Teacher Notes

Themes

- Marine habitats
- Conservation and threats
- Life cycles

Key learning outcomes

- Describe shallow and deep marine habitats and the adaptations of animals living there.
- Identify threats to endangered marine animals and their vulnerability to those threats.
- Comprehend that science and communication are vital to the conservation of a species.
- Compare and contrast the life cycles of marine fish from the shallows and deep sea.
- Compare natural breeding strategies with human-assisted breeding actions.

Key curriculum areas

- **Science:** Biological Sciences, Science as a Human Endeavour, Science Inquiry Skills
- **English:** Language, Literacy
- **Mathematics:** Statistics and Probability
- **Design and Technologies:** Processes and Production Skills
- **The Arts:** Visual Arts, Dance, Drama
- **Cross Curriculum Priorities:** Sustainability – Systems, World Views, Futures

Publication details

Hold On! Saving the Spotted Handfish
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Hold On! Saving the Spotted Handfish

Gina M. Newton and Rachel Tribout

About the book

Have you ever seen a fish that could do a handstand? This is the story of a quirky and primitive little fish that is famous for two reasons: walking on its 'hands' (pectoral fins), and being one of the first marine fish in the world to be listed as Critically Endangered on the IUCN Red List of Threatened Species.

The Spotted Handfish has survived since the time of the dinosaurs – until now. Invasive seastars, pollution and climate change mean that this unique Australian is in serious trouble – hands up if you want to know more!

Hold On! Saving the Spotted Handfish is perfect for primary aged readers.

Recommended for

Readers aged 6 to 10 years

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About the author and illustrator

Dr Gina M Newton is a scientist, science communicator and award-winning author of *Amazing Animals of Australia's National Parks*. She's also a Past National President of the Australian Marine Sciences Association.

Rachel Tribout is an illustrator and graphic designer from France based in Tasmania. She's the creator of *The Monsters of Tasmania* and is a member of the Society of Children's Book Writers and Illustrators.

Pre-reading activities

A whole different world

The Spotted Handfish is a type of anglerfish that mainly lives in shallow depths of 5–10 metres, whereas its relative, the Humpback Anglerfish, lives in the mysterious and very different environment of the deep sea. Show a selection of YouTube clips to stimulate discussion about shallow and deep-sea life, for example:

- https://www.youtube.com/watch?v=hXtrIy95V80 (Under the sea: Ocean animal moves) (shallow)
- https://www.youtube.com/watch?v=A23wI4lvCgY (Why does deep sea life look so strange?)
- https://www.youtube.com/watch?v=IeXUuhLGBCQ (Challenges of the deep)

What do students notice about the colours and shapes of the sea life? How might their unusual features help with their survival?

Use a KWL chart to discuss what students know and what they want to find out about our undersea world.

Hold on! We're endangered

Unpack the words 'conservation' and 'endangered'. What do they mean? How is 'endangered' different from 'protected', 'extinct' and 'threatened'? Make a list of endangered animals. Why are they endangered and what is being done to help them?

Discuss the animals listed on the WWF website (https://www.wwf.org.au/what-we-do/species#/). Group the 21 animals. What types of animals are missing from this list? [*Answer: fish*]

Life cycles in the sea

The *Life cycle* diagram for the Spotted Handfish and Humpback Anglerfish (at the end of these notes) may be used in different ways:

- Students create their own life cycle representations, comparing theirs to the diagram.
- Provide deconstructed versions of the two life cycles and have students work cooperatively to reconstruct them.
- Compare the two life cycles and discuss how different stages may contribute to the vulnerability of the Spotted Handfish.

Discussion questions

Science

1. **The Spotted Handfish is a unique member of the anglerfish family. What are some things that make it so special?**

   [They have 'hands' and walk on their pectoral fins. They don't swim or have a swim bladder like most fish do. They are one of the first marine fish in the world to be listed as Critically Endangered. Plus, the species is millions of years old.]

2. **Some of the special features of the Spotted Handfish also make its life difficult. What are they and why?**

   [Because Spotted Handfish can't swim and they don't have planktonic larvae, they can't move far from their home. This means they cannot escape or move away when their habitat is damaged or threatened. Also, Spotted Handfish need to lay their eggs around the Sea Tulip or a similar structure – no structure = no eggs.]

