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Environmental systems and societies
Standard level
Paper 1 – resource booklet

Monday 20 May 2019 (afternoon)

1 hour

Instructions to candidates

- Do not open this booklet until instructed to do so.
- This booklet contains all the resources to answer paper 1.

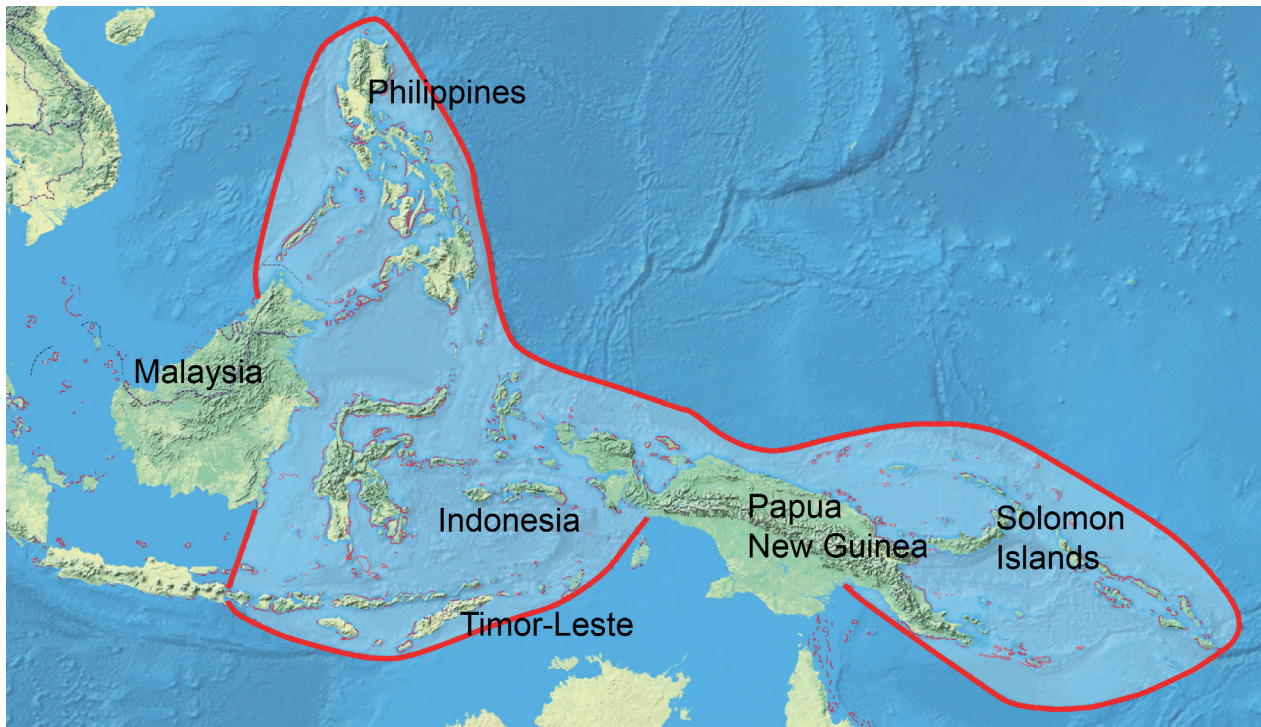
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Figure 1(a): Map showing the location of the Coral Triangle



[Source: The World Factbook. Washington, DC: Central Intelligence Agency.
<https://www.cia.gov/library/publications/the-world-factbook/index.html>]

Figure 1(b): Map showing the six countries within the Coral Triangle



[Source: adapted from: https://commons.wikimedia.org/wiki/File:Übersichtskarte_zur_Lage_des_Korallendreiecks.png,
created by Benutzer:Devil_m25; <https://creativecommons.org/licenses/by-sa/3.0/de/deed.en>]

Figure 2: Fact file on the Coral Triangle

- The Coral Triangle is an area of approximately 6 million square kilometres in South-east Asia.
- It is the most biodiverse marine ecosystem in the world.
- Its habitats include coral reefs, seagrass beds and mangroves.
- The Coral Triangle provides a range of ecosystem goods and services, and supports the livelihoods of over 120 million people.
- It provides an important spawning area to the largest tuna fishery in the world.
- In 2014, capture fisheries within the Coral Triangle were valued at US\$9.9 billion representing over 10% of the world market.
- Income in the area is also generated through a growing recreation and tourist industry.

