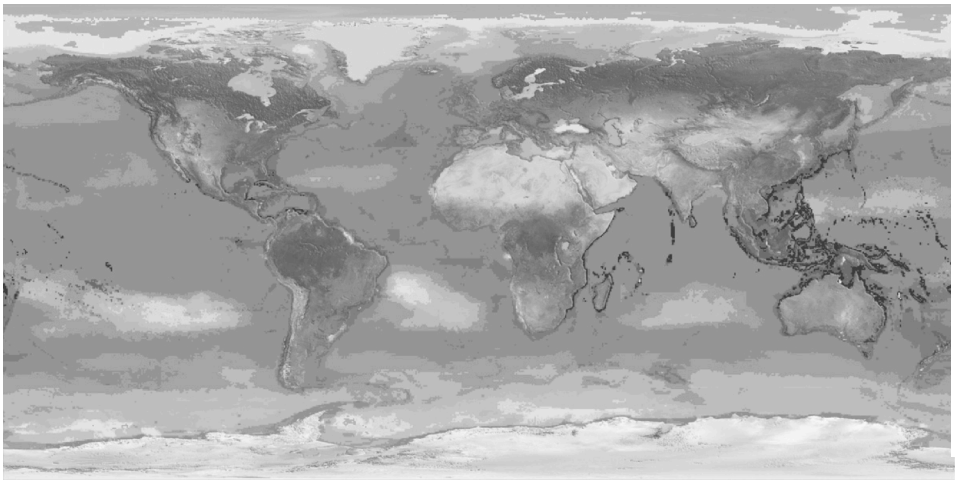
Answers to data response and decision making exercises

1. Examine the map of marine species diversity below. This is available in colour in the Student Book (Figure 5.10).



Species No.
3209–7867
1309–3208
534–1308
219–533
90–218
37–89
16–36
7–15
3–6
1–2

Fig. 5.13 Marine species diversity.

a) Describe the global distribution of marine species.
The main concentrations of marine species are found in shallower waters around the continental shelf and in the tropics. There are lower concentrations in cooler polar waters and areas of the South Atlantic and South Pacific oceans.

b) Identify three key areas where major concentrations of fish populations are found.
Three key areas that have major concentrations of fish populations are in coastal waters, around coral reefs and in the shallow waters on the continental shelf – particularly where ocean currents cause upwelling of water.

c) Using the map above and figures 5.11–5.13 in the Student Book, suggest reasons for the distribution of major marine species.
In coastal areas where upwelling occurs, nutrients are brought to the surface. This stimulates photosynthesis and leads to the development of high concentrations of marine species. In areas of shallow warm water around reefs and oceanic islands, the sunlight can penetrate the shallow water to the seafloor. This also stimulates photosynthesis of phytoplankton which leads to the development of complex food webs and greater biodiversity.

d) What is the global ocean conveyor?
The global ocean conveyor is the description given to the movement of water around the oceans in a continuous motion. The warm water from the equator moves towards the polar regions where it cools and becomes saltier and more dense. This water then sinks to the seabed and moves back towards the equator. It is estimated that water takes 1000 years to complete one full circuit of the global conveyor.

e) Describe the oceanic temperature conditions in the Pacific Ocean in an El Niño event. How does this differ from a normal year?

In an El Niño event, ocean temperatures rise in the eastern Pacific Ocean off the coast of South America. In a normal year, easterly trade winds push the warmer water to the western pacific. This allows cool water upwelling to occur which lowers the ocean temperatures off the western coast of South America.

f) Outline the impact of El Niño on marine fisheries along the western coast of South America.

In an El Niño year the warming of the eastern Pacific Ocean means sea temperatures become between 4 °C and 8 °C warmer than normal. This reduces the upwelling of cold water, which reduces the productivity of the ecosystems and causes fish to reproduce in fewer numbers or migrate elsewhere. The loss of fish has a devastating effect on the economies of countries along the coast. There have been a number of occasions where overfishing off the coast of Peru during an El Niño event has caused fish stocks of Peruvian anchoveta to completely collapse – with a reduction in the catch of up to 80 per cent. In Peru, an El Niño year often reduces gross national income by 5 per cent.

