T050 Assess population data

Syllabus statement

At the end of this topic you should be able to ...

Assess

assess population data to measure population size, density, abundance, distribution, carrying capacity

Assess

measure, determine, evaluate, estimate or make a judgment about the value, quality, outcomes, results, size, significance, nature or extent of something

Question

As per syllabus

Assess population data to measure population size, density, abundance, distribution, carrying capacity.

So what is carrying capacity?

Physical, economic and ecological

CARRYING CAPACITY IN COASTAL AREAS

The concept of capacity has received considerable attention as a result of increasing anthropogenic pressure in certain natural environments. Much consideration has recently been given to increases in coastal populations, with the implication that the carrying capacity of the world's coast is finite and such considerations form part of several coastal management initiatives (UNEP, 1996).

Johnson and Thomas (1996) argue that present interest in tourism capacity is due to growth in tourism combined with increasing awareness of environmental issues. The concept is particularly important in the coastal zone which is undergoing rapid change as a result of demographic changes and industrialization (see Kay and Alder, 1999, p. 21) in the context of global climate and sea-level change. In its broadest sense, carrying capacity refers to the ability of a system to support an activity or feature at a given level. In the coastal zone, these systems can vary greatly in both scale and type, and range from small salt marshes through large beach resorts to entire continental coasts. The activities or features that they support are also varied and include, for example, beach recreation or species abundance. The term "carrying capacity" does not therefore have a single precise definition. Rather, it is a broad term that covers a range of different concepts. These concepts are related by the idea that systems such as beaches have certain limits or

grazed

limits is

case of

arrying

on, for

Physical carrying capacity: This is a measure of the spatial limitations of an area and is often expressed as the number of units that an area can physically accommodate, for example, the number of berths in

example, the physical integrity of the site, its ecological status, or its recreational value. In practice, these features may be interrelated.

The situation is further complicated by the subjective nature of certain limits. For example, the point at which the aesthetic impac
ing becomes unacceptable is difficult to define and may vary
location or cultural setting to another. In recognition of th
nature of carrying capacity as a concept, a variety of types o
capacity have been identified. Most of these fall into the follo
gories: physical, ecological, social, and economic.

Physical carrying capacity: This is a measure of the spatial limitations of an area and is often expressed as the number of units that an area can physically accommodate, for example, the number of berths in a marina. Determining the physical capacity for certain activities can, however, become problematic when subjective elements are introduced. For example, the maximum number of people that can safely swim in a bay depends on human perceptions and tolerance of risk.

Ecological carrying capacity: At its simplest, this is a measure of the population that an ecosystem can sustain, defined by the population density beyond which the mortality rate for the species becomes greater than the birth rate. The approach is widely adopted in fisheries science (e.g., Busby *et al.*, 1996). In practice, species interactions are complex and the birth and mortality rates can balance over a range of population densities. In a recreational context, ecological carrying capacity can also be defined as the stress that an ecosystem can withstand in terms of

unacceptably affected. This approach raises the difficult question of defining ecological value and what constitutes an unacceptable change in it.

Social carrying capacity: This is essentially a measure of crowding tolerance. It has been defined as "... the maximum visitor density at which recreationists still feel comfortable and uncrowded" (De Ruyck *et al.*, 1997, p. 822). In the absence of additional changes, beyond this density visitor numbers start to decline. The social carrying capacity can, however, be influenced by factors such as the recreational infrastructure, visitor attitudes, and sociocultural norms.

Economic carrying capacity: This seeks to define the extent to which an area can be altered before the economic activities that occur in the area are affected adversely. It therefore attempts to measure changes in economic terms (Rees, 1992). Examples from the coastal zone might include examining the effect of increased numbers of trailer parks on agricultural activity in dune systems.

In addition to these s
of composite measures
ity. These attempt to d
recreation by combinin

Economic carrying capacity: This seeks to define the extent to which an area can be altered before the economic activities that occur in the area are affected adversely. It therefore attempts to measure changes in

actual carrying capacity of a coastal area assessed according to any of the above approaches depends largely on the nature of the area. Carter (1989, p. 357) noted that "Coastal environments vary considerably in their ability to absorb anthropogenic pressure. The carrying capacity of dune grassland is many orders of magnitude below that of rock cliffs." While this may be true, at least in some views of carrying capacity, it should be borne in mind that capacities are not necessarily fixed in time. They can often be altered by management practices for example, the provision of recreational facilities can increase the social carrying capacity of an area. They can also alter in response to wider environ-

affect

s, or a

ptable

rrying

ey are

Ecological carrying capacity: At its simplest, this is a measure of the population that an ecosystem can sustain, defined by the population density beyond which the mortality rate for the species becomes greater than the birth rate. The approach is widely adopted in fisheries science

contingent on technology, preferences, and the structure of production and consumption. They are also contingent on the ever-changing state of interactions between the physical and biotic environment."

M. MacLeod and J.A.G. Cooper

Cross-references

Springer
http://www.springer.com/978-1-4020-1903-6
Encyclopedia of Coastal Science
Schwartz, M. (Ed.)
2005, LXVI, 1213 p., Hardcover
ISBN: 978-1-4020-1903-6

Ecological carrying capacity

The size of a population is affected by four processes: "BIDE"

Birth rate (B),

Immigration rate (I)

Death rate (D),

and

Emigration rate (E).

The rate of change of a population (R) is calculated by $R = (B + I) - (D + E)$. "BIDE"

When a population reaches its carrying capacity due to the limitation of resources there will be zero population growth:

R = 0.

The syllabus says

Use models to examine factors that influence changes in population (BIDE)

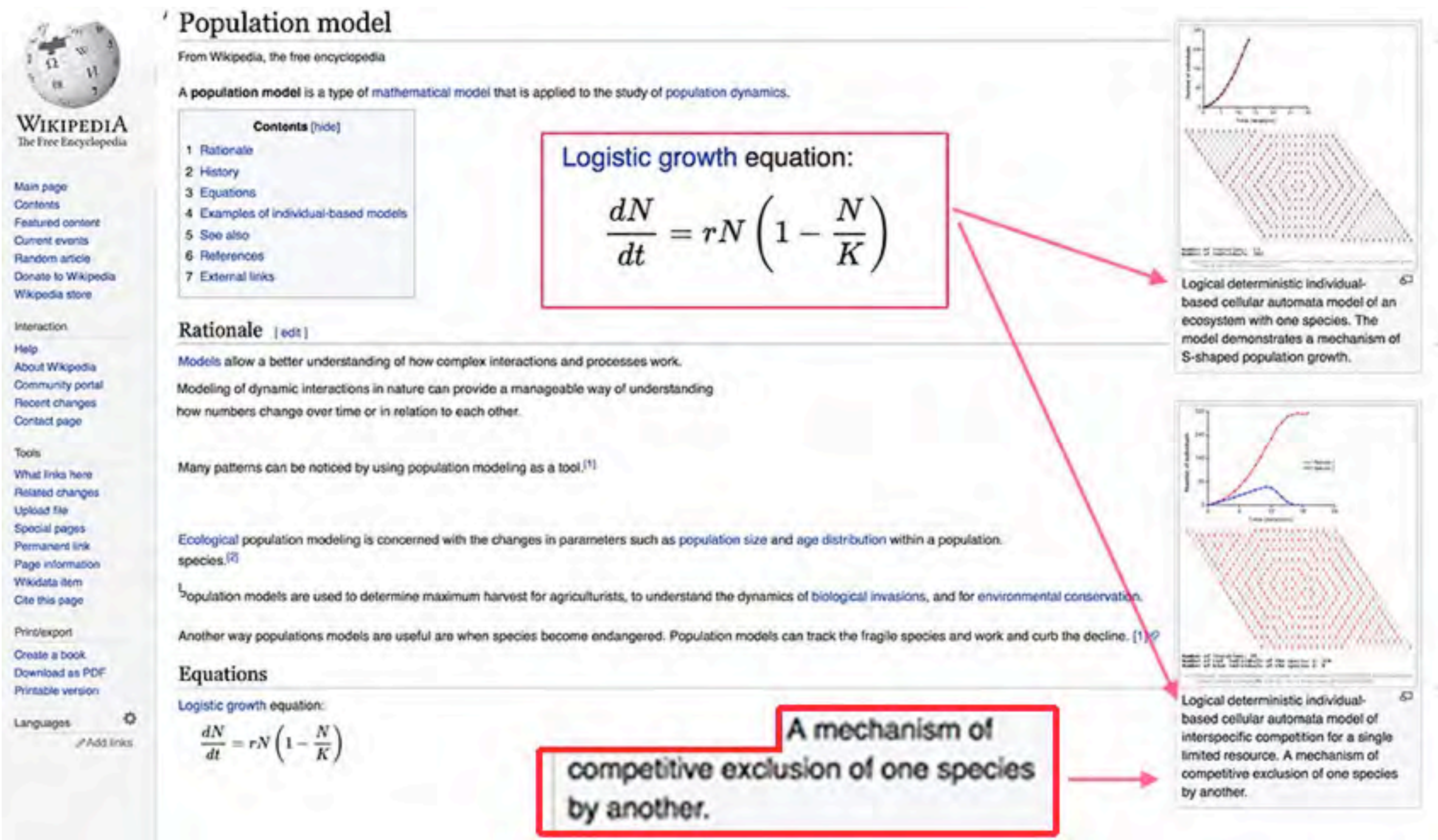
One such model can be found at wiki

By Lev Kalmykov - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=41287678

Reference:
https://en.wikipedia.org/wiki/Population_model#/media/File:Logical_deterministic_individual-based_cellular_automata_model_of_single_species_population_growth.gif

In this model

Logical deterministic individual-based cellular automata model of an ecosystem with one species.



WIKIPEDIA
The Free Encyclopedia

Main page
Contents
Featured content
Current events
Random article
Donate to Wikipedia
Wikipedia store

Interaction
Help
About Wikipedia
Community portal
Recent changes
Contact page

Tools
What links here
Related changes
Upload file
Special pages
Permanent link
Page information
Wikidata item
Cite this page

Print/export
Create a book
Download as PDF
Printable version

Languages
Add links

Population model

From Wikipedia, the free encyclopedia

A **population model** is a type of mathematical model that is applied to the study of population dynamics.

Contents [hide]

Logistic growth equation:

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

Rationale [edit]

Models allow a better understanding of how complex interactions and processes work.