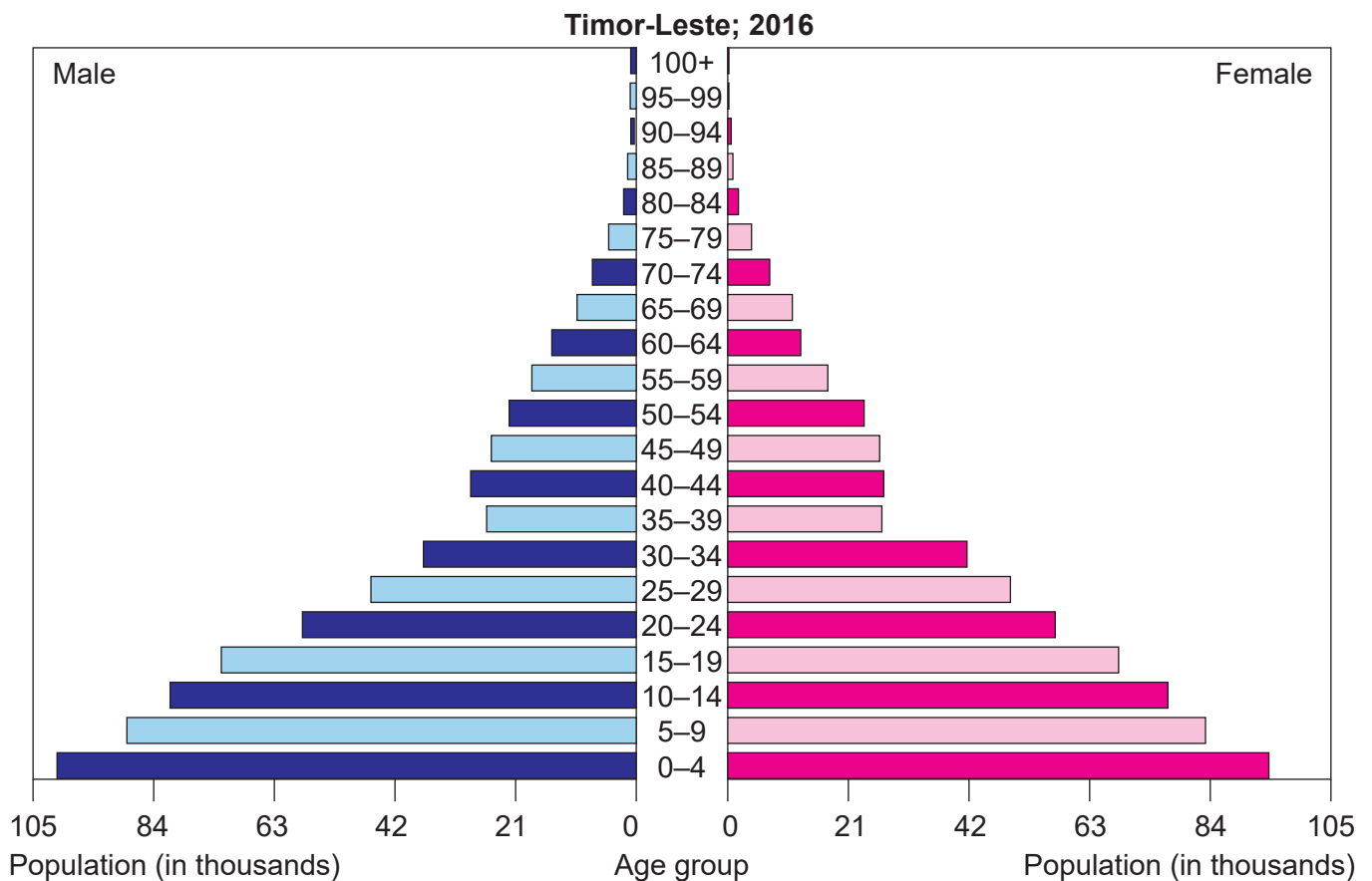
