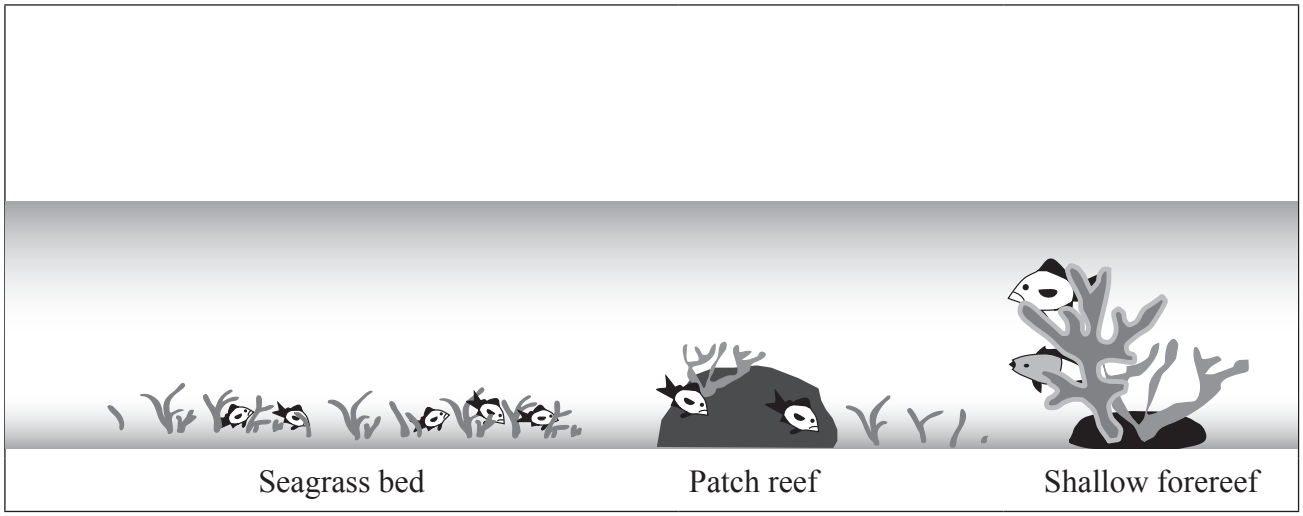
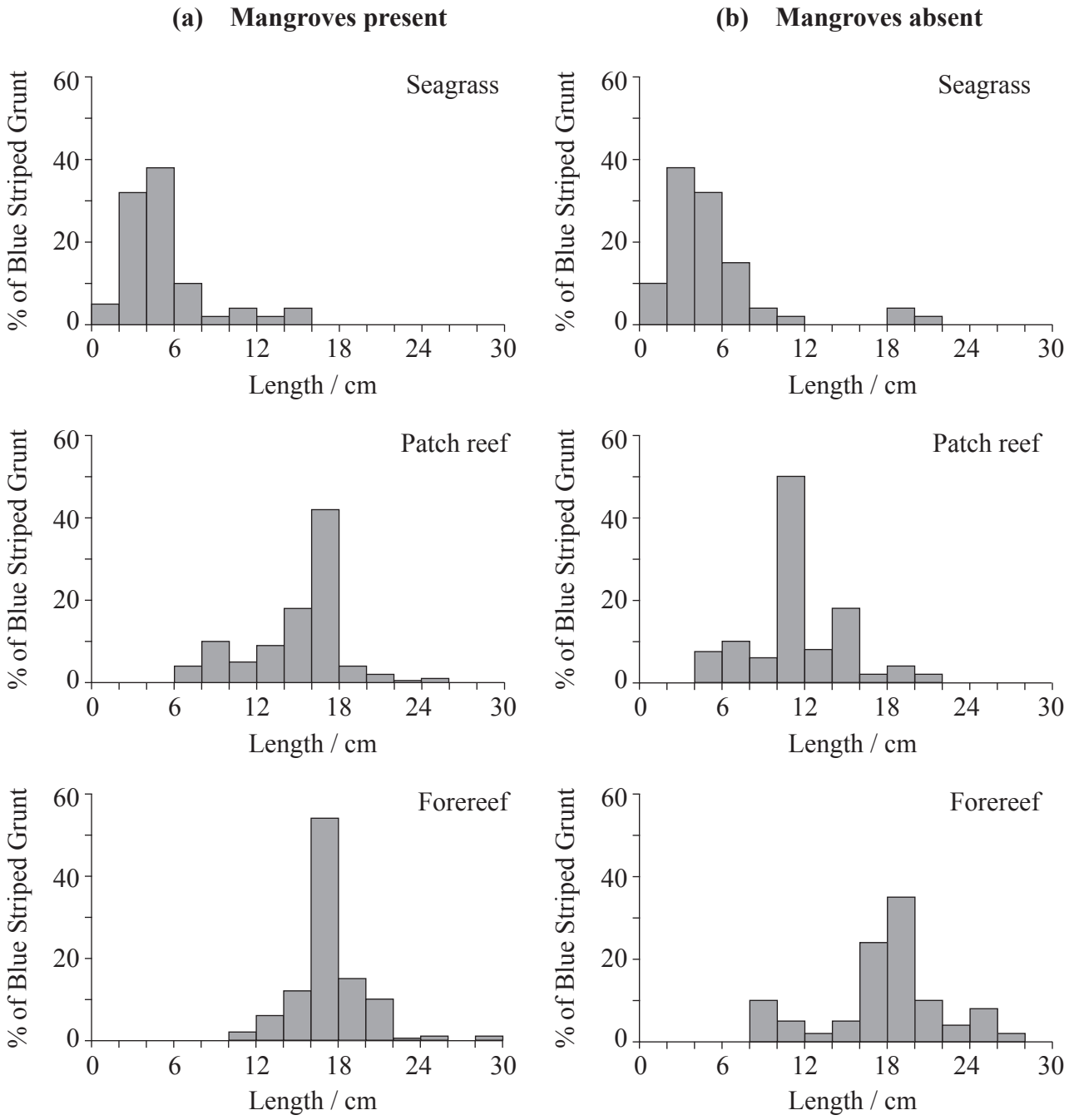