3. **What is a Sea Tulip and why is it so important?**

   [The Sea Tulip is an ascidian or 'sea squirt' – an invertebrate animal that lives permanently attached to the seafloor. It looks like a tulip. Spotted Handfish have a unique relationship with the Sea Tulip because they lay their eggs around the stems.]

4. **How is the life cycle of the Spotted Handfish different to other fish? What problems does this life cycle present?**

   [Spotted Handfish lay eggs in their home territory and juveniles cannot move far from where they hatch. Other fish lay and fertilise their eggs in the water. These float away for long distances and hatch into swimming larvae that can colonise new areas, far away from their parents' home. So, there is no competition with the parents for space or food.]

5. **When we are thinking about animals, what do we mean when we refer to a 'threat'? What are some examples of threats?**

   [Threats are anything that can cause a negative 'impact' (i.e. harm, damage or death) to an animal and the habitat it depends on to survive. Examples of human-made threats include: pollution by chemicals from factories or rubbish, capture, rising temperature from climate change, boat anchors and transport of alien species in boats. Natural threats are predation by another animal or competition for resources with another organism.]

6. **The 'Red List of Threatened Species' is an internationally recognised list. Why is it so important? Are there other lists as well?**

   [The Red List is published by the International Union for Conservation of Nature (IUCN) which has members from over 170 countries around the world. It is not a law, but many countries refer to the Red List to guide their own conservation actions and regulations. Some countries also have their own conservation law and lists, for example Australia has the Environment Protection and Biodiversity Conservation Act.*]*

7. **There may be fewer than 14 handfish species left in the world, and they are in trouble. What are some reasons why there are so few left?**

   [Handfish species have evolved over millions of years to live in specific marine habitats and conditions that they need to survive. Human activities have caused these conditions to change quickly (over about the last 40 years). Some handfish species have not had the time, nor the biological or behavioural ability, to adapt to these changes.]

8. **Why are the seastars referred to as 'invaders'?**

   [They are not an Australian native species and normally live in the Northern Hemisphere. They are an invasive or alien species. They were accidentally brought to Tasmanian waters where they multiplied quickly and damaged the Spotted Handfish's habitat, including eating the Sea Tulips they lay their eggs around.]

9. **We use science to understand the world around us and make it better. How have people used science and technology knowledge to help the Spotted Handfish?**

   [Scientists conducted underwater surveys to collect data about the size and distribution of the Spotted Handfish population. They also conducted research on their breeding biology and behaviour. They used this knowledge to help devise a captive breeding program and design artificial spawning habitat. Scientists also used computer software to identify individual fish based on their patterns of spots.]

10. **Are captive breeding and artificial spawning habitat both positive developments? Explain.**

    [With most of the Sea Tulips gone, the Spotted Handfish had nowhere to lay its eggs. Without captive breeding and artificial spawning habitat (the plastic or ceramic poles) it may have become extinct already. The poles have helped this species to breed in both the laboratory and in the wild. Laboratory bred fish can also be released back into the wild to boost numbers in the wild population.]

Teacher Notes

Sustainability

1. **To achieve sustainability, it is essential that the world recognises that living things need healthy habitats. What have scientists done to help this?**

   [The Red List of Threatened Species helps the world to recognise that plants and animals are endangered and heading towards extinction. Many countries also have their own conservation laws. Animals that are placed on a threatened species list have undergone scientific assessments. These are used to identify conservation actions to protect the animal and reduce threats. The Spotted Handfish listing and Recovery Plan led scientists to try out artificial spawning habitat, develop a captive breeding program, use computer software to identify individual fish from their spots, and research eco-friendly boat moorings.]

2. **For a sustainable future, we must care for and understand environments. What important messages does the author give us through Handstand's story?**

   [Animals depend on their environment to survive. Human activities create threats which affect our wildlife. Scientists play an important role in helping us understand how we can protect and save our threatened species. Sometimes they need to be creative to produce solutions, such as the development of ceramic poles to replace Sea Tulips.]

3. **Our natural ecosystems provide the perfect conditions to sustain life. What happened to make the Spotted Handfish endangered after surviving for such a long time?**

   [The Spotted Handfish lived in harmony with its natural environment, along with natural threats, for millions of years. Human-made threats started having an impact on this fish about 40 years ago and are increasing. This means there is not enough time for this species to adapt to the changes without help from scientists.]