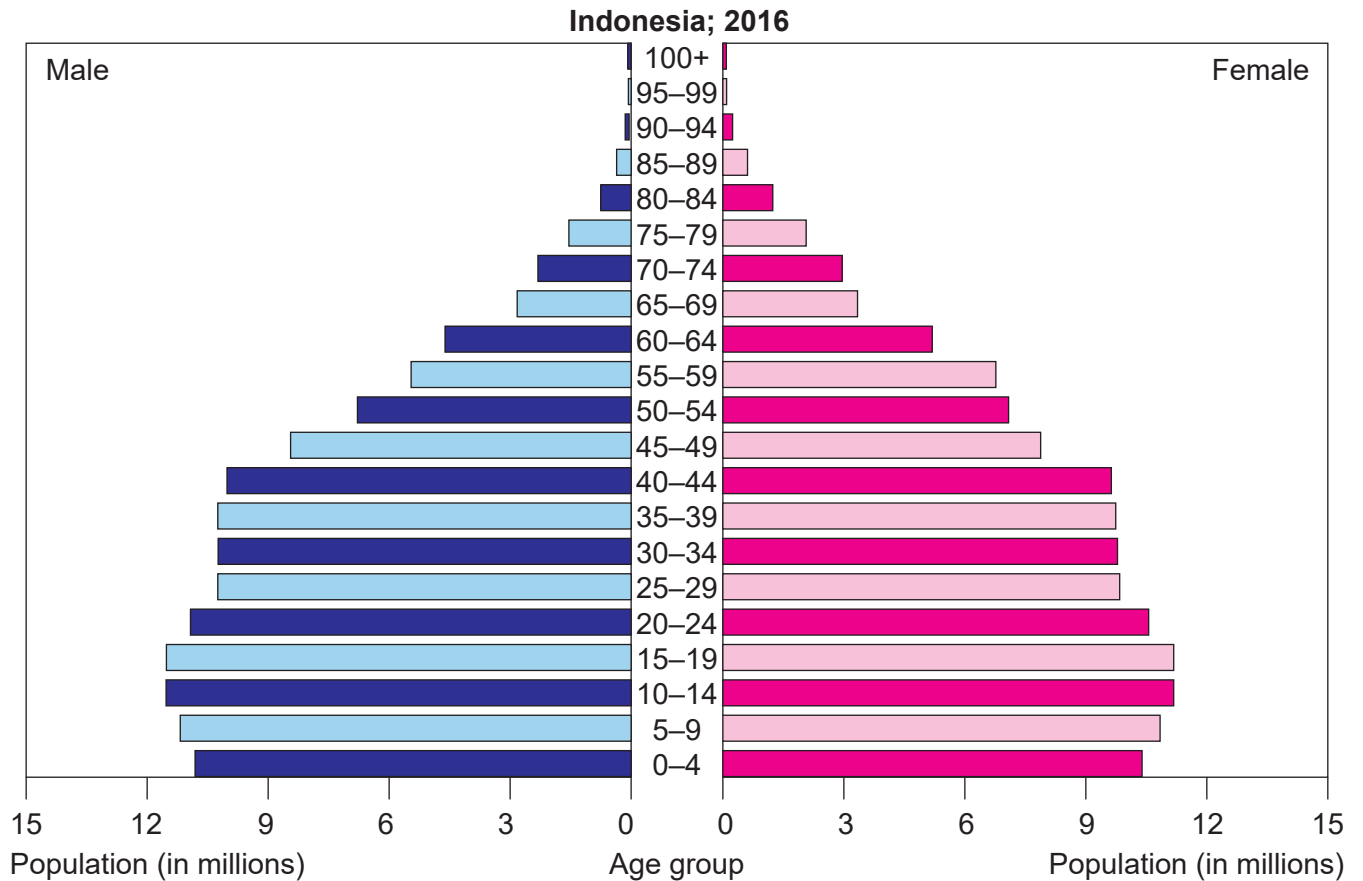
[Source: adapted from www.adb.org]