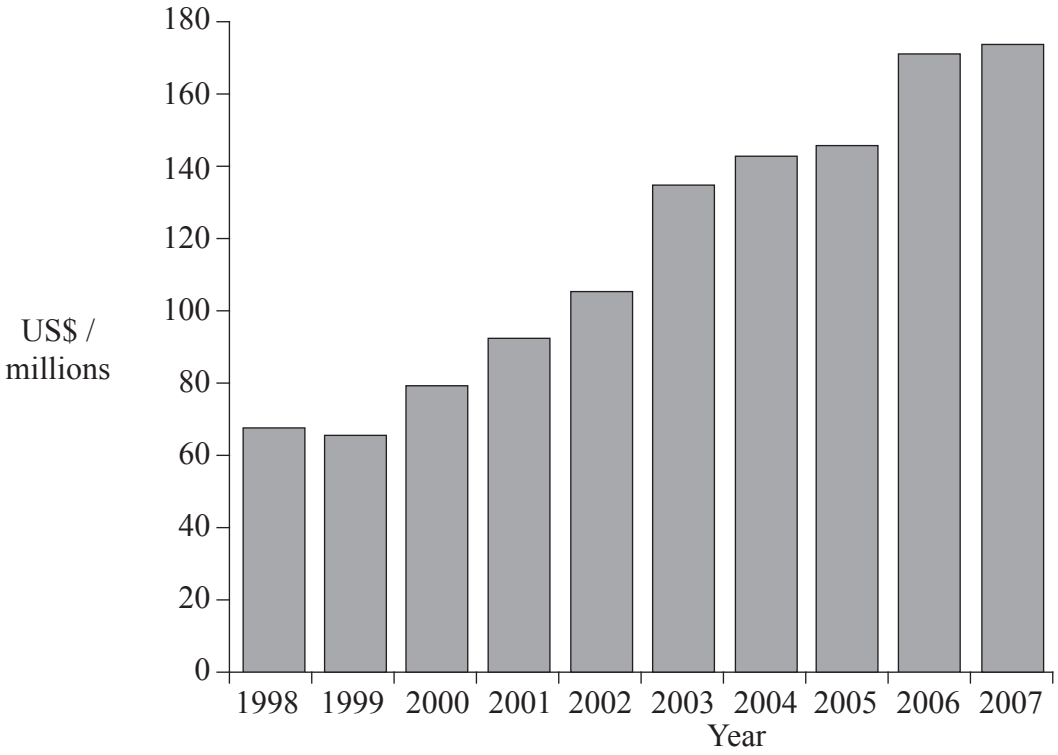
Figure 5 Total length of Blue Striped Grunt (*H. sciurus*) in ecosystems with mangrove trees present and absent



Mumby, P.J. *et al*. (2004) Mangroves enhance the biomass of coral reef fish communities in the Caribbean. *Nature*, 427, 533–536. Reprinted by permission from Macmillan Publishers Ltd.