Modeling of dynamic interactions in nature can provide a manageable way of understanding how numbers change over time or in relation to each other.

Many patterns can be noticed by using population modeling as a tool.[1]

Ecological population modeling is concerned with the changes in parameters such as population size and age distribution within a population.

species.[2]

Population models are used to determine maximum harvest for agriculturists, to understand the dynamics of biological invasions, and for environmental conservation.

Another way populations models are useful are when species become endangered. Population models can track the fragile species and work and curb the decline. [1]

Equations

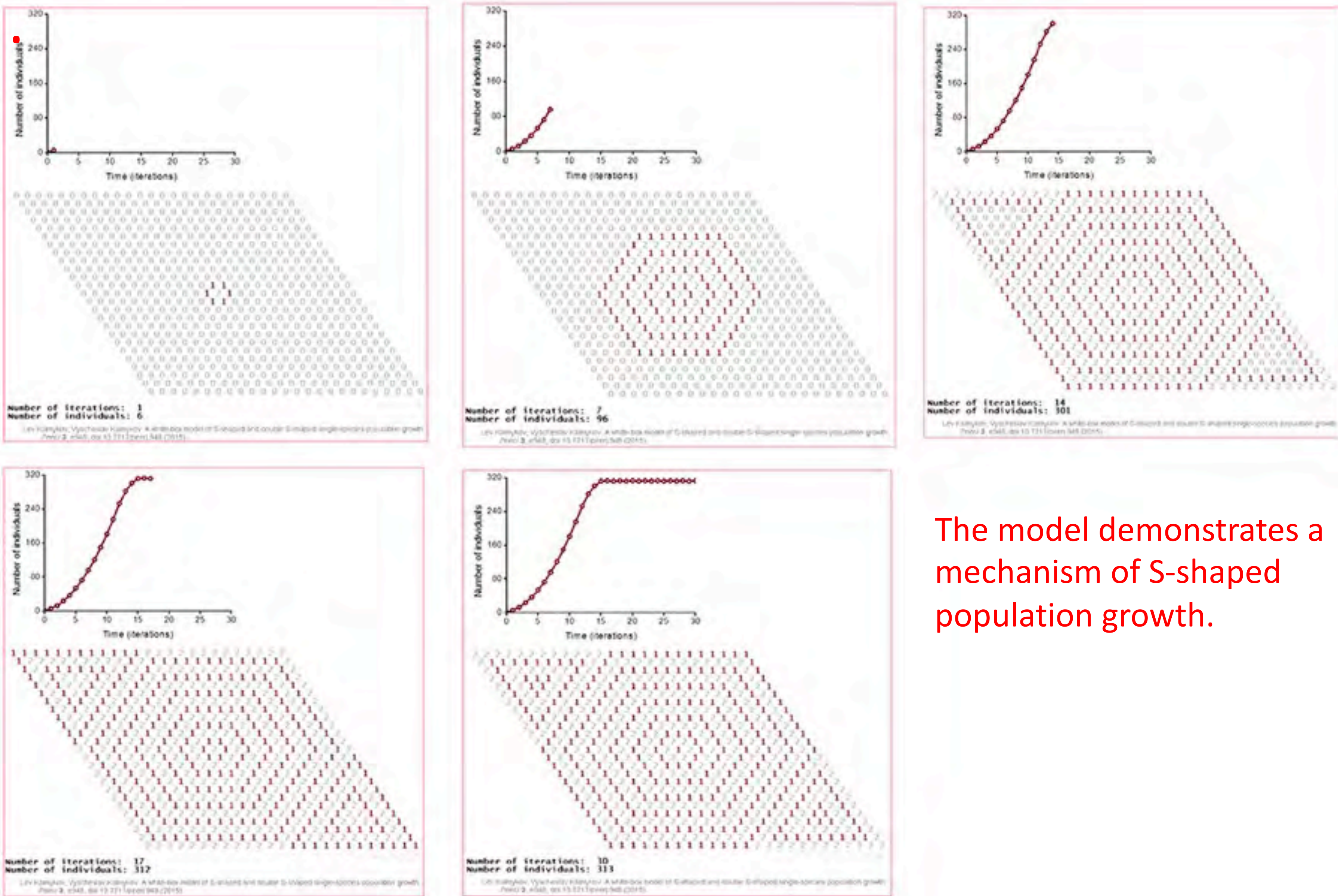
Logistic growth equation:

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

A mechanism of competitive exclusion of one species by another.

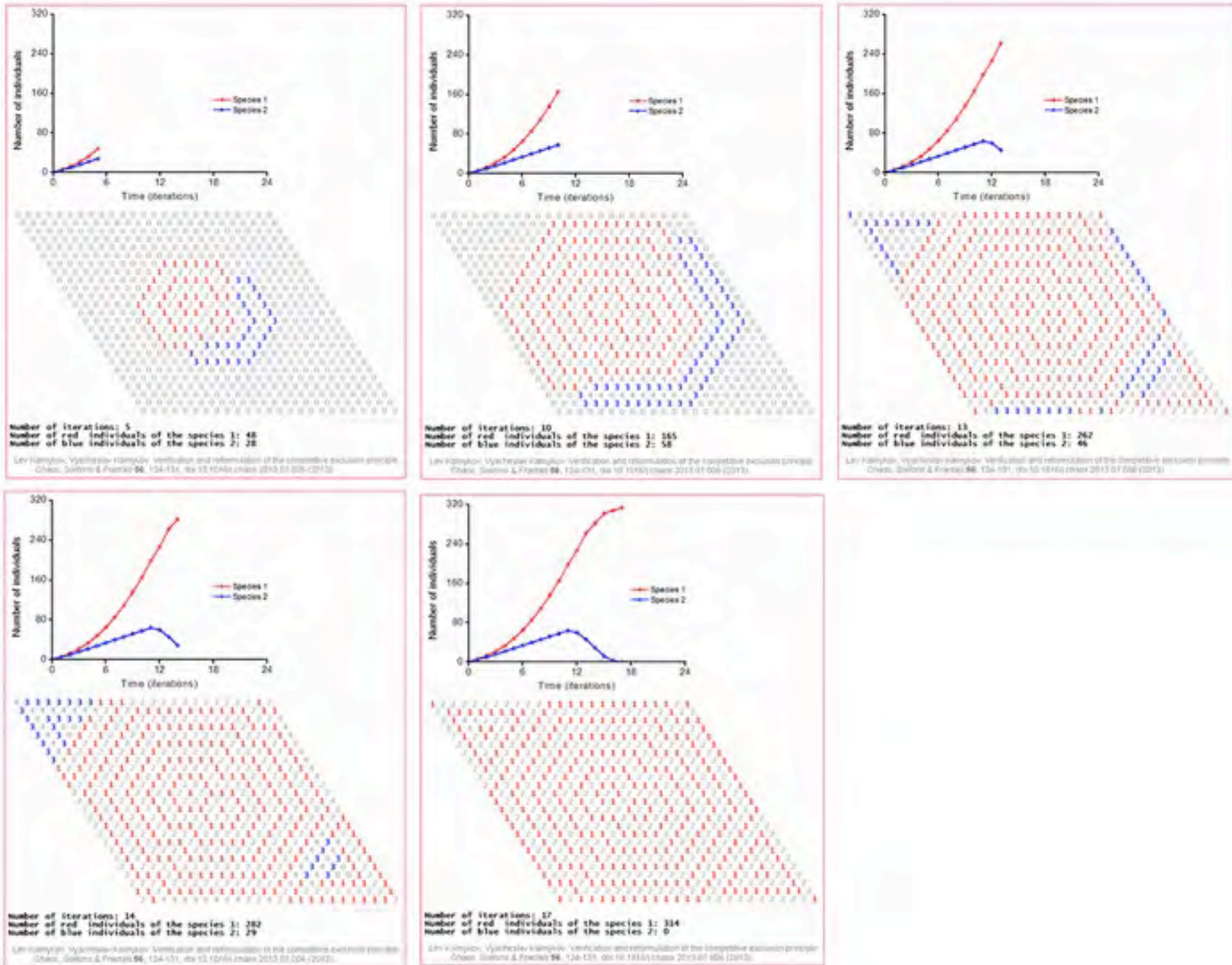
Logical deterministic individual-based cellular automata model of an ecosystem with one species. The model demonstrates a mechanism of S-shaped population growth.

Logical deterministic individual-based cellular automata model of interspecific competition for a single limited resource. A mechanism of competitive exclusion of one species by another.



The model demonstrates a mechanism of S-shaped population growth.

Add a second species and relevant data and the formula will predict which species gets excluded.



So in your data collection you need to look for evidence of this. Look for things like

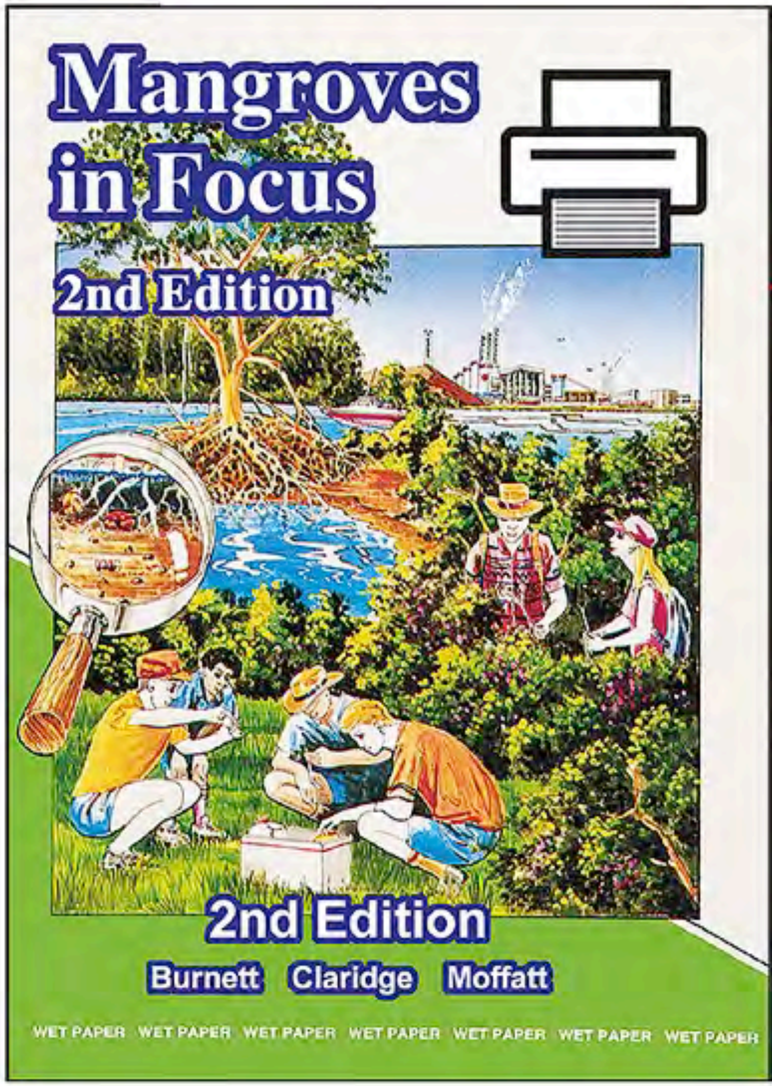
One species of mangrove excludes another.
Soldier crabs exclude mud welks.