Figure 3(a): Population and land information

	Indonesia	Malaysia	Papua New Guinea	Philippines	Solomon Islands	Timor- Leste
Population	260 580 739	31 382 992	6 909 701	104 256 076	647 581	1 291 358
Population growth rate (%)	0.9	1.4	1.7	1.6	1.9	2.4
Land area (km ²)	1 811 569	328 657	452 860	298 170	27 986	14 874
Population density (people/land area)	143.8	95.5	15.3	349.7	23.1	86.8
Coastline (km)	54 716	4 675	5 152	36 289	5 313	706
Land use (%):						
Agriculture	31.2	23.2	2.6	41.0	3.9	25.1
Forest	51.7	62.0	63.1	25.9	78.9	49.1
Other	17.1	14.8	34.3	33.1	17.2	25.8

[Source: The World Factbook. Washington, DC: Central Intelligence Agency.
<https://www.cia.gov/library/publications/the-world-factbook/index.html>]

Figure 3(b): Age-gender pyramids for Indonesia and Timor-Leste



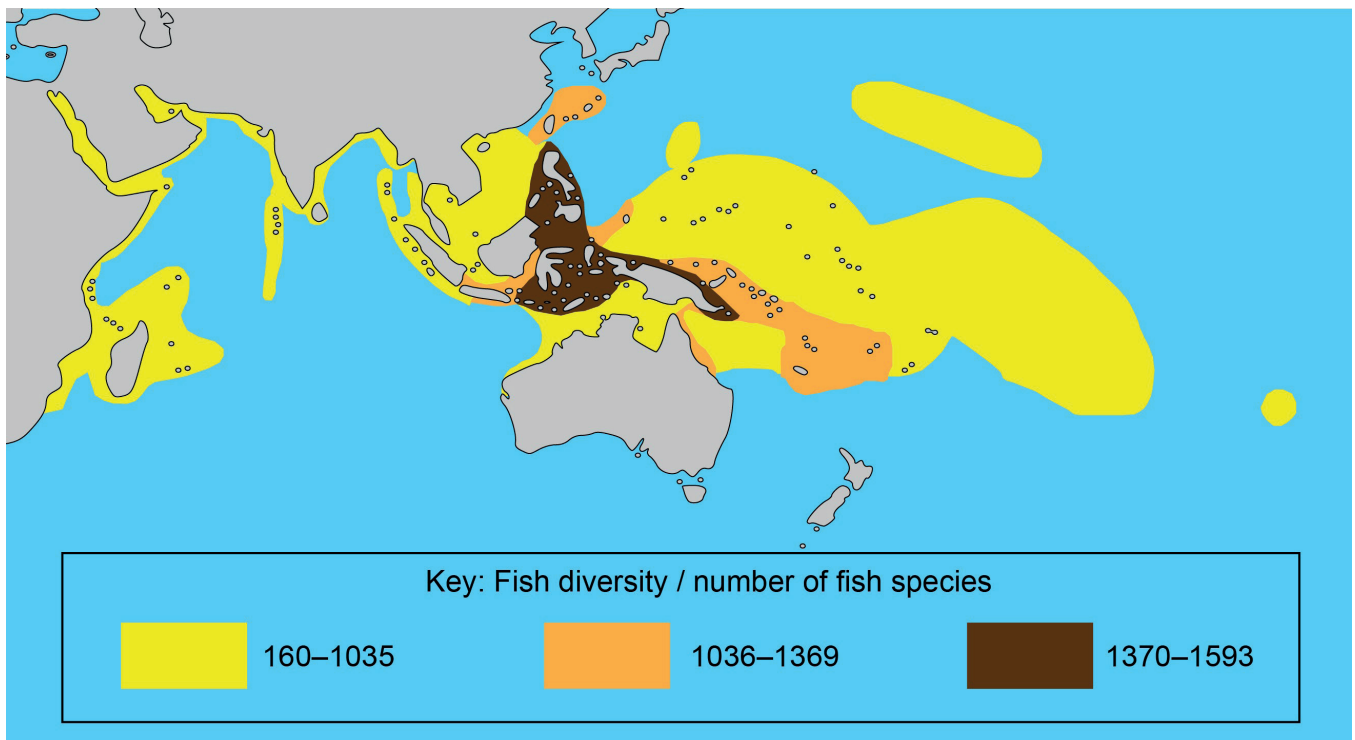
[Source: The World Factbook. Washington, DC: Central Intelligence Agency.
<https://www.cia.gov/library/publications/the-world-factbook/index.html>]

Figure 4(a): Species within the Coral Triangle

	Number within Coral Triangle	Global number
Coral species	605	798
Coral reef fishes	2228	6000
Marine turtles	6	7
Whale, dolphin and porpoise species	29	92