English

1. **How can citizen scientists and volunteers help a threatened species?**

   [Citizen scientists and volunteers can help in various ways. For example, in the case of the Spotted Handfish, volunteer scuba divers were involved in surveying their habitat and counting fish, and in fixing the poles to the seafloor. They also helped scientists to locate 'founder' fish for the captive breeding program. Concerned community groups also work to raise awareness of this threatened species and oppose developments such as marinas that may affect its habitat.]

Activities

Ocean zones

Using Diagram 1 and Table 1 below, discuss the different environments and habitats found in each ocean zone. Create representations of these zones and the animals that can live in each one for display, e.g. labelled artworks, dioramas of each zone, whole class mural.

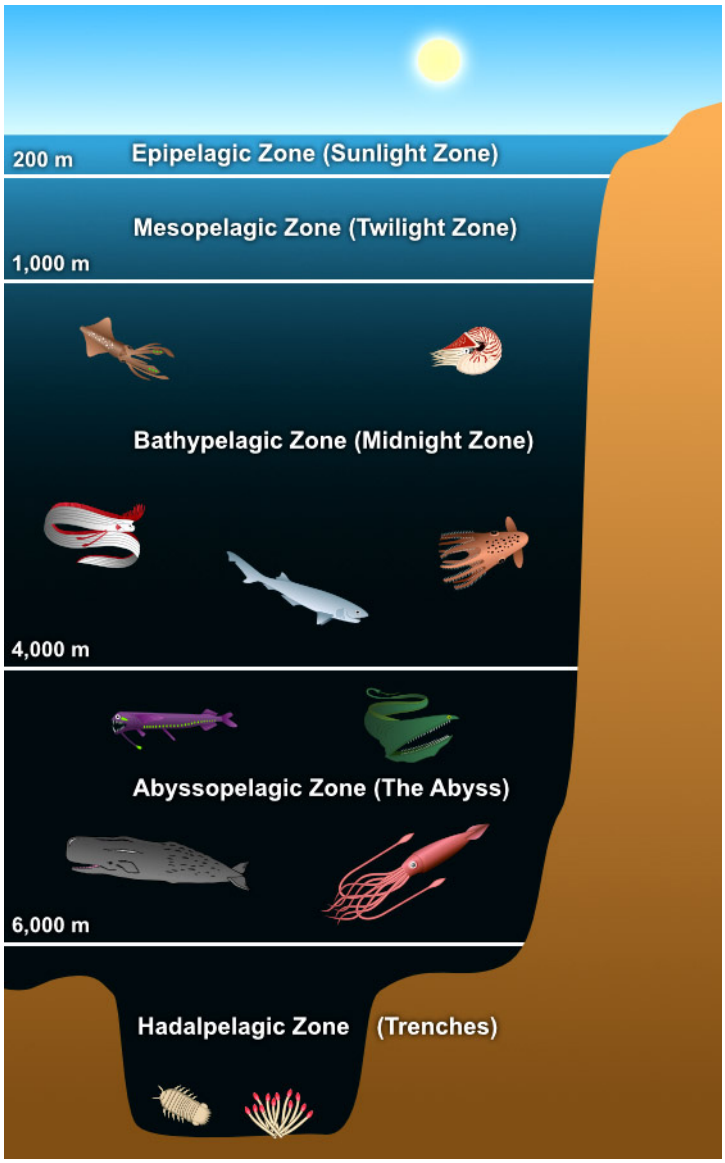

Diagram 1: Ocean zones
(Source: with permission from www.seasky.org)

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Table 1: Ocean zones (and their physical characteristics)