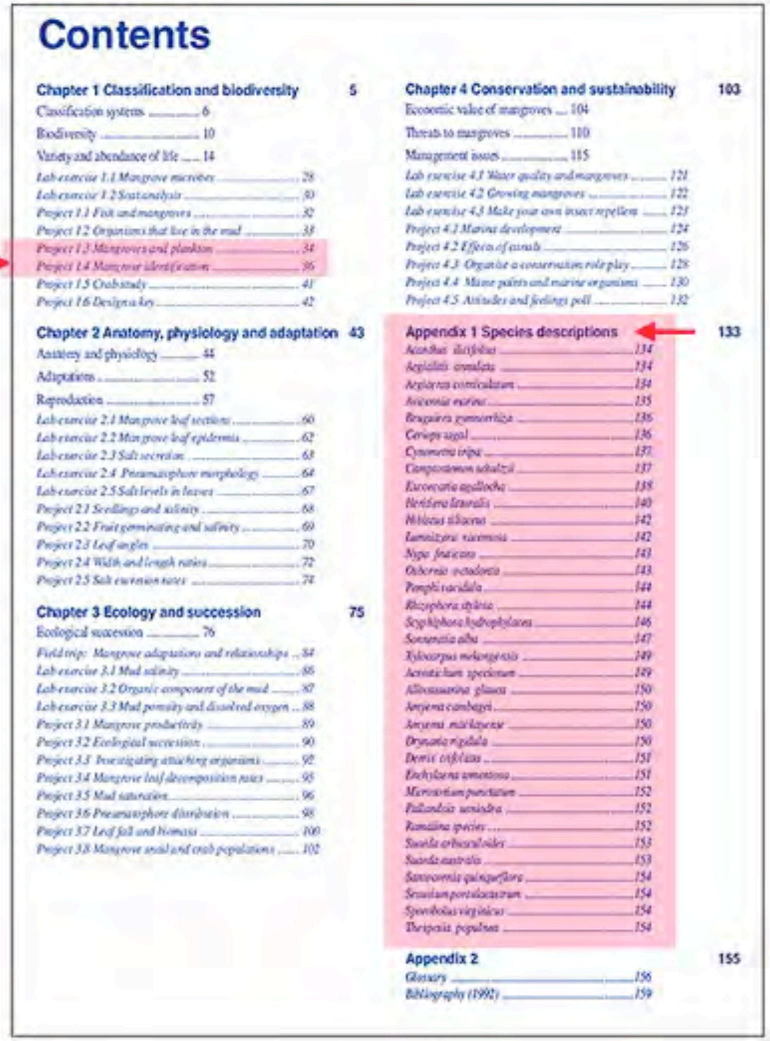
Activities

Estimate the population size and density and the distribution of plants and invertebrates within a local mangrove system e.g. survey count, quadrats, species density, percentage coverage, direct observation.

Use a range of field equipment to measure abiotic factors (light, temperature, salinity) related to mangrove systems in the local area.
(See also rocky shore investigation T056)

Use field guides in mangroves.





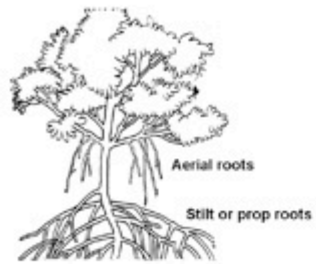
Contents

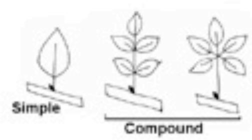
Identify four mangrove species

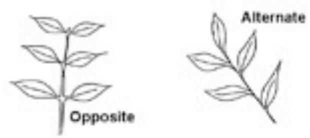
(see page 36)

Morphology key

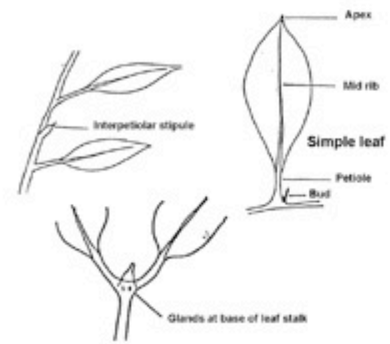
These keys are based on visual identification of plants.

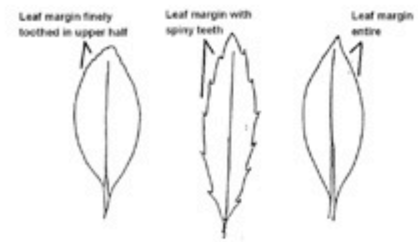


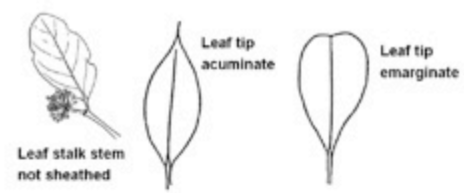


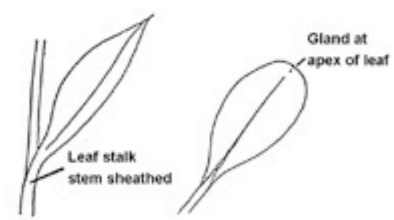


	Characteristic	Genus / species
1.	Stilt roots and/or knee roots present	go to 2
	Stilt roots and/or knee roots absent	go to 3
2.	Aerial prop roots	*Rhizophora* sp.
	No aerial prop roots	*Bruguiera* sp.
3.	Leaves compound	go to 4
	Leaves simple	go to 5
4.	Mid rib vein central	*Xylocarpus* sp.
	Mid rib vein slightly off centre	*Cynometra iripa*
5.	Leaves opposite	go to 6
	Leaves alternate	go to 10
6.	Underside of leaf grey	*Avicennia* sp.
	Underside of leaf not grey	go to 7
7.	Interpetiolar stipules present	*Scyphiphora* sp.
	Interpetiolar stipules absent	go to 8
8.	Leaf stalk with two glands at base	*Sonneratia* sp.
	Leaf stalk without glands at base	go to 9
9.	Leaf margin finely toothed in upper half	*Osbornia* sp.
	Leaf margin with spiny teeth	*Acanthus* sp.
	Leaf margins entire	*Ceriops* sp.
10.	Leaf underside grey	go to 11
	Leaf underside not grey	go to 12
11.	Leaf tip acuminate	*Heritiera* sp.
	Leaf tip emarginate	*Camptostemon* sp.
12	Latex (milky sap) present	*Excoecaria* sp.
	No latex	go to 13
13.	Gland at leaf apex	*Lumnitzera* sp.
	No gland at apex	go to 14
14.	Leaf stalk stem sheathed	*Aegialitis* sp.
	Leaf stalk not sheathed	*Aegiceras* sp.





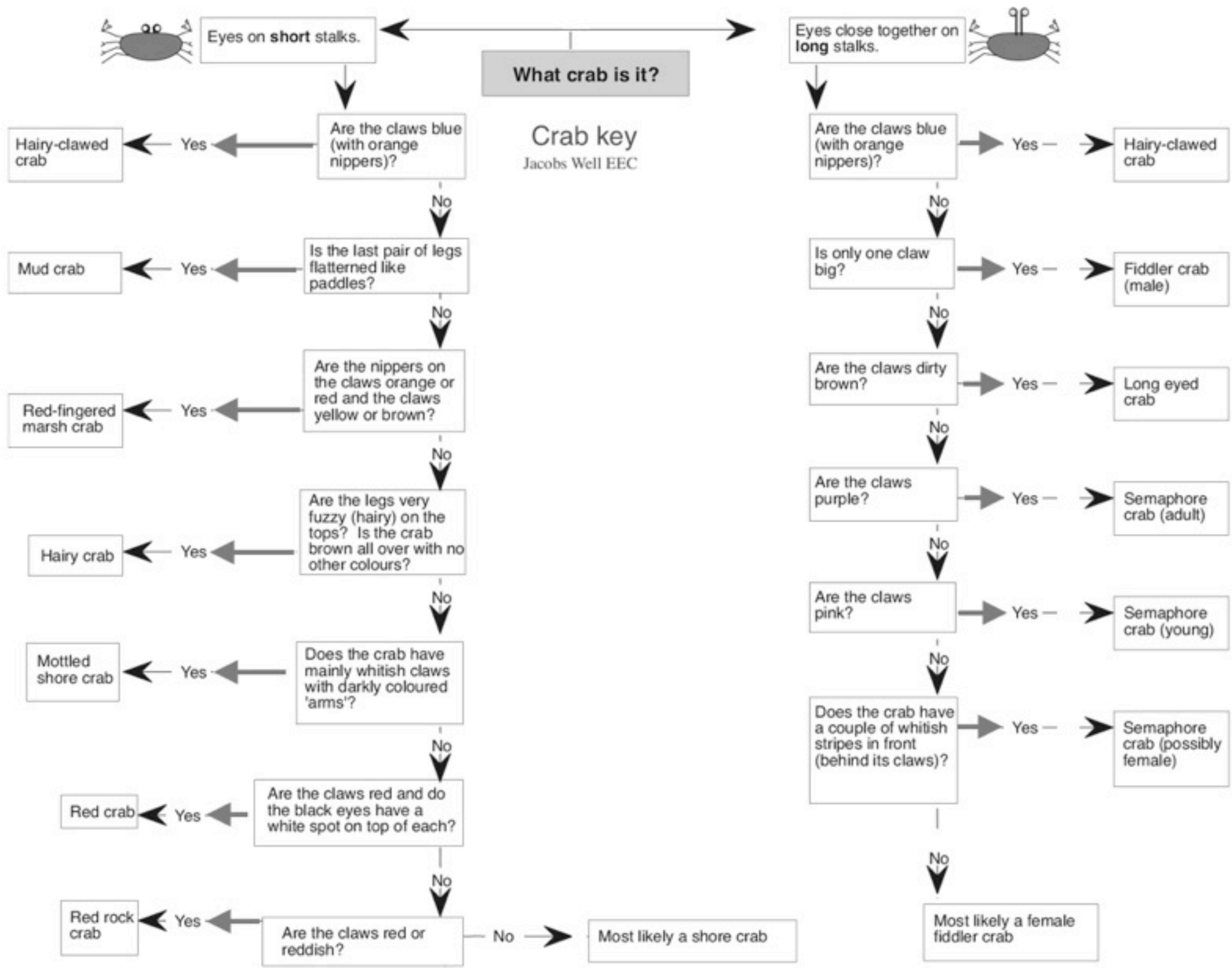




based on an original exercise by staff at Ingham State High School.