2. The graph below shows the data of global fish production over time.

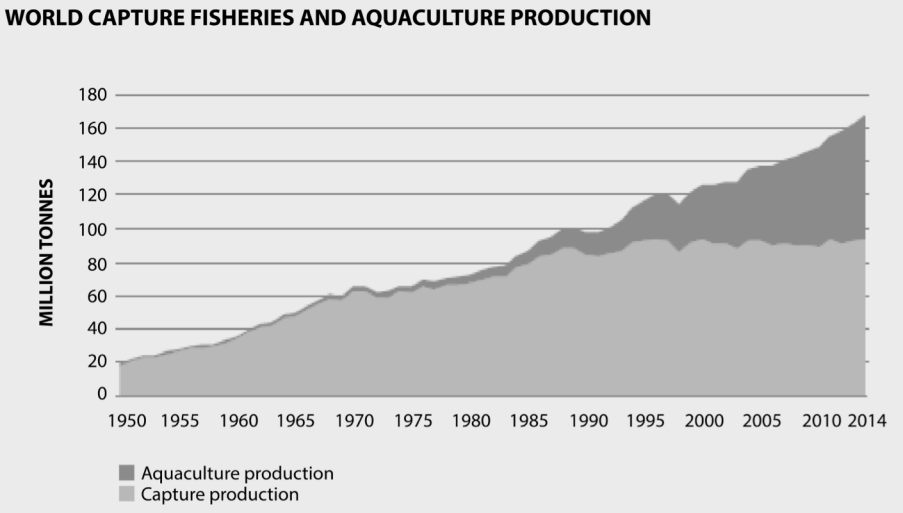


Fig. 5.14 World capture fisheries and aquaculture production.

a) Describe the trend in total fish production over time.

Since 1950 there has been a significant rise in total fish production from 20 million tonnes to 168 million tonnes in 2014. From 1970 there has been steady then rapid growth in the amount of fish produced by aquaculture. In 2014 this made up approximately 70 million tonnes of the total.

b) Suggest reasons for the increase in global fish production over time.

Global population rise has meant there has been a significant increase in demand for marine products. This, coupled with improvements in technology, increases in boat size and the ability to refrigerate goods for long periods whilst out at sea has led to a significant industrialisation of fish production. These factors combined could account for the increase in fish production.

c) Describe what has happened to production from world capture fisheries since 1980?
Since 1980, production from world capture fisheries has seen very little growth. From 1980 to 1990, there was an increase from 70 to 83 million tonnes. Since then, production has been fluctuating around this figure.

d) Define the term aquaculture.
Aquaculture is the rearing of aquatic animals or the cultivation of aquatic plants for food.

Aquaculture is now an important part of global fish production – meeting the dietary needs of millions of people. In 2014, 73.8 million tonnes (or 44.1 per cent of the global total) of fish was produced by aquaculture, with an estimated value of US$160.2 billion. Almost all fish produced from aquaculture are destined for human consumption. Thirty-five countries produced more farmed than wild-caught fish in 2014. This group of countries has a combined population of 3.3 billion, or 45 per cent of the world's population.

e) Outline the advantages and disadvantages of aquaculture production:

Advantages of aquaculture	**Disadvantages of aquaculture**
• A global supply of marine products can increase to meet demand. • Employment is generated in coastal aquaculture areas. • Large profits stimulate the local economy in often rural areas, which suffer a lack of investment. • Controlled water quality and protection against predators ensure stocks survive. • Regular feeding and selective breeding can lead to more rapid growth than wild fisheries. • Fish farming could fulfil the protein needs of millions of people in developing countries.	• Larger farmed fish are fed pellets made of fish oil and fishmeal that come from small ocean fish such as anchovy. These are small wild fish, caught with fine mesh nets, leading to bycatch. • Every 1 kg of salmon produced requires, on average, two to three times their weight of wild-caught fish. • Removing smaller species of fish can damage food webs, leading to impacts on larger fish. • Waste from fish cages and uneaten food is deposited on the sea floor, causing sea floor pollution and a reduction in water quality, if unmanaged. • There can be possible impacts on sensitive habitats and species in polluted areas. • Fish are more closely packed than in the wild, so diseases can spread more easily. • Open water systems can lead to fish escapes and interaction with endangered wild species.