Ocean zone	Sunlight Zone (Epipelagic)	Twilight Zone (Mesopelagic)	Midnight Zone (Bathypelagic)	The Abyss (Abyssal)	The Trenches (Hadal)
Geology	Continental shelf	Continental slope	Continental rise	Ocean basin	Ocean trenches
Depth	0–200 m	200–1000 m	1000–4000 m	4000–6000 m	6000–11 000 m
Light	• Sunlight • Photosynthesis possible	• Gloomy light • Photosynthesis not possible • Bioluminescence	• Dark • Photosynthesis not possible • Bioluminescence	• Dark • Photosynthesis not possible • Bioluminescence	• Dark • Photosynthesis not possible • Bioluminescence
Temperature and maximum pressure	• Warm to cool • 21 ATM	• Cool • 101 ATM	• Refrigerator cold • 401 ATM	• Near freezing • 601 ATM	• Near freezing • 1101 ATM
Who lives there?	90% of all marine life, including all plants and most fish, turtles and mammals	Fish and squid with bioluminescence, jellyfish; eyes on fish are larger and point upward (to see silhouettes)	Red and black fish, squid, shrimps and specific animals on hydrothermal vents; some whales can dive to 3000 m	75% of ocean floor in this zone; e.g. basket stars, seastars, giant squid, tripod fish, ratfish	Crabs, prawns, tubeworms, snailfish, sea cucumbers, amphipods

Living shallow versus deep

Using the information in Table 2 and from the YouTube clips listed below, compare and contrast the different lifestyles, environmental conditions and physical adaptations of the Spotted Handfish and the Humpback Anglerfish.

https://www.youtube.com/watch?v=PN9Rc5DrOzw (Spotted Handfish)

https://www.youtube.com/watch?v=VqPMP9X-890 (Humpback Anglerfish)

Write a short information report about one of the fish. Alternatively, write a creative piece (e.g. a conversation, poem, comic strip, letter) from the point of view of one of the fish, explaining what life is like in their habitat.

Table 2: Living shallow versus deep: habitat and lifestyle profile

Name (common) (*Taxonomic*)	Spotted Handfish (*Brachyonichthys hirsutus*)	Humpback Anglerfish (Black Seadevil) (*Melanocetus johnsonii*)
	 (Image: Rick Stuart-Smith / Reef Life Survey, Tasmania)	 (Image: Public domain, from Brauer 1906)
Habitat	• Shallow	• Deep
Ocean zone	• Sunlight (Epipelagic)	• Midnight (Bathypelagic)
Light	• Bright light in day; moonlight at night • Photosynthesis possible	• Dark (even in daytime) • Has bioluminescent lure
Depth	• 5 metres	• 2000 metres
Distribution	• South-east Australia off Hobart only	• Atlantic, Pacific and Indian Oceans
Length	• Up to 13.5 centimetres	• Female – up to 18 cm; male – 3 cm
Mobility	• Walking on seabed	• Floating, drifting and burst swimming
Territory	• Small and restricted	• Large and not restricted
Eyesight	• Good	• Female – poor; male – good
Jaw	• Small jaw with small grinding teeth	• Expandable jaw, long needle-like teeth
Stomach	• Normal	• Large and elastic
Diet	• Small creatures on/in seafloor (e.g. worms, crustaceans, shells) • Feed constantly – ambush predators	• Small to large creatures in water column • Ambush predators, attract prey with bioluminescent lure, feed periodically
Reproduction	• Mature at around 2 years • 80–250 eggs laid around rigid pole-like structure • Direct development (egg to mini adult)	• Age at maturity unknown • Up to a million eggs released into a floating jelly sheet • Planktonic larvae (swim to surface to feed and migrate back down when older)
Lifespan	• 5–20 years (most less than 5 years)	• Estimated up to 30 years

Why am I vulnerable?

Return to the *Vulnerability checklist* presented by Handstand in the book (page 20). What does it mean if something is vulnerable? Identify the threats to the Spotted Handfish and the species' features that make it vulnerable.

Create a *Vulnerability checklist* for another marine animal, or any other threatened/endangered species, such as the Corroboree Frog, from the Red List shown in the book on page 15.

Use the information from the completed checklists to create a data display of picture and column graphs about threats to vulnerable threatened animals.

Taking action

Discuss the information in Table 3 or cut up the information and ask the students to read and reassemble it, matching impacts with solutions.

Interpret and represent selected threats and solutions creatively in one of the following ways:

- Create a narrative presentation through iMovie or Puppet Pals (or a similar story app).
- Write, rehearse and perform a short dramatic skit.
- Choreograph a dance sequence to demonstrate one impact and solution.