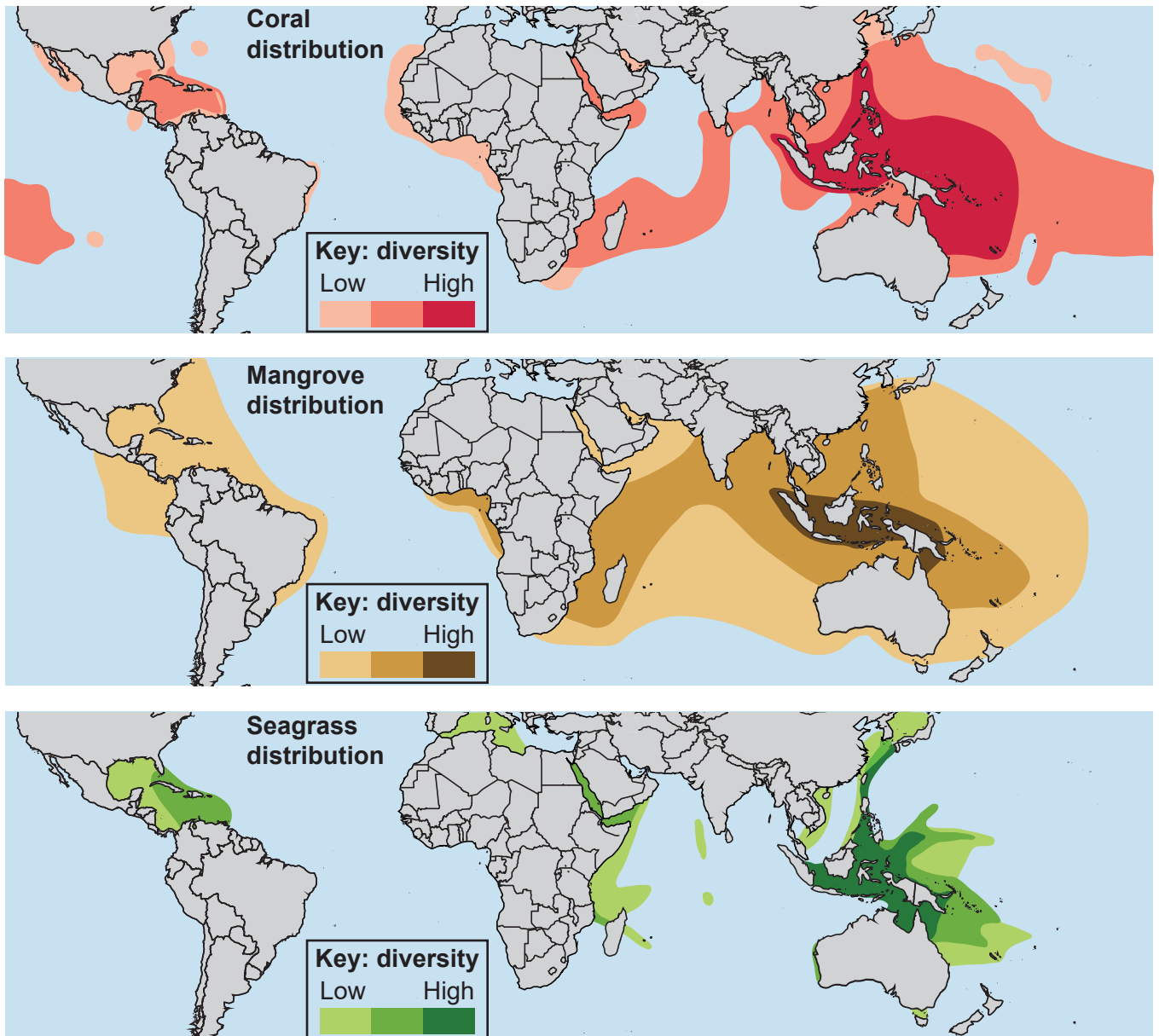
[Source: adapted from <http://wwf.panda.org> and www.marinespecies.org]

Figure 4(b): Coral reef fish diversity



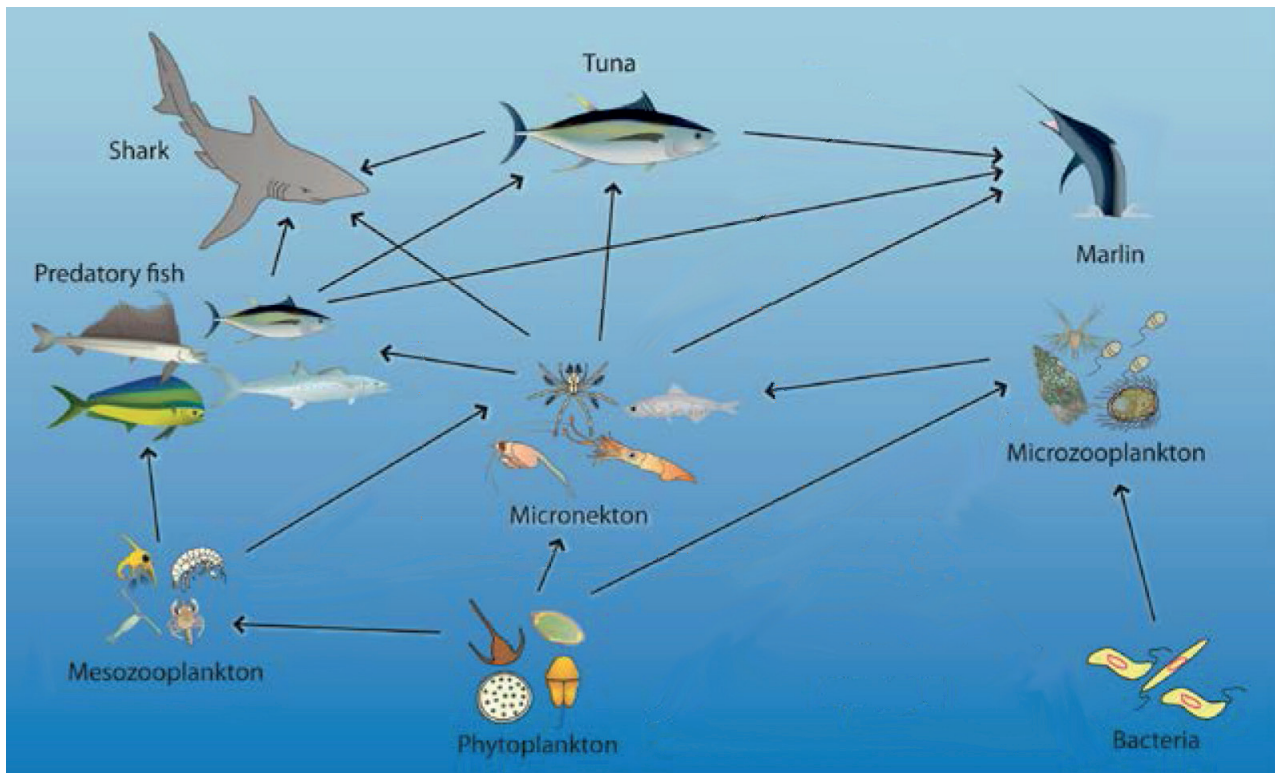
[Source: © International Baccalaureate Organization 2019]