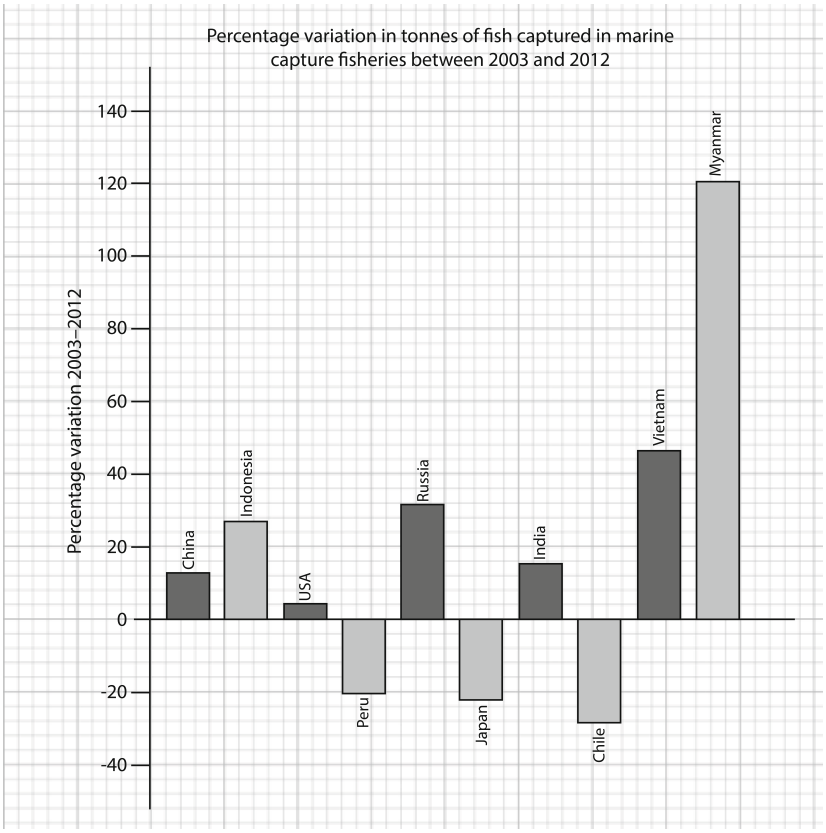
f) Suggest reasons for the rapid growth in aquaculture production globally.

There are a number of reasons behind the rapid growth in aquaculture around the world. Rising demand for fish from the oceans has led to extensive overfishing and global fish stocks are facing a crisis. Over 60% of stocks are fished at capacity and 28% of stocks are being fished at unsustainable levels. This has led to the decline of many species and the extinction of others. Practices such as illegal fishing, destructive fishing methods and catching of vulnerable species are causing the oceans to be overfished – at a time of increasing demand. The growth of aquaculture is a response to the decreasing supply in the oceans. Aquaculture allows fish to be produced rather than caught, which is easier to manage. There are also fewer restrictions on aquaculture when compared to the quotas, bans and closed seasons being used to manage oceanic fish stocks.

3. Just as the human population is not evenly distributed, marine species are found in abundance in some places and are scarce in others. The data below shows the top 10 producer countries that catch the most fish.

Marine capture fisheries: major producer countries					
2012 Ranking	**Country**	**Continent**	**2003 capture in tonnes**	**2012 capture in tonnes**	**% variation 2003–12**
1	China	Asia	12 212 188	13 869 604	13.6
2	Indonesia	Asia	4 275 115	5 420 247	27
3	USA	North America	4 912 627	5 107 559	4
4	Peru	South America	6 053 120	4 807 923	–20.6
5	Russia	Asia/Europe	3 090 798	4 068 850	31.6
6	Japan	Asia	4 626 904	3 611 384	–21.9
7	India	Asia	2 954 796	3 402 405	15.1
8	Chile	South America	3 612 048	2 572 881	–28.8
9	Vietnam	Asia	1 647 133	2 418 700	46.8
10	Myanmar	Asia	1 053 720	2 332 790	121.4

a) Plot the data for % variation over time as a bar graph on the grid below:



b) Describe the pattern of growth or decline in capture fisheries in the top 10 producing countries.
Seven of the top 10 producing countries have seen a growth in the amount of fish caught at sea in the period 2003 to 2012. The greatest increases were seen in Myanmar and Vietnam. Chile, Japan and Peru all saw greater than 20% declines in the amount of fish caught in this period.