Identify three crab species

See page 41



Recall the procedures involved in the identification and construction of food chains and as part of the follow up work from the mangrove field trip, apply this to the mangrove system

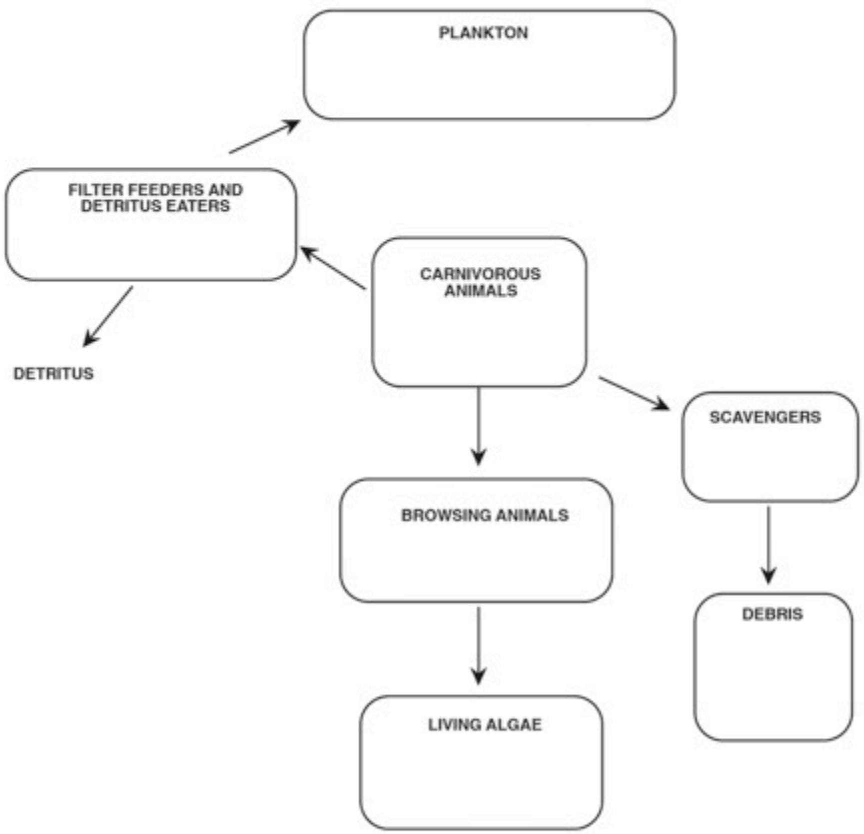
Compile list and sort into categories

(See page 85 Mangroves in focus)

Producers	Herbivores	Predators	Scavengers	Decomposers

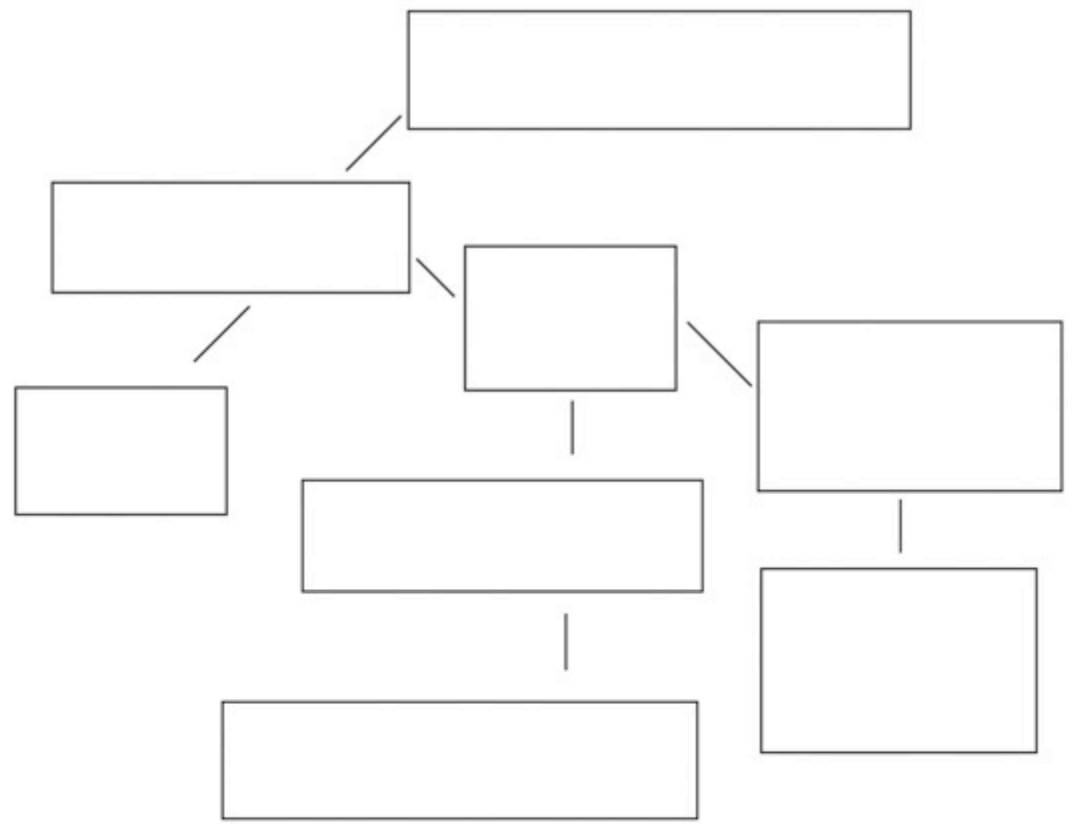
Figure 85.2 Food web table

Use this collated data to identify biotic components of a mangrove ecosystem (i.e. food chains and food webs).
Use the “fill in the boxes method” below devised by Pope and McDonald below to draw a draft food chain.

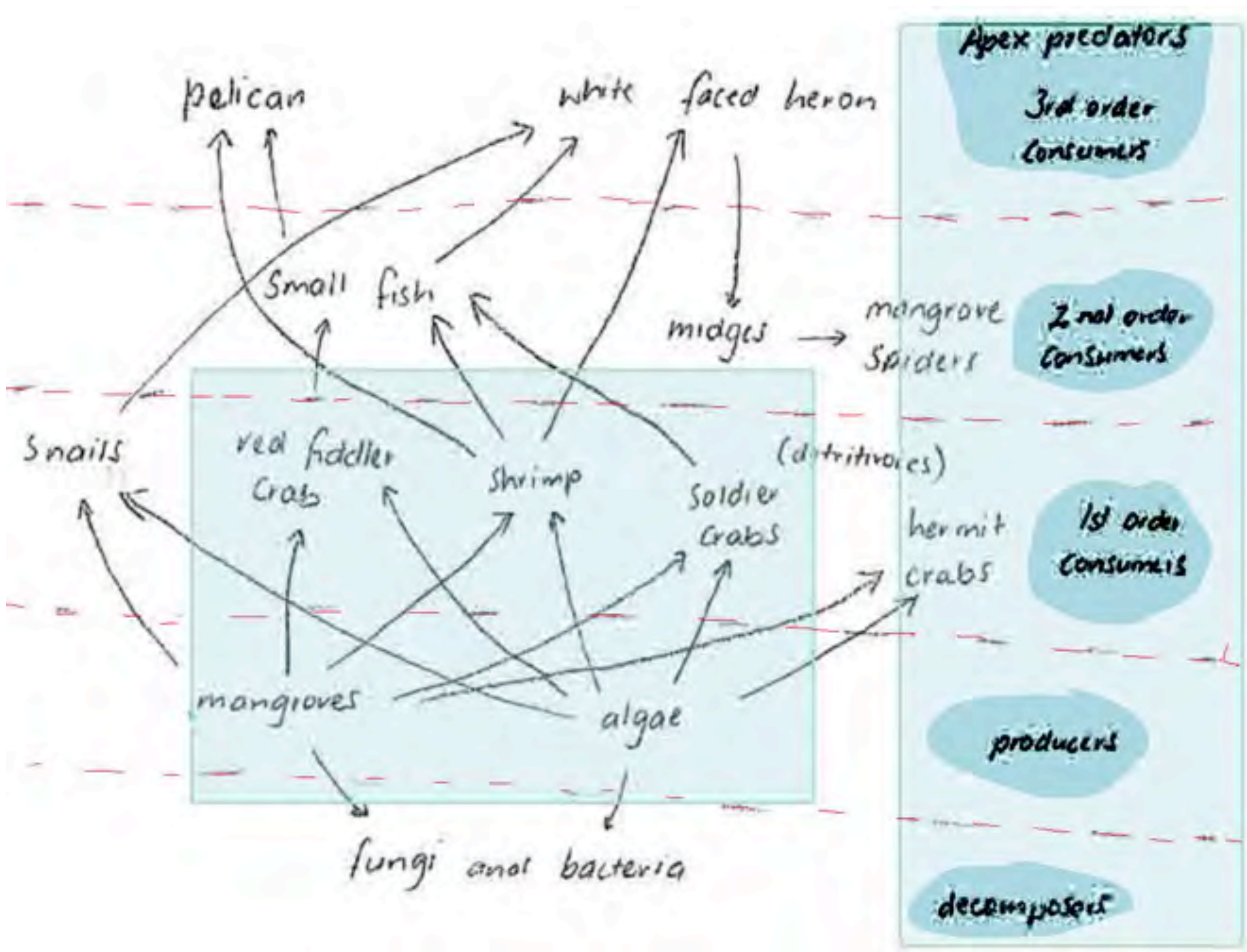


Food relationships of animals (Pope and McDonald (1968) in Below High Water. SA Department.)
Reproduced with permission

Food chain for your data



Now draw lines or use colours to classify organisms in the collated data into trophic levels.