Figure 4(c): Global distribution and species diversity of corals, mangroves and seagrasses



[Source: adapted from GRID-Arendal and UNEP-WCMC
 Coral distribution: UNEP-WCMC 2001 World Atlas of Coral Reefs
 Mangrove distribution: UNEP-WCMC 1997 World Mangrove Atlas
 Seagrass distribution: UNEP-WCMC 2003 World Atlas of Seagrasses]

Figure 4(d): Example of a Coral Triangle marine food web



[Source: reproduced in modified form with the kind permission of the Pacific Community (SPC). © SPC 2019]

Figure 5: Ecosystem goods and services in coastal marine habitats

Mangrove	Seagrass	Coral reef
Provides nursery and habitat for fish and shellfish	Provides nursery and habitat for variety of species	Provides nursery and habitat which supports high biodiversity
Intercepts freshwater flow, traps sediments and absorbs nutrients	Traps sediments and absorbs nutrients from the water	Filters particulate matter from the water, increasing water clarity
Absorbs carbon dioxide and emits oxygen	Absorbs carbon dioxide and emits oxygen	
Provides a source of fish and shellfish	Provides a source of fish and shellfish	Provides a source of fish and shellfish
Reduces coastal erosion		Provides coastal protection by buffering incoming waves and currents
Provides a source of wood		Provides a tourist and recreation attraction

[Source: adapted from <https://www.sciencedirect.com/science/article/pii/S0921800999000099>]

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Figure 6: Carbon storage in different ecosystems

Some ecosystems are very effective at absorbing carbon dioxide from the atmosphere and storing this carbon either within their living biomass or in the soil below ground.

		Soil organic carbon (metric ton carbon per hectare)	Living biomass (metric ton carbon per hectare)	Total (metric ton carbon per hectare)
Terrestrial forest ecosystems	Boreal forest	150	94	244
	Tropical forest	83	167	250
Coastal marine ecosystems	Mangroves	1030	464	1494
	Tidal marsh	920	31	951
	Seagrass meadows	608	10	618

[Source: © International Baccalaureate Organization 2019]

Figure 7: Threats to biodiversity and ecosystems within the Coral Triangle

- Coral reefs and mangroves in the Coral Triangle have declined by over 40 % since the 1970s.
- Over 85 % of coral reefs are under threat from population growth and human activity.
- Mangroves have commonly been removed to make way for agriculture, aquaculture or urban development.
- Increase in unsustainable fishing practices, because of the demand for marine resources, has led to the decline of many species, such as bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*).
- Destructive fishing methods that impact marine habitats have been used throughout the region, such as use of dynamite and cyanide.
- Demand for wildlife goods such as turtle products and shark fins (used to make shark-fin soup) has caused a reduction in population numbers of some species.
- Land-based pollution from agriculture, logging, mining and urban development has damaged habitats within the Coral Triangle.

Large-scale tourism development also threatens the Coral Triangle through:

- pollution produced by tourists, such as sewage effluent, plastic waste materials
- coral trampling by snorkelers and divers
- physical damage caused by boat anchors ripping up corals and seagrass
- stress to marine wildlife caused by tourists following them too closely
- collection of wildlife souvenirs, such as corals, shellfish or turtle shells.

Climate change is a major threat to the Coral Triangle. The World Wide Fund for Nature (WWF) estimates that at current rates of global temperature increase, most coral reefs could be destroyed by 2050.