Table 3: Threats, impacts and solutions for the Spotted Handfish

Threat	Impact	Potential solutions
Invasive species (e.g. seastar came in ballast tank water)	• Destroys natural breeding habitat (Sea Tulips) • Competes for food and space • Disturbs habitat	• Place Artificial Spawning Habitat (ASH) like the poles on seafloor • Physically remove invader species • Stop dumping ships' ballast tank water in nearby waters
Pollution	• May poison or kill fish and its food organisms • Lowers the survival rate of juveniles	• Prevent or limit people or industry putting pollutants into waterways by introducing laws or penalties and surveillance
Siltation (from land clearing)	• Smothers fish and habitat • Destroys plant life • Limits photosynthesis by making water cloudy	• Improve land management in the adjacent catchments (prevent erosion of soil) • Stop cutting down trees nearby
Climate change (from too much green-house gas)	• Increases water temperature • Affects biological processes like breeding and egg hatching success	• Reduce greenhouse gas emissions • Build resilience of ecosystem by limiting other threats
Predation (natural)	• Being eaten or wounded by a predator reduces genetic diversity if population is small • May drive fish out of its home territory	• Try to help population numbers stay in a healthy range by monitoring, providing ASH and captive breeding programs
Boat anchors and moorings	• Remove plants and structural habitat from seafloor • Increase siltation	• Build and use environmentally friendly anchors and moorings • Prevent anchoring and mooring over 'critical' handfish habitat through laws or regulations
Fishing	• Fishing nets and dredges disturb and destroy seafloor habitat • May remove handfish from the seafloor and reduce population size and genetic diversity (and resilience)	• Ban fishing near 'critical' handfish habitat • Ban/limit fishing using nets and dredges that drag the seafloor • Education of fishing community
Rubbish	• Creates hazards and barriers for movement • May encourage predators to come for shelter • May be toxic	• Use good recycling programs in adjacent local councils • Use signs (and fines) to warn people about dumping rubbish • Education of the community
Competition from other animals	• May limit prey (food) availability • May limit space to live and move around in habitat	• Build resilience of ecosystem by stopping other threats • Try to stop invasive species becoming established
Aquarium trade – illegal capture	• Reduces size of population and breeding success • Reduces genetic diversity (and resilience of species)	• Educate public • Advertise fines and punishment • Volunteer community surveillance

Communicating conservation

Investigate the *Conservation report card* and *Conservation timeline* diagrams for the Red Handfish (at the end of these notes). Use these as models, and the book, to develop a conservation report card and/or conservation timeline story for the Spotted Handfish or another Australian endangered animal chosen by the class. Use information from these to create a brief presentation for the class or to make a class poster or album with the report cards.

Build a breeding structure

Discuss the solutions scientists came up with to help the Spotted Handfish with breeding. Complete a comparison matrix to compare the pros and cons of the Spotted Handfish using the Sea Tulip versus the artificial plastic and ceramic poles to lay their eggs around.

Make a breeding structure for the Spotted Handfish using recyclable materials. Surround it with made items to represent the habitat. Create some Spotted Handfish from papier mâché or plastic bottles (decorate these with unique spotted patterns).

Suggested YouTube clip:

https://www.youtube.com/watch?v=WFPDc_J_r0I (Ceramic artist creates artificial spawning habitat to help scientists save the Spotted Handfish)