Syllabus says

Identify their niche within the ecosystem.

An ecological niche is

- the role and position a species has in its environment
- how it meets its needs for food and shelter
- how it survives, and reproduces.

Example

Archer Fish spitting at flying insects, using the air above water as a ecological niche.

The Archer fish is using the ecological niche of the " air above water " and has adapted to this niche by being able to spit water at flying insects.

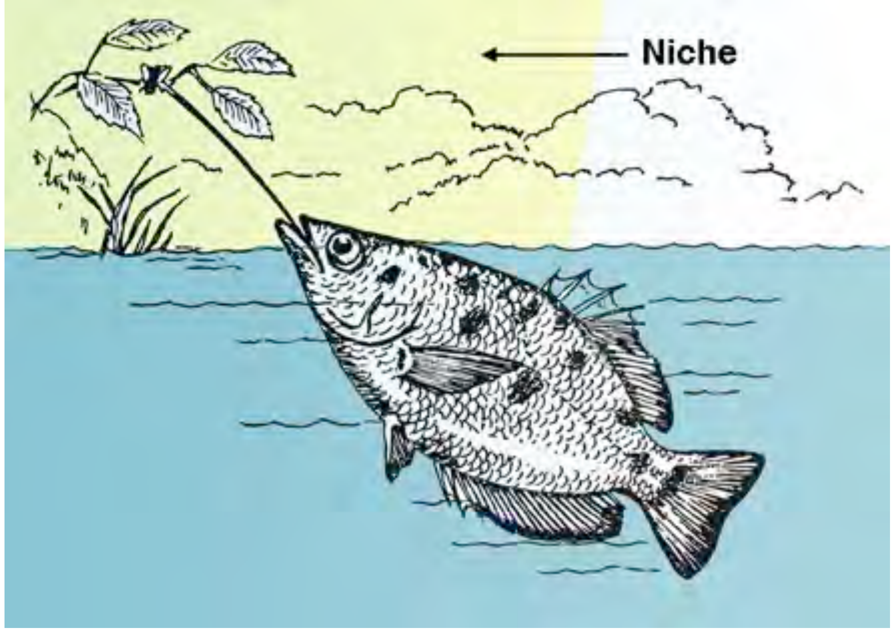


Illustration of an archerfish shooting water at a bug on a hanging branch
By Pearson Scott Foresman - Archives of Pearson Scott Foresman, donated to the Wikimedia FoundationThis file has been extracted from another file: PSF A-50002.png, Public Domain, https://commons.wikimedia.org/w/index.php?curid=3596173

Syllabus says

Identify the niche of the organism listed in the mangroves.

For example

- Crabs are the most abundant and important larger invertebrate in mangroves.
- When building their burrows, crabs improve the penetration of ground water, water from high tides and freshwater runoff.
- This helps to flush out excess salt and reduce soil salinity.
- The burrows also increase oxygen levels in the mud by creating air spaces.

Crab holes also provide a habitat for many organisms, including fish molluscs and worms.Crabs are vital to the recycling of nutrients, in particular nitrogen.

Many crabs eat large amounts of fallen mangrove litter while other species eat algae and detritus.

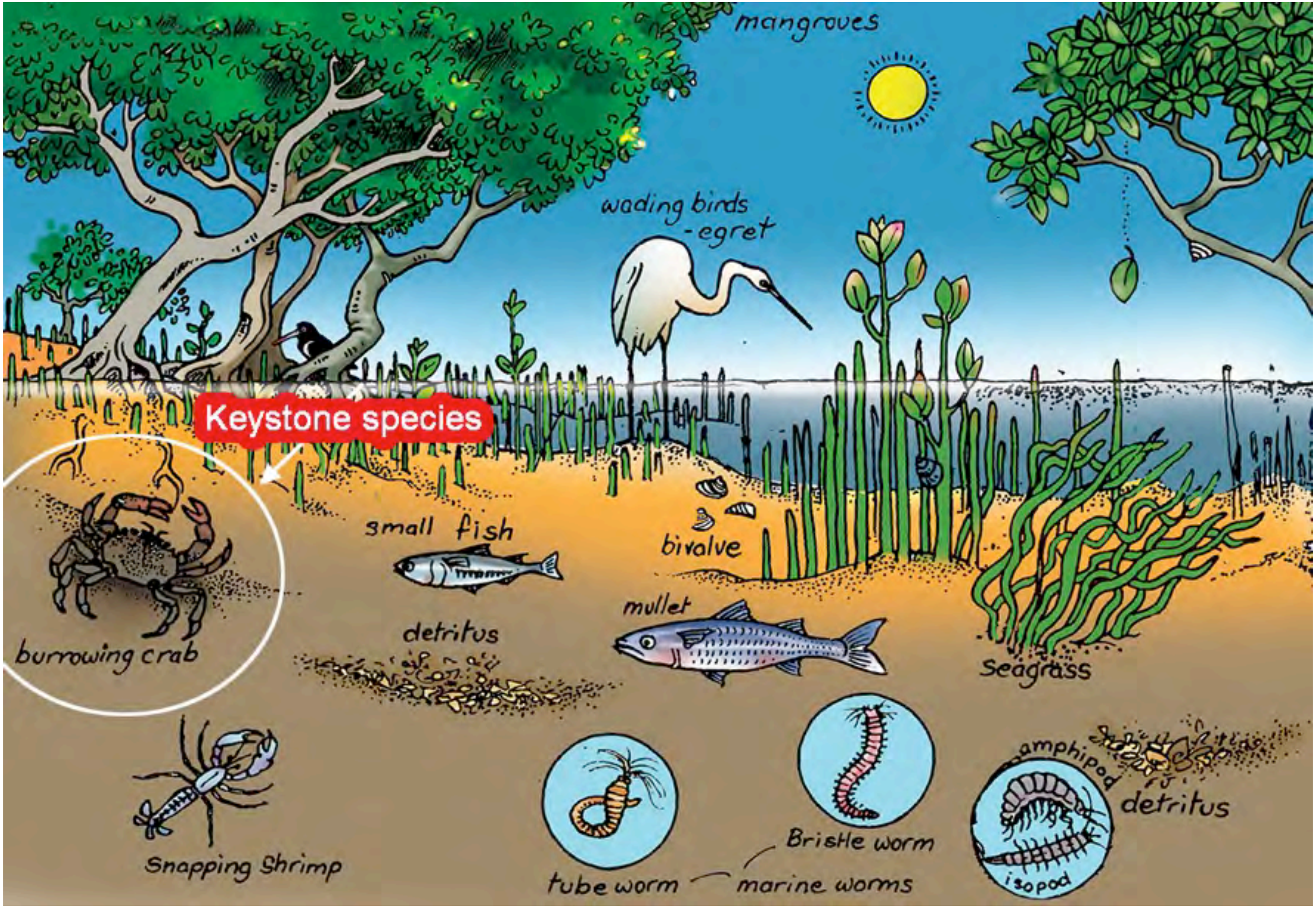
The presence of crabs in these ecosystems has been shown to improve the growth of mangrove plants, and also increases the biomass and diversity of other organisms.

The syllabus says

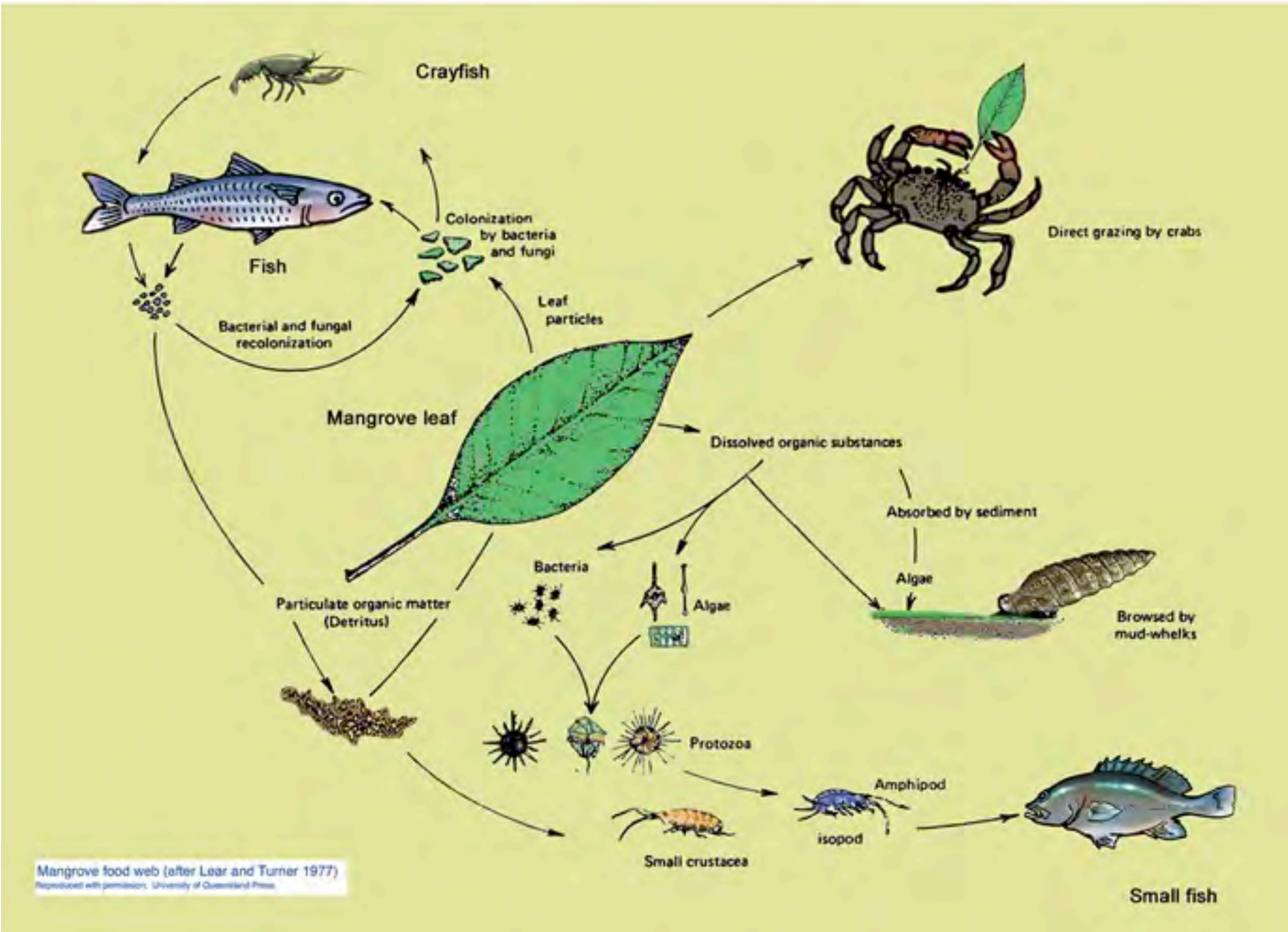
Use the observations and secondary sources to identify keystone species in the mangrove ecosystem, providing evidence based on research and collected data to support these statements.