c) Compare and contrast the trend in capture fisheries between Asia and the Americas over time.
During the period 2003 to 2012, fisheries in the Americas either declined or grew at a low rate of 4%. In contrast, all Asian capture fisheries in the top 10 grew, with the exception of Japan. Growth varied from 13 to 121%. China's growth was the lowest, however they still captured the largest volume of fish in the world.

d) Identify and explain any possible causes of the trends identified above. You will need to draw upon information from more than one section, as well as your own research.
There are a number of reasons that Asian fisheries grew and North and South American fisheries saw limited growth and decline during the period 2003 to 2012. With higher population growth and increasing levels of economic development, demand for fish in Asia will have increased at a faster rate than that of North and South America. The waters around southern Asia are marine biodiversity hotspots so there are relatively more fish to be caught. Many of the Asian countries have large trawler fleets that travel out into the Pacific Ocean and there are fewer regulations controlling the amount of fish they land and the techniques used. Furthermore, at the same time the USA was introducing stricter controls and quotas in order to

protect marine fisheries and reduce the risk of extinction. This could account for the slower growth in the USA. In addition, both Chile and Peru are highly vulnerable to the El Niño Southern Oscillation which would significantly reduce the numbers of fish being caught by the fishing fleets in these countries.

4. The graph below is from the biannual Food and Agriculture Organization of the United Nations report 'The State of World Fisheries and Aquaculture 2016'.

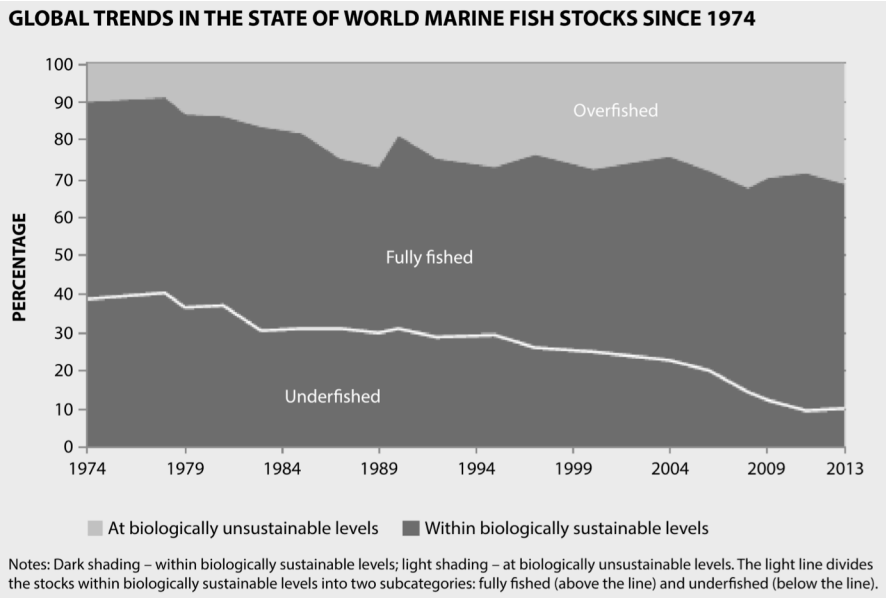


Fig. 5.15 Global trends in the state of world marine fish stocks since 1974.