Worksheets

Diagram: Life cycle of Spotted Handfish and Humpback Anglerfish

Diagram: Conservation report card – Red Handfish

Diagram: Conservation timeline – Red Handfish

Australian Curriculum Links

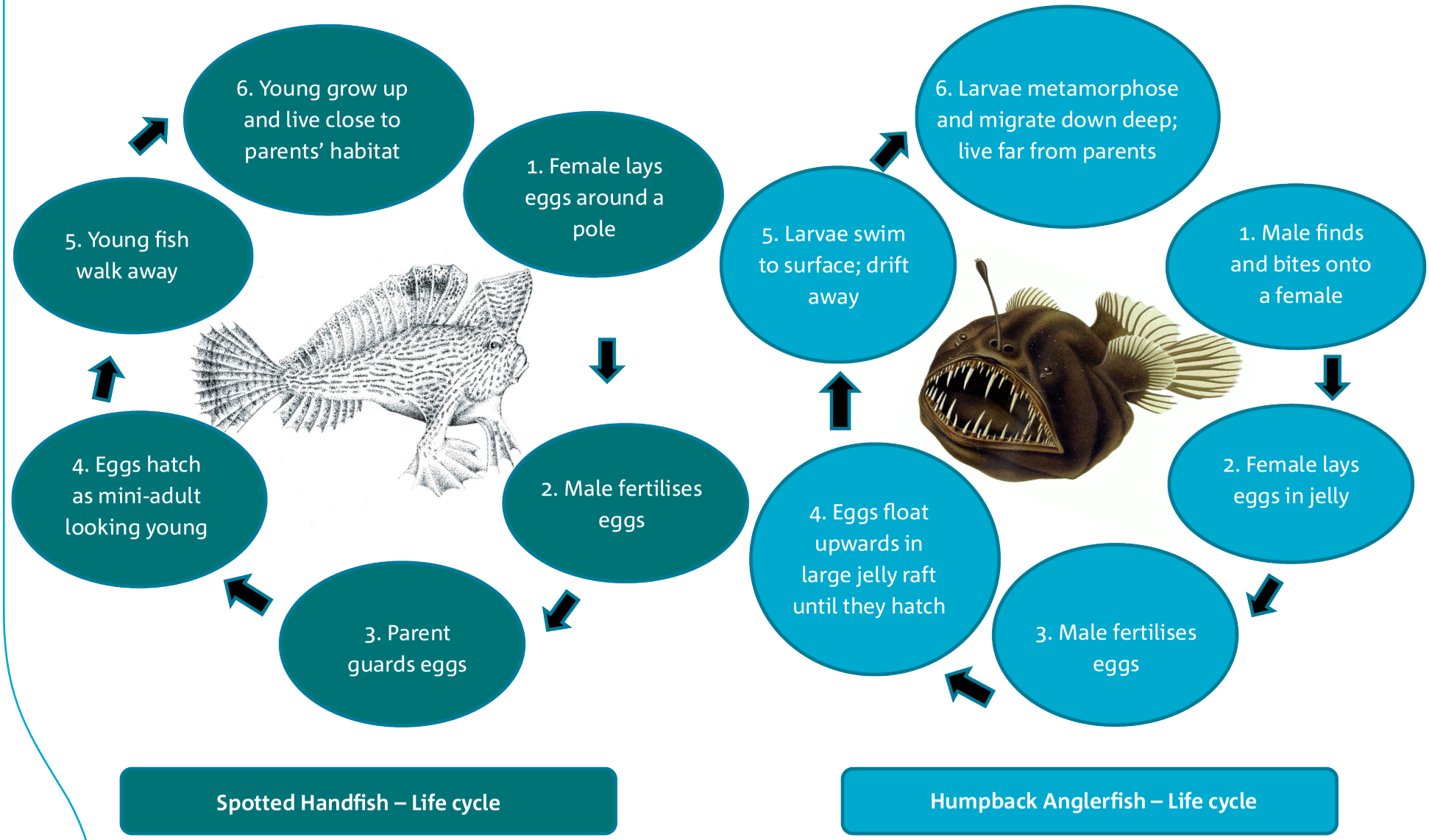
Year level	Learning area: Science	Other learning areas
Year 1/2	**Science Understanding: Biological Sciences** • Living things have a variety of external features ACSSU017 • Living things live in different places where their needs are met ACSSU211 • Living things grow, change and have offspring similar to themselves ACSSU030 **Science as a Human Endeavour** Science involves observing, asking questions about, and describing changes in, objects and events ACSHE021 and ACSHE034 **Science Inquiry Skills** • Participate in guided investigations to explore and answer questions ACSIS025 and ACSIS038 • Use a range of methods to sort information, including drawings and provided tables and through discussion, compare observations with predictions ACSIS027 and ACSIS040 • Represent and communicate observations and ideas in a variety of ways ACSIS029 • Compare observations with those of others ACSIS213	**English: Literacy** • Use comprehension strategies to build literal and inferred meaning ACELY1660 and ACELY1670 • Rehearse and deliver short presentations on familiar and new topics ACELY1667 • Create short imaginative and informative texts ACELY1661 and ACELY1671 **English: Language** • Understand the use of vocabulary ACELA1454 and ACELA1470 **Mathematics: Statistics and Probability** • Represent and create displays of data using objects, drawings, lists, table and picture graphs and interpret them ACMSP263 and ACMSP050 **The Arts: Visual Arts** • Create and display artworks to communicate ideas to an audience ACAVAM108 **The Arts: Dance** • Present dance that communicates ideas to an audience ACADAM003 **The Arts: Drama** • Present drama that communicates ideas ACADRM029 **Design and Technologies: Process and Production Skills** • Use materials, components, tools, equipment and techniques to safely make designed solutions ACTDEP007
Year 3/4	**Science Understanding: Biological Sciences** • Living things can be grouped on the basis of observable features and can be distinguished from non-living things ACSSU044 • Living things depend on each other and the environment to survive ACSSU073 • Living things have life cycles ACSSU072 **Science as a Human Endeavour** • Science knowledge helps people to understand the effect of their actions ACSHE051 and ACSHE062 • Science involves making predictions and describing patterns and relationships ACSHE050 and ACSHE061 **Science Inquiry Skills** • Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends ACSIS057 and ACSIS068 • Represent and communicate observations, ideas and findings using formal and informal representations ACSIS060 and ACSIS071 • With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS053 and ACSIS064	**English: Literacy** • Plan, draft and publish imaginative, informative and persuasive texts ACELY1682 and ACELY1694 • Plan and deliver short presentations, providing some key details in logical sequence ACELY1677 and ACELY1689 • Use comprehension strategies to build literal and inferred meaning ACELY1680 and ACELY1692 **English: Language** • Learn extended and technical vocabulary ACELA1484 • Incorporate new vocabulary from a range of sources into students' own texts including vocabulary encountered in research ACELA1498 **Mathematics: Statistics and Probability** • Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs ACMSP069 and ACMSP096 **The Arts: Visual Arts** • Present artworks and describe how they have used visual conventions to represent their ideas ACAVAM112 **The Arts: Dance** • Perform dances using expressive skills to communicate ideas, including telling cultural or community stories ACADAM007 **The Arts: Drama** • Shape and perform dramatic action using narrative structures and tension ACADRM033 **Design and Technologies: Process and Production Skills** • Select and use materials, components, tools, equipment and techniques and use safe work practices to make designed solutions ACTDEP016