Observation

Why are there no leaves on a mangrove boardwalk? Do crabs eat them at night and if so are they a keystone species?

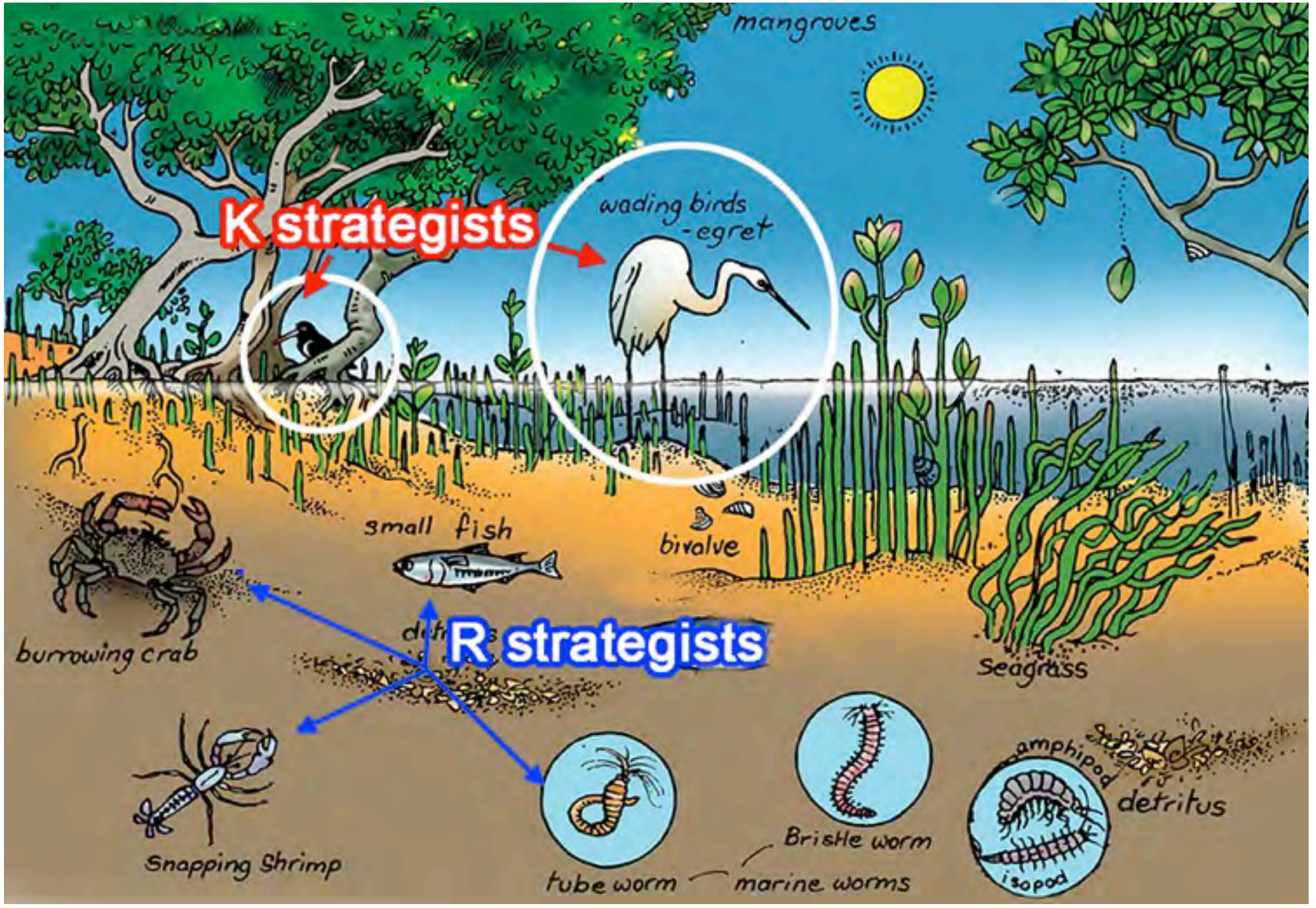

mangroves
wading birds
-egret
Keystone species
small fish
bivalve
burrowing crab
mullet
detritus
seagrass
amphipod
detritus
Snapping Shrimp
Bristle worm
tube worm
marine worms
isopod

Principal role as a keystone species is to recycle carbon. There are many others.

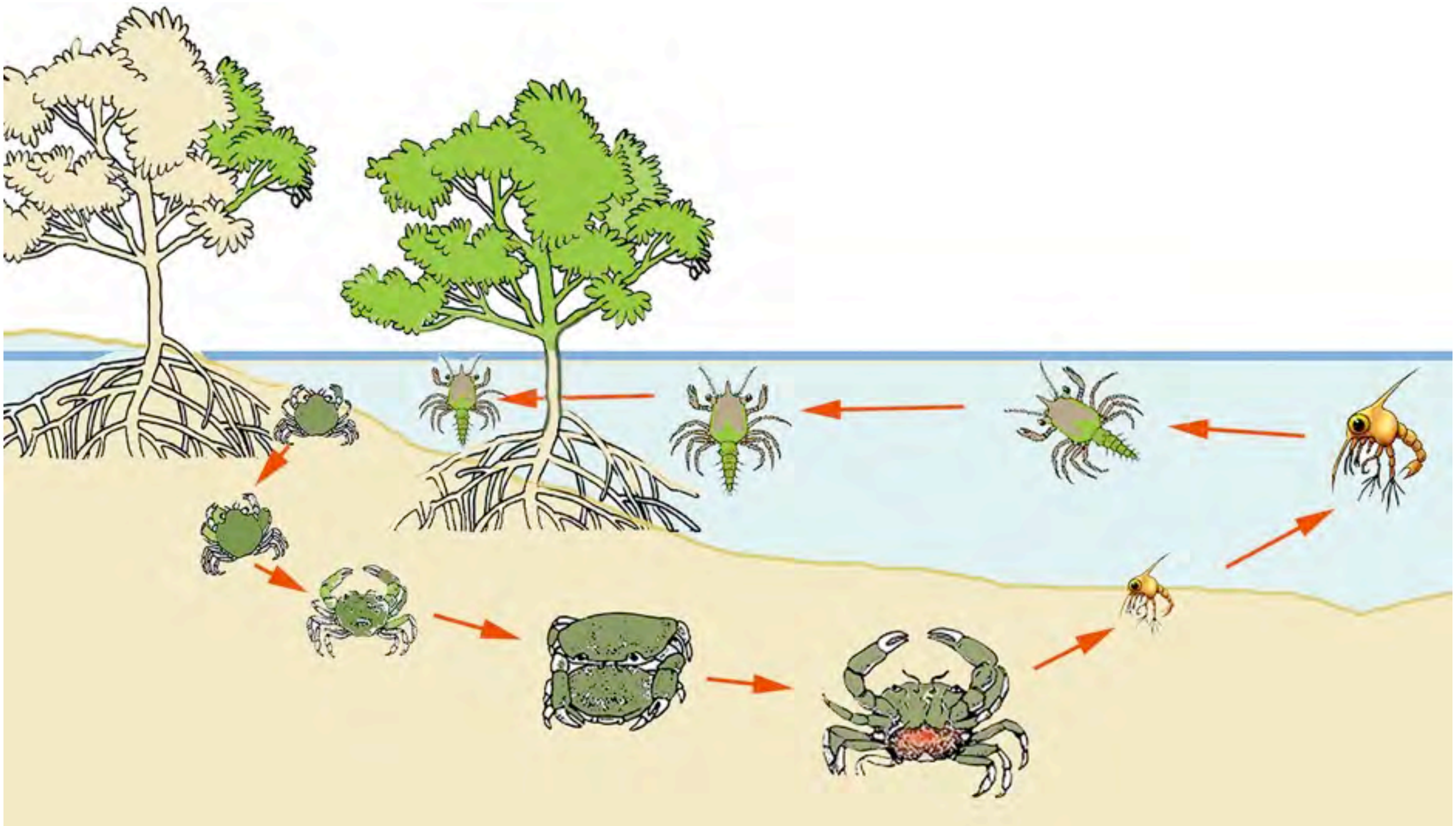


Use the observations and secondary sources to identify k and r strategists in the mangrove ecosystem, providing evidence based on research and collected data to support these statements.

K-selection strategy, with few offspring, long gestation, long parental care, and a long period until sexual maturity.



Crabs have a *r*-selection strategy, with many offspring, short gestation, less parental care, and a short time until sexual maturity.



Using examples from the mangrove ecosystem food web analyse the flow of toxic non-biodegradable material through a food web.