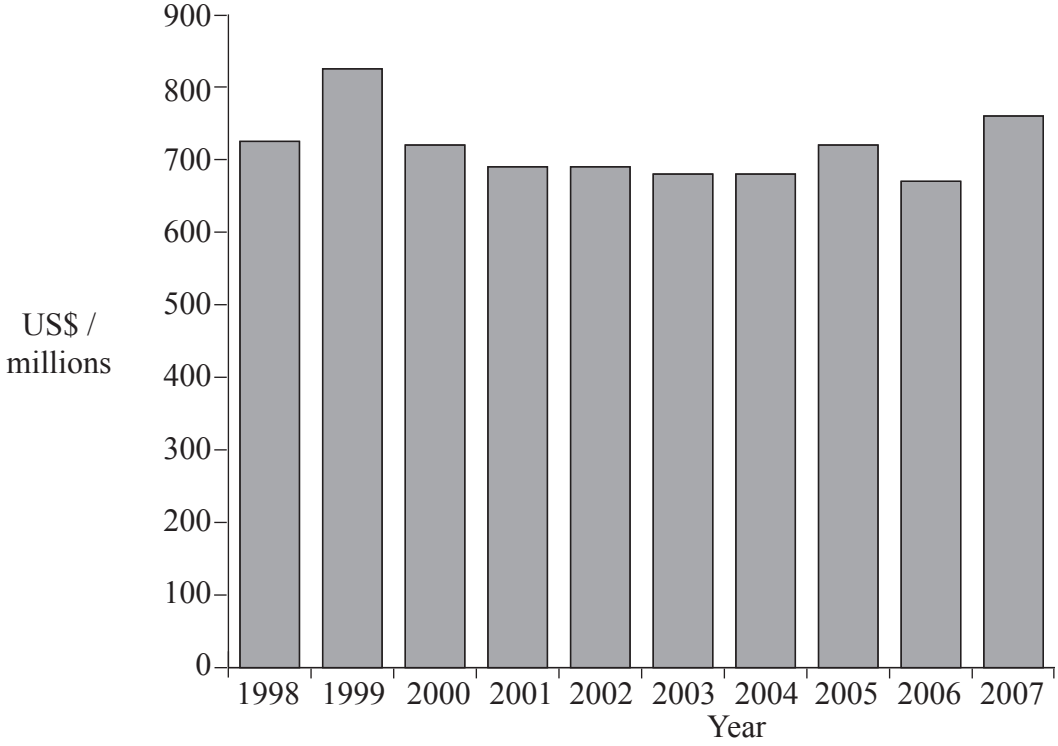
Figure 6 Export of products from Gulf of Fonseca countries

(a) Export of aquaculture product (shrimp) from Gulf of Fonseca countries



[Source: adapted from www.fao.org/fishery/statistics/global-aquaculture-production/en] FAOSTAT and FIGIS: Graphs showing exports from the Gulf of Fonseca countries. Used with the permission of the Food and Agriculture Organization of the United Nations.

(b) Total exports of major agricultural products (bananas, coffee, beef) from Gulf of Fonseca countries



[Source: adapted from http://faostat.fao.org/site/339/default.aspx] FAOSTAT and FIGIS: Graphs showing exports from the Gulf of Fonseca countries. Used with the permission of the Food and Agriculture Organization of the United Nations.

Figure 7 Ecological services of mangrove ecosystems

Ecological service	Estimated economic value of service
Water quality maintenance	US$5820 ha^{-1} yr^{-1}
Protection from environmental disturbance	US$3679 ha^{-1} yr^{-1}
Carbon storage	US$952 ha^{-1} yr^{-1}

Reprinted from Walters et al. (2008) "Ethnobiology, socio-economics and management of mangrove forests: A review." *Aquatic Botany*, 89, 220–236. With permission from Elsevier.