The comprehensive report examines all of the patterns and trends across the world oceans in terms of fish production. You can access the report at **http://www.fao.org/3/a-i5555e.pdf**. This graph shows an alarming increase in the number of fish stocks globally that are overfished to biologically unsustainable levels. These stocks require management plans to rebuild fish levels. The number of fish stocks that are now fully fished (at the extent of a biologically sustainable level) has grown over time and have no further room for an expansion in catches.

a) Describe and explain how the following practices have contributed to the decline of fish stocks:

i. Overfishing

Overfishing occurs when too many fish of one particular species are taken. This removes the breeding fish population which then have too few numbers for the species to recover. Overfishing is caused by unsustainable fishing practices such as using fine mesh drift nets which lead to high levels of wasteful bycatch.

ii. Illegal fishing

When steps are taken to protect areas by designating them as Marine Protected Areas with 'no take' zones, fish stocks can be seen to recover. However, MPAs are threatened by illegal fishing, when boats deliberately target protected area. Taking from MPAs illegally adversely affects the recovering fish population leading to further declines in fish stocks. In addition, illegal fishing can involve catching and landing fish that are protected by bans or quota systems. Boats that do this are ignoring the reasons why the ban is in place –

putting short term financial gain ahead of longer term recovery of fish stocks and the associated benefits of this.

iii. Overcapacity of global fishing fleet
It is estimated that the global fishing fleet is two to three times larger than the oceans can sustainably support. This means there are simply too many boats at sea looking for a declining number of fish. More boats leads to more fish being taken in total, which leads to a decline in global fish stocks.

Examine the selection of fishing methods below from the Marine Conservation Society.
The league table scores different fishing methods for:

- impact on habitat (how the fishing gear impacts the seabed or coral reefs)
- impact on target species (how selected is the method, what happens to young fish when caught, are they discarded?)
- impact on non-target species (the level of bycatch associated with the method)

Method	**Species targeted**	**Impact on habitat**	**Impact on target species**	**Impact on non target species**	**Overall impact rating**
Pole and line	Tuna	Very low	Very low	Very low	Very low
Pelagic longline	Tuna	Very low	Low	High	Some
Purse seine using FAD	Tuna	Moderate	Low	Moderate	Some
Beam trawl	Plaice, sole, turbot	High	Moderate	High	Moderate
Drift net (high seas)	Tuna, shark	Very low	High	High	High

b) Evaluate the range of fishing methods shown. Consider which are the most sustainable methods. Suggest how higher impact methods can be modified to reduce unwanted effects.
The most sustainable fishing method here is the pole and line method which has a low impact on habitats and other species. The least sustainable method of fishing is using drift nets. These have significant impacts on the target species and other species. They do not impact marine habitats particularly. One way the impact of drift nets could be reduced is to change the design of nets so that younger fish can escape. Restricting the time used, alongside controls over where drift nets are used would also reduce the impact of these nets.

5. The government of Vanuatu in the western Pacific Ocean has become increasingly concerned with the level of fishing from foreign-owned vessels inside its Exclusive Economic Zone. The innovative GIS from Global Fishing Watch has allowed the government to clearly identify the areas of highest fishing activity in a four-month period. The government need an action plan to help manage the situation sustainably. They need income from selling fishing licences but need to ensure stocks remain viable in the future.