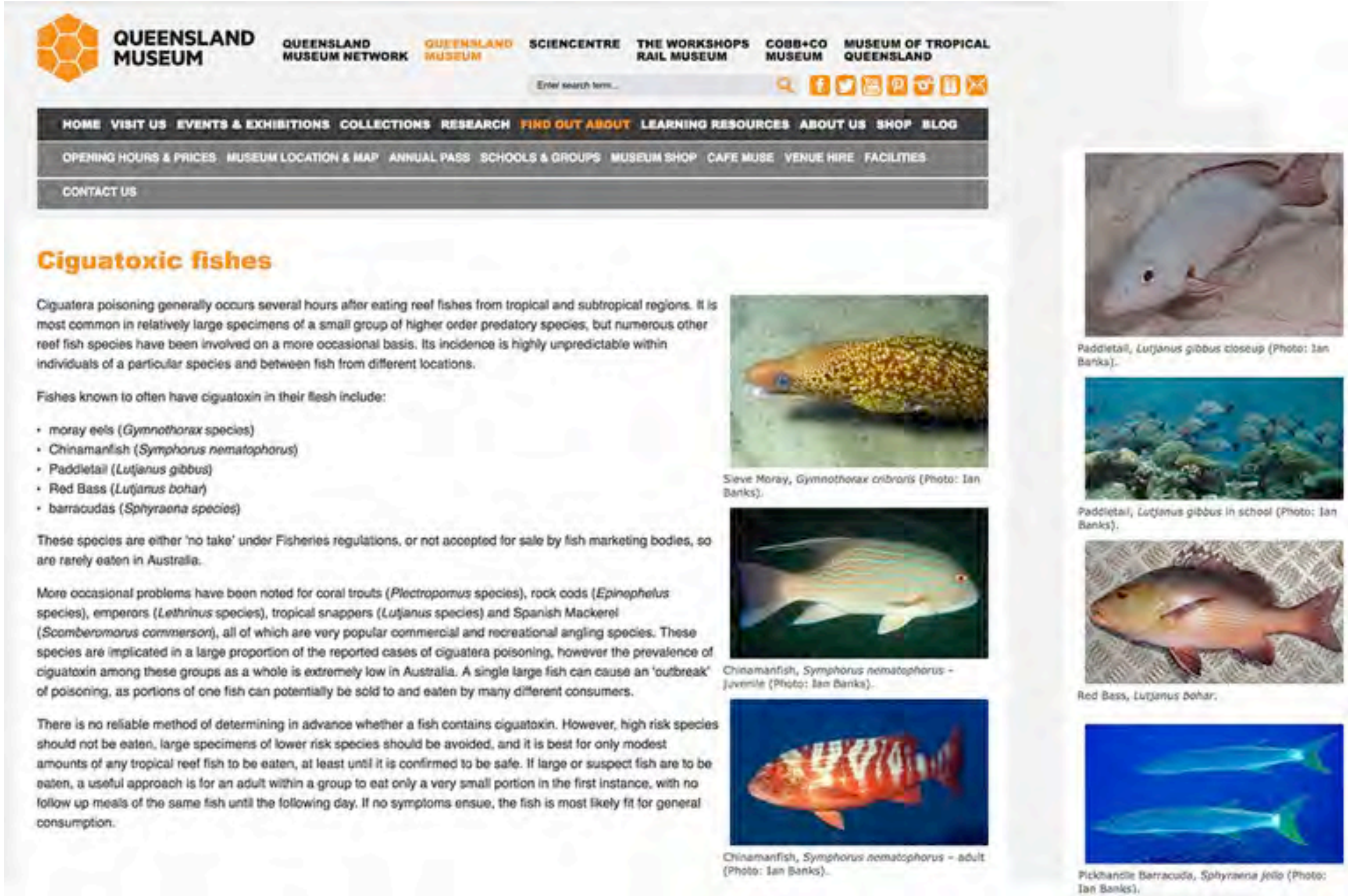
Consider the sediment concentration of heavy metals and PCBs (bioaccumulation).

The syllabus says include ciguatera as a further example of bioaccumulation.

Look at the photos below and if one of these fish are found in the mangroves, include it in your discussions.

Refer back to Topic T048

Search for ciguatera


QUEENSLAND MUSEUM

QUEENSLAND MUSEUM NETWORK | QUEENSLAND MUSEUM | SCIENCENTRE | THE WORKSHOPS RAIL MUSEUM | COBB+CO MUSEUM | MUSEUM OF TROPICAL QUEENSLAND

HOME | VISIT US | EVENTS & EXHIBITIONS | COLLECTIONS | RESEARCH | FIND OUT ABOUT | LEARNING RESOURCES | ABOUT US | SHOP | BLOG

OPENING HOURS & PRICES | MUSEUM LOCATION & MAP | ANNUAL PASS | SCHOOLS & GROUPS | MUSEUM SHOP | CAFE MUSE | VENUE HIRE | FACILITIES

CONTACT US

Ciguatoxic fishes

Ciguatera poisoning generally occurs several hours after eating reef fishes from tropical and subtropical regions. It is most common in relatively large specimens of a small group of higher order predatory species, but numerous other reef fish species have been involved on a more occasional basis. Its incidence is highly unpredictable within individuals of a particular species and between fish from different locations.

Fishes known to often have ciguatoxin in their flesh include:

- moray eels (*Gymnothorax* species)
- Chinamanfish (*Symphorus nematophorus*)
- Paddletail (*Lutjanus gibbus*)
- Red Bass (*Lutjanus bohar*)
- barracudas (*Sphyraena species*)

These species are either 'no take' under Fisheries regulations, or not accepted for sale by fish marketing bodies, so are rarely eaten in Australia.

More occasional problems have been noted for coral trouts (*Plectropomus* species), rock cods (*Epinephelus* species), emperors (*Lethrinus* species), tropical snappers (*Lutjanus* species) and Spanish Mackerel (*Scomberomorus commerson*), all of which are very popular commercial and recreational angling species. These species are implicated in a large proportion of the reported cases of ciguatera poisoning, however the prevalence of ciguatoxin among these groups as a whole is extremely low in Australia. A single large fish can cause an 'outbreak' of poisoning, as portions of one fish can potentially be sold to and eaten by many different consumers.

There is no reliable method of determining in advance whether a fish contains ciguatoxin. However, high risk species should not be eaten, large specimens of lower risk species should be avoided, and it is best for only modest amounts of any tropical reef fish to be eaten, at least until it is confirmed to be safe. If large or suspect fish are to be eaten, a useful approach is for an adult within a group to eat only a very small portion in the first instance, with no follow up meals of the same fish until the following day. If no symptoms ensue, the fish is most likely fit for general consumption.

Sieve Moray, *Gymnothorax cribroris* (Photo: Ian Banks).

Chinamanfish, *Symphorus nematophorus* – juvenile (Photo: Ian Banks).

Chinamanfish, *Symphorus nematophorus* – adult (Photo: Ian Banks).

Paddletail, *Lutjanus gibbus* closeup (Photo: Ian Banks).

Paddletail, *Lutjanus gibbus* in school (Photo: Ian Banks).

Red Bass, *Lutjanus bohar*.

Pickhandle Barracuda, *Sphyraena jello* (Photo: Ian Banks).

http://www.qm.qld.gov.au/Find+out+about/Animals+of+Queensland/Fishes/Fish+poisoning/Ciguatoxic+fishes#.W58q4JMzbUZ

The syllabus says

Recall carbon cycle and relate this to build up of organic matter and the productivity of the mangrove system. Use this as a starting point.

Executive summary

Carbon production

- Mangrove net primary production averages 11.1 t dry weight ha^{-1} year^{1}, roughly equivalent to tropical terrestrial forests.
- Mangroves may constitute a carbon sink for up to a century.

Carbon allocation & storage

- Belowground biomass is equivalent to aboveground biomass in mangroves.
- Most carbon in mangroves is stored as large pools of soil carbon and belowground roots.
- Storage of carbon in mangroves averages 937 tC ha^{-1}.

Mechanisms facilitating sediment accretion

- Mangroves actively facilitate accumulation of carbon and other elements associated to fine particles.

Rates of soil accretion & carbon sequestration

- Rates of soil accretion in mangroves average 5 mm year^{-1}.
- Frequency if tidal inundation is the main factor controlling accretion.
- Global carbon burial rates for mangroves approximate 24 TgC year^{-1}.

Significance of mangroves to terrestrial & marine carbon sequestration

- Mangroves account for 3% of carbon sequestered by the world's tropical forests, but 14% of carbon sequestered in the world's ocean.
- If disturbed, mangroves may emit 0.02–0.12 PgC year^{-1}, equal to 2–10% of global deforestation emissions.

Future perspective

- Mangroves are prime candidates for REDD+ and blue carbon projects, but a number of issues and specific actions must be carefully addressed prior to commencement of such projects.

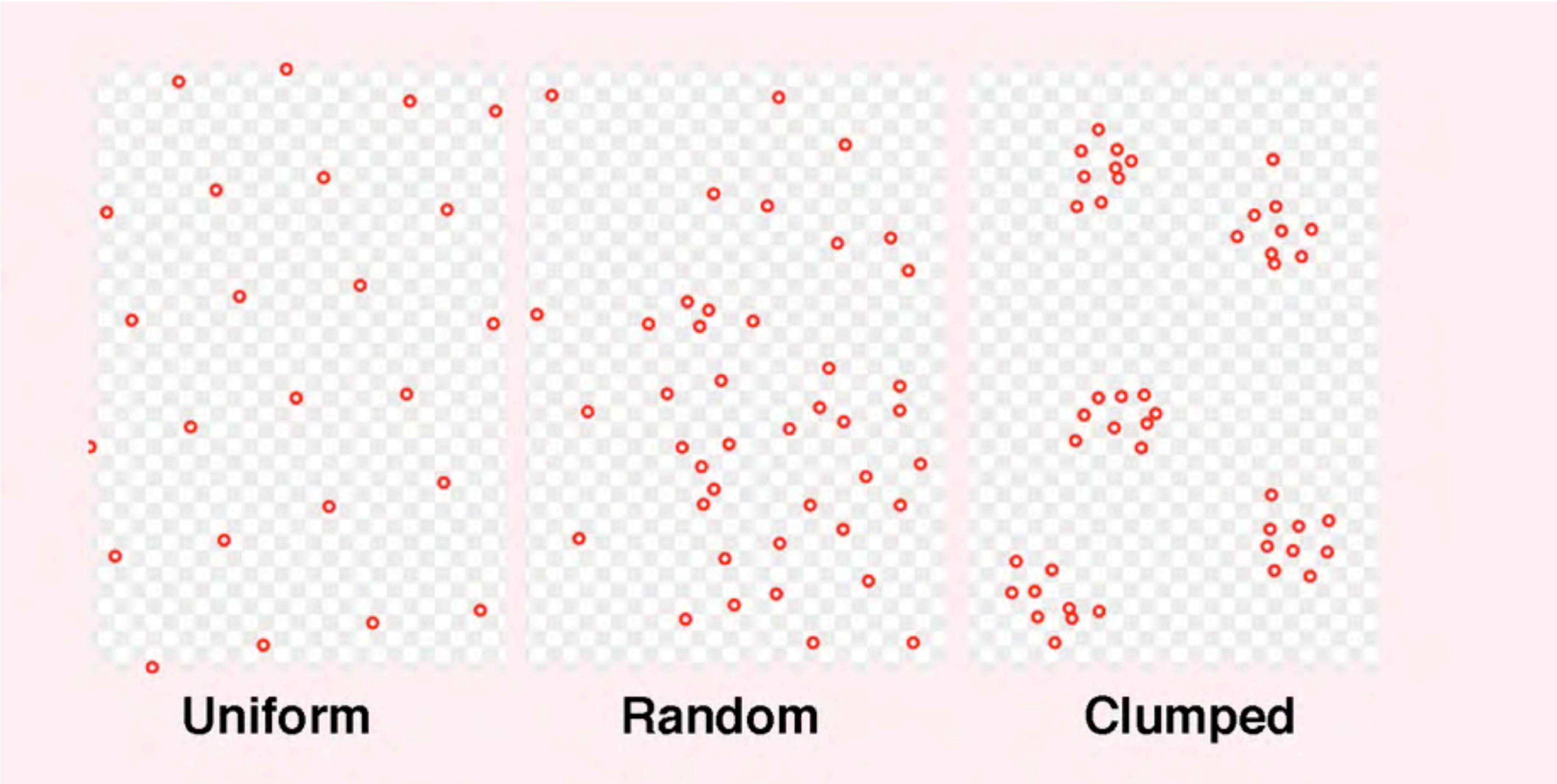
https://www.researchgate.net/publication/274116107_Carbon_sequestration_in_mangrove_forests