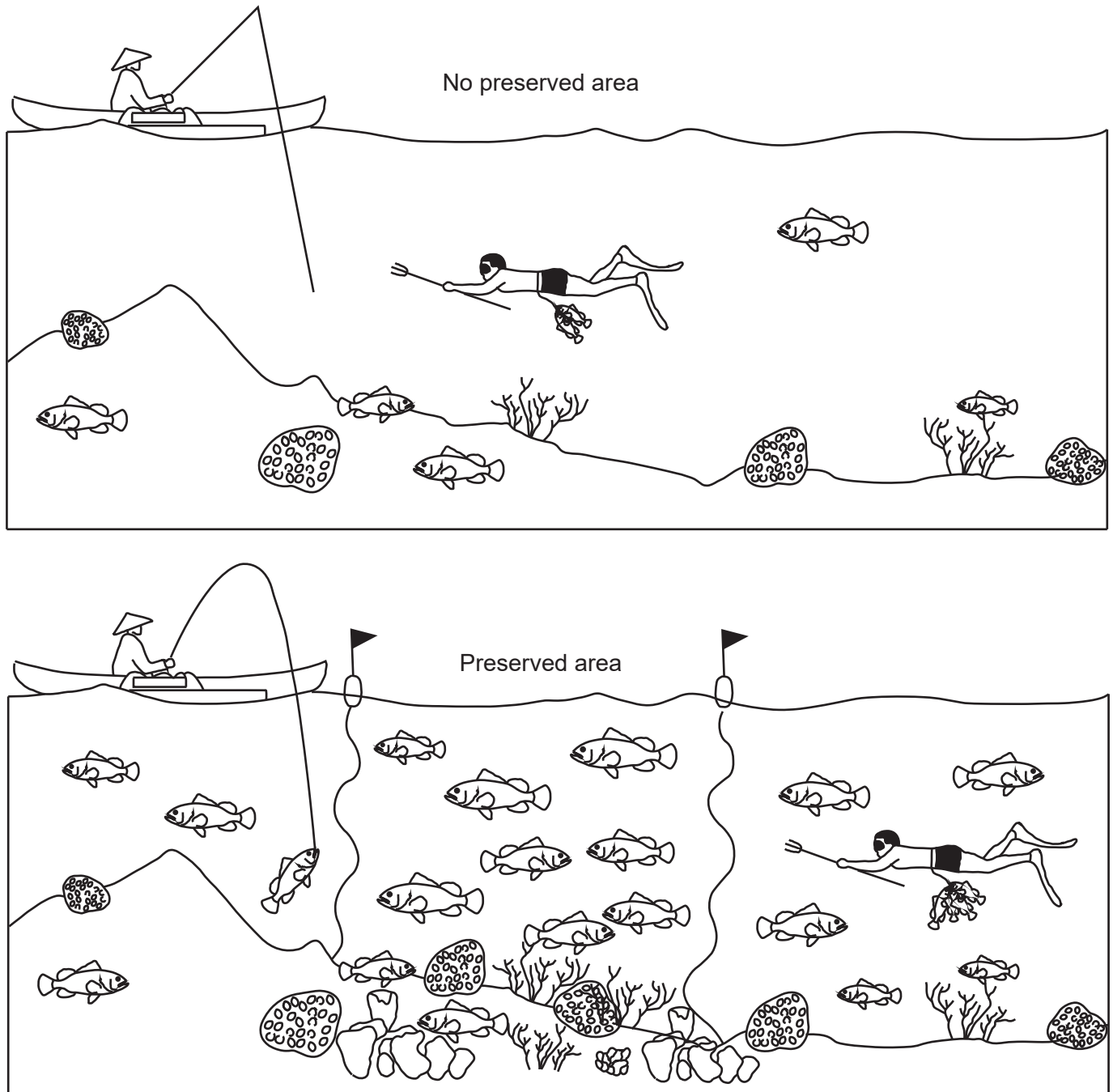
[Sources: adapted from <http://wwf.panda.org>; www.wwf.org.au; www.coraltriangle.org]

Figure 8(a): Conservation within the Coral Triangle

- The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) is an agreement between all six nations in the area with the objectives of:
 - ensuring food security and a sustainable livelihood of residents of the Coral Triangle
 - protecting the unique ecosystem and marine species within the Coral Triangle.
- Conservation projects in the Coral Triangle involve collaboration between national governments, regional organisations, non-governmental organisations, private companies and local communities.
- Popular approaches to encourage sustainable use of the sea and its resources include creation of Marine Protected Areas (MPAs) and networks of Locally Managed Marine Areas (LMMAs).
- MPAs are usually managed by national and local government whereas LMMAs are more likely to be managed by the local community.
- These designated areas are often classified according to their use or the restrictions placed on them, such as “no-take zones” where no fishing is allowed or “tourism zones” that can be used for recreation but where other activities such as fishing are banned.
- Some zones allow restricted activity, such as use by local fishermen using only traditional fishing methods or during certain times of the year.
- Research has shown that over time in a well-managed MPA there is an increase in fish size, fish numbers and overall biodiversity.
- There are currently over 1000 MPAs within the Coral Triangle.
- The Coral Triangle Initiative aims to designate 20% of each of the main habitats within the Coral Triangle as MPAs by 2020.