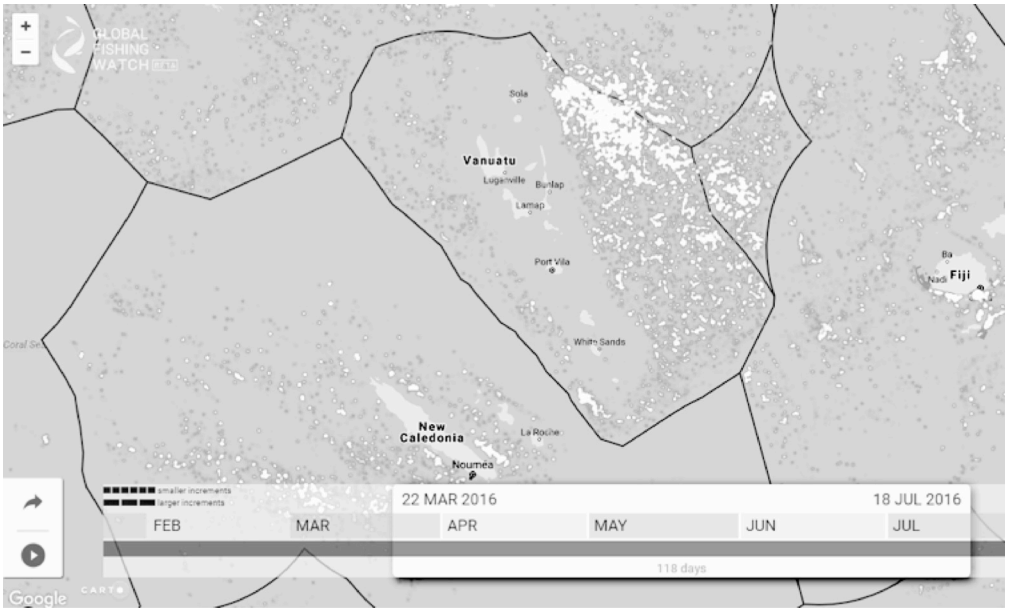


Fig 5.16 Fishing activity in Vanuatu.

Using the PIPA case study from the Student Book (pages 136–138), plus other parts of the section and your own research, write a detailed action plan for the government of Vanuatu that meets the needs of the people today, without compromising the ability of people in the future to meet their own needs. Some options you might wish to consider recommending:

- a complete ban on all fishing for three years
- sell more fishing licences to maximise short-term income for the country
- develop a ‘no take’ Marine Protected Area
- develop a restricted-use Marine Protected Area where fishing is restricted at certain times of year
- ban certain types of boat associated with the most destructive fishing methods
- introduce a fishing quota system
- sell cheaper permits to those vessels using the most sustainable methods
- work with Global Fishing Watch to identify, report and ban vessels fishing illegally
- ask environmental charities to support monitoring of fishing vessels
- lobby governments of those vessels found to be illegally fishing to prevent them returning

You might wish to suggest a combination of the ideas as well as some of your own. You must justify why you are selecting certain methods and rejecting others. You might wish to use **http://map.globalfishingwatch.org/** to look at MPA successes in other parts of the world.

There are a range of options available to the government of Vanuatu, which will allow them to maximise income and ensure the fish stocks remain healthy. They should look carefully at a combination of methods rather than just one. The priority is to designate a restricted use Marine Protected Area where fishing is restricted at certain times of year. There is intense fishing activity in the northeast of the EEZ, so this area should be protected. Allowing it to be closed for certain periods of the year – or longer if needed – will give fish time to reproduce. They could completely ban fishing in part of the MPA to allow stocks to recover – much as they have done in the Phoenix Island protected area in Kiribati. The government of Vanuatu could consider a system of rotating no-take areas within the MPA. This would allow fish stocks to recover and spill over into areas that have carefully controlled access.

Controlling access would be achieved by changing the way permits are sold. Reduced-price permits to fish could be sold to fishing vessels that offer guarantees of more sustainable methods. Fishing permits could be removed from boats that do not comply with the new rules. Key to the success of this plan is effective monitoring and reporting. The government of Vanuatu should work closely with Global Fishing Watch to ensure that MPAs are respected and that any illegal fishing activity is reported. The government will need to ensure that they report this activity to the authorities in the fishing boats home country. Vanuatu is a low-income country and doesn't have the resources to enforce the MPA with a large navy. It is important that they request help from environmental charities such as Greenpeace to assist in the monitoring of the MPA.

Vanuatu could also choose an alternative route. Selling more fishing licences in the short term would increase the fishing intensity but would make more money. They could then try to control the amount of fish caught by using a quota system. This would be difficult to manage as vessels sometimes catch a quota of fish then transport it to another ship, so they can continue. Much of the fish is landed in other countries so monitoring whether boats have stuck to their quota would be a challenge. This method is a less sustainable long-term solution and would be harder for the government to monitor. Short-term financial gain would eventually lead to overfishing and a potential collapse of fish stocks.

In conclusion, Vanuatu must adopt a multi-method solution that includes MPAs with no-take and restricted-use areas that can rotate, alongside more, cheaper permits for vessels that guarantee sustainable methods. If this is effectively monitored then Vanuatu can maximise its income and ensure the sustainability of its fish stocks.