Use collected data to construct transect graphs that compare the distribution (i.e. clumped, uniform, random) and species diversity of the local mangrove system to Systems in northern Queensland and South East Queensland.

Variable	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5
Height above low tide mark (m)					
Wind direction N,N/E etc					
Wind speed km/hr					
Air temperature °C					
Mud temperature °C					
Relative humidity %					
Mud composition					
Mud salinity					
Mud pH					
Light intensity (canopy)					
Light intensity (ground level)					
Ground cover %					

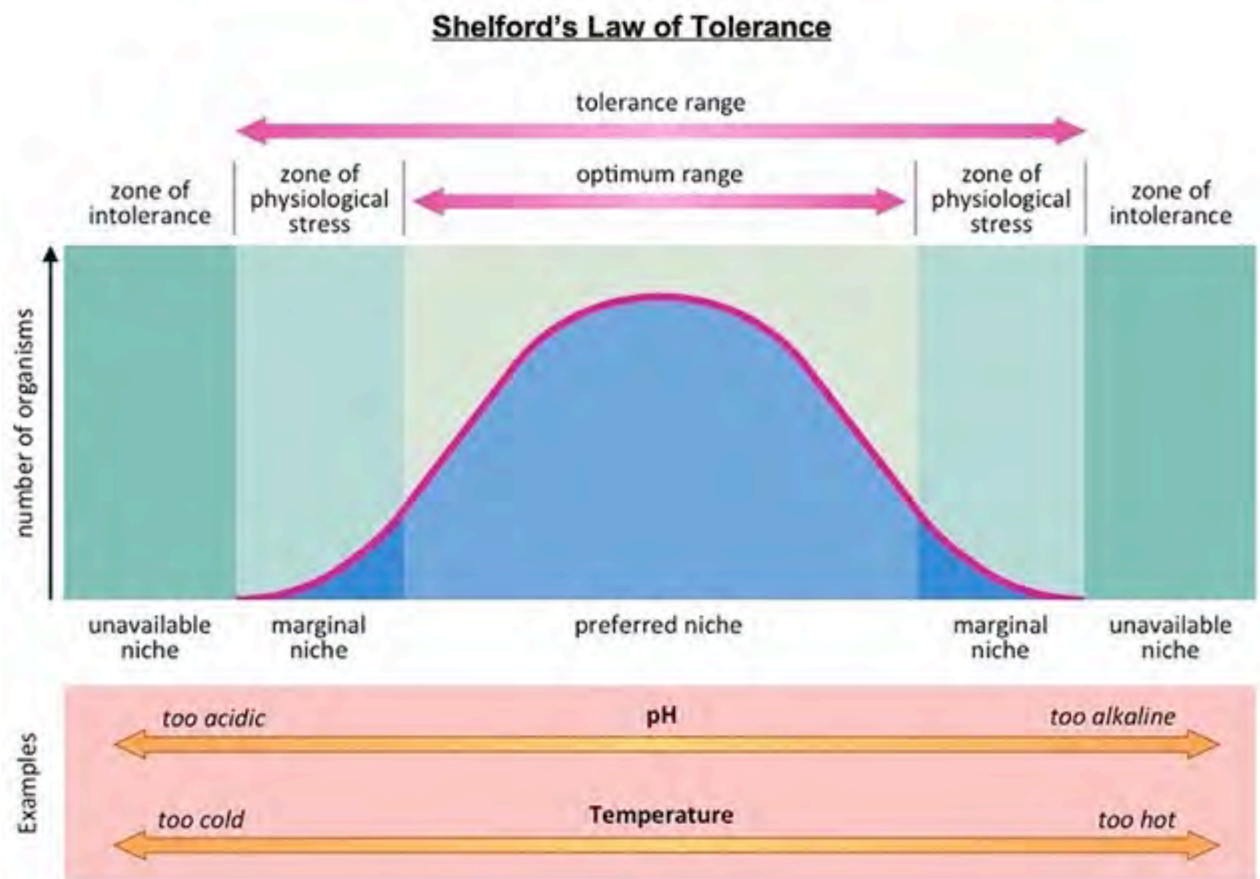
Variable	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5
Animals present					
Mangrove species present					
Other plant species					

Remember Topic T049

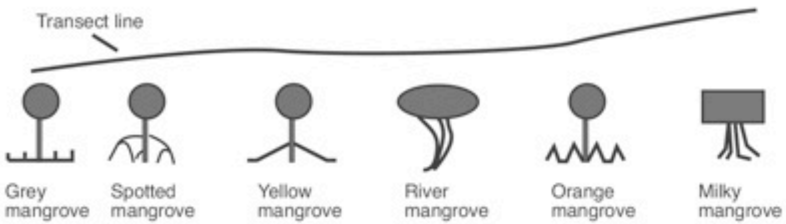


Relate the distribution of mangrove species to the limiting factors and tolerance limits.
Add data from table and comment on zonation.

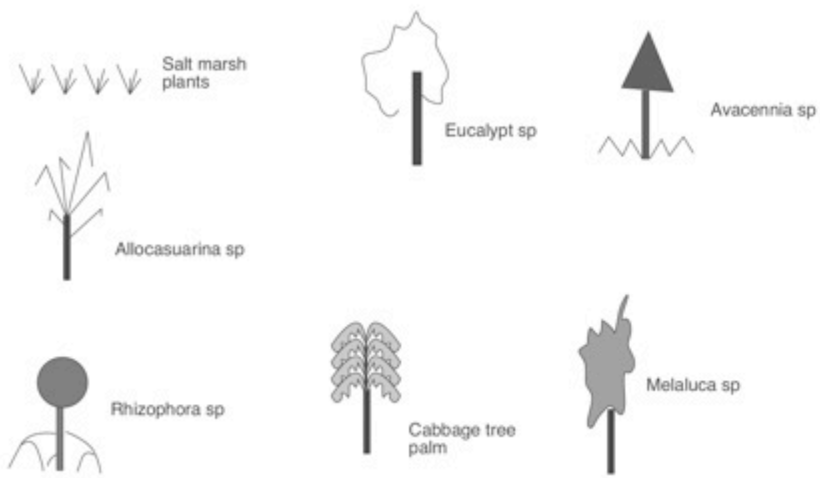
Variable	Quadrat 1	Quadrat 2
Height above low tide mark (m)		
Wind direction N,N/E etc		
Wind speed km/hr		
Air temperature ^{o}C		
Mud temperature ^{o}C		
Relative humidity %		
Mud composition		
Mud salinity		
Mud pH		
Light intensity (canopy)		
Light intensity (ground level)		

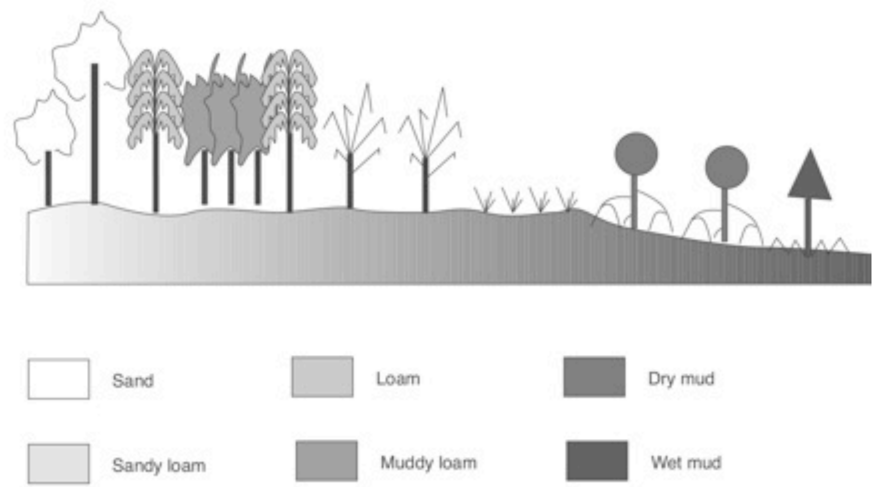


Illustrate your answer



Profile suggestions





Vegetation profile (Example)

Using secondary sources examine J curve distribution patterns, predator-prey graphs to draw conclusions about population changes and carrying capacity.

Remember

J-shaped growth curve A curve on a graph that records the situation in which, in a new environment, the population density of an organism increases rapidly in an exponential (logarithmic) form, but then stops abruptly as environmental resistance (e.g. seasonality) or some other factor (e.g. the end of the breeding phase) suddenly becomes effective.

It may be summarized mathematically as: $dN/dT = r$ (with a definite limit on N) where N is the number of individuals in the population, T is time, and r is a constant representing the biotic potential of the organism concerned.

Population numbers typically show great fluctuation, giving the characteristic 'boom and bust' cycles of some insects, or the pattern seen in algal blooms.

This type of population growth is termed 'density-independent' as the regulation of growth rate is not tied to the population density until the final crash.

Compare S-shaped growth curve.

Good luck