Figure 8 Shrimp consumption and farming

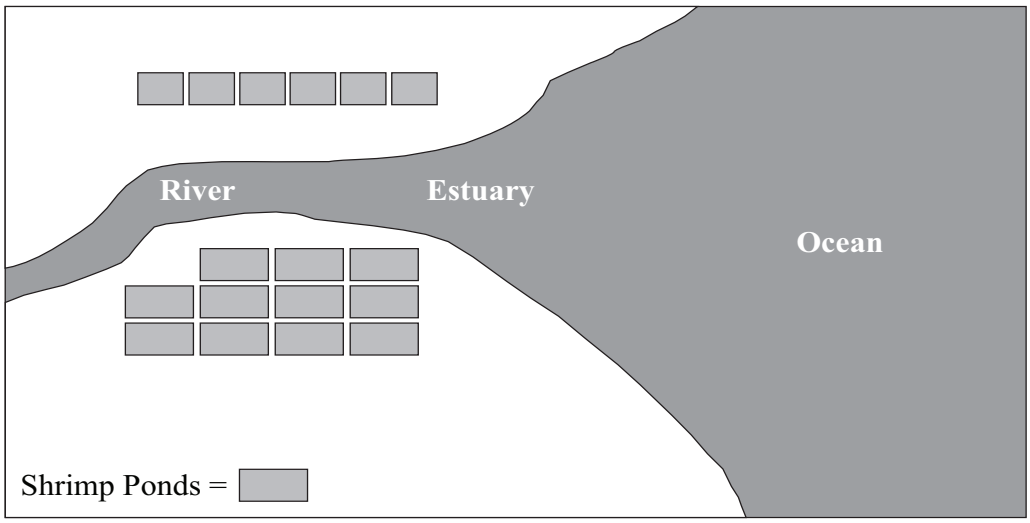
- 28 % of shrimp consumed worldwide are commercially farmed.
- Most shrimp produced by commercial farms are Tiger Shrimp *(Penaeus monodon)*.

http://en.wikipedia.org/wiki/File:Penaeus_monodon.jpg, Created by Wikipedia user Rotatebot

- In extensive shrimp farming, mangrove ecosystems are cleared to set up shrimp ponds.
- The loss of 50 % of Ecuador's mangrove ecosystems, and 33 % of those in Honduras are thought to be caused by extensive shrimp farming.
- Extensive shrimp farming prevents local communities from accessing the coastline for subsistence activities.
- Nursery grounds of marine aquatic species are also displaced by extensive shrimp farming.

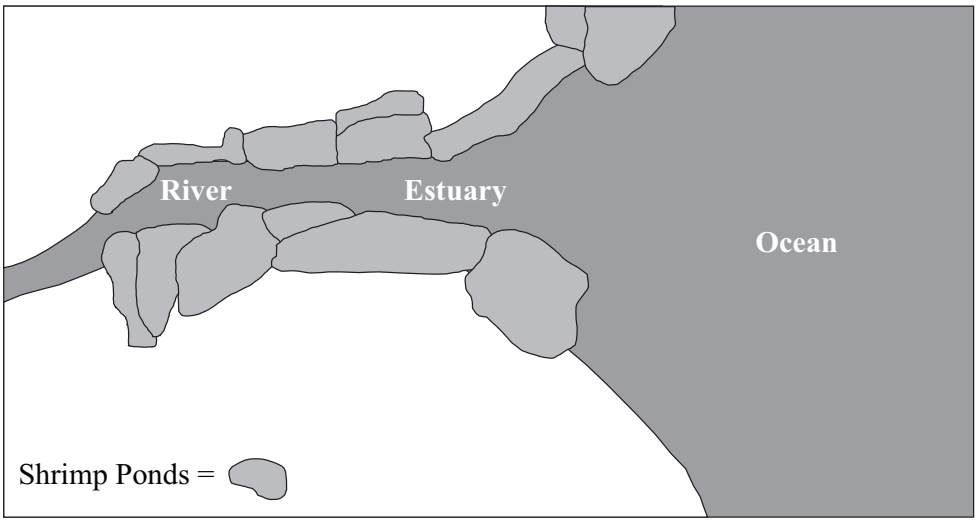
Figure 9 Commercial shrimp farming techniques

(a) Semi-intensive shrimp farming



- Located along the shore above the high tide line
- Sea water is pumped into constructed ponds using mechanized pumps
- Ponds are fertilized (nitrogen, phosphorus and silicate) to encourage a natural food chain
- Shrimp density is high because farmers increase production with manufactured shrimp feeds
- Yields range from 500 to 5000 kg ha^{-1}.

(b) Extensive shrimp farming



- Located along the shore below the high tide line
- Sea water flows in naturally with the tides
- Shrimp feed on naturally occurring organisms, which may be encouraged with organic or chemical fertilizer
- Construction and operating costs are low
- Yields range up to 500 kg ha^{-1}.

[Source: adapted from www.shrimpnews.com/About.html]