Teacher Notes

Year level	Learning area: Science	Other learning areas
All	**Cross Curriculum priority: Sustainability** OI.2 All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival. OI.3 Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems. OI.4 World views that recognise the dependence of living things on healthy ecosystems, and value diversity and social justice, are essential for achieving sustainability. OI.7 Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments.	

Related books from CSIRO Publishing

Animal Eco-Warriors (2017)
Bouncing Back (2018)
Ocean Animals (2020)
Phasmid (2015)



Spotted Handfish – Life cycle

Humpback Anglerfish – Life cycle

Conservation report card

Common name:	Red Handfish
Scientific name:	*Thymichthys politus*
Conservation status (Australia – EPBC Act):	Critically Endangered
Conservation status (IUCN Red List):	Critically Endangered
Recovery plan:	2015; Under the EPBC Act – includes two other handfish species
Major threats:	Pollution, climate change, invasive species
Number left (mature individuals):	80 (2020 estimate)
Distribution:	**QLD ❑ NSW ❑ ACT ❑ VIC ❑ SA ❑ WA ❑ NT ❑ TAS ☑**

Endangered Aussie wildlife – conservation timeline story
Red Handfish

1840s

First discovered – The Red Handfish was first named by an English scientist after a specimen was found in coastal waters off Port Arthur, south of Hobart, Tasmania.

1974

Sea urchin moves south – The Long-spined Sea Urchin was first recorded off Tasmania's east coast. It had travelled south from NSW with the warming of the East Australia Current to invade the Red's home.

1980

100 years later – A few Red Handfish were discovered in waters off the Acteon Islands, even further south.

1990

Biggest population found – The biggest population of Red Handfish was found living around Primrose Sands Reef in Frederick Henry Bay, near Hobart, Tasmania. There were estimated to be 100s of them.

2000

Urchin barrens formed – By the year 2000, the Long-spined Sea Urchin had formed extensive barrens in reefs off southern Tasmania, destroying seaweed that Reds lay eggs on. This pest has contributed to the decline of Reds, along with other threats like pollution, poaching and warming seas from climate change.

2004

Threatened species – Listed as a *Vulnerable* threatened species under the EPBC Act.

2005

Disappeared – A scientific survey of the Primrose Sands population failed to find any Red Handfish. And, the first Recovery Plan under the EPBC Act for the Red Handfish was released