[Source: adapted from www.coraltriangleinitiative.org; <http://www.panda.org>]

Figure 8(b): Impact of excluding fishing in areas designated as either a Marine Protected Area (MPA) or a Locally Managed Marine Area (LMMA)



[Source: adapted from: Panduan Pembentukan dan Pengelolaan Daerah Perlindungan Laut Berbasis Masyarakat (Guide for the establishment and management of community-based marine sanctuaries). 2002. J. Tulungen, T. Bayer, B. Crawford, M. Dimpudus, M. Kasmidi, C. Rotinsulus, A. Sukmara and N. Tangkilisan. Ministry of Marine Affairs and Fisheries and the Coastal Resources center, University of Rhode Island, Narragansett, RI, USA. pp.77. (Figure 8, p. 18)]

Figure 8(c): An example of a community-based ecological restoration project in Tiwoho Village within Bunaken National Park, Indonesia

Conservation projects within the Coral Triangle have included restoring mangrove ecosystems through planting schemes.

Community planting of mangroves in 2004

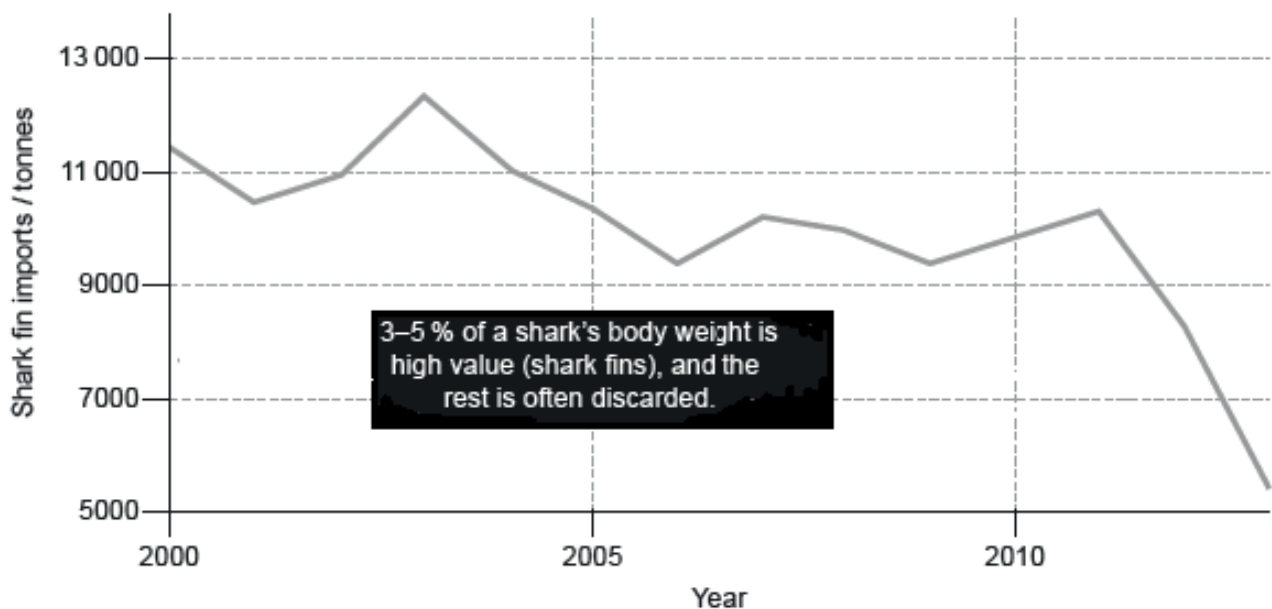
Same site in 2011 with established mangroves



[Source: Benjamin M. Brown]

Figure 8(d): Drop in demand for shark fins in Hong Kong and mainland China

Conservation efforts have also focused on reducing trade of wildlife parts such as shark fins.



[Source: Data: FAO; Hong Kong Census and Statistics Department. Courtesy of Quartz at QZ.com, adapted from <https://qz.com/197436/two-charts-show-how-shark-fin-soup-is-going-out-of-style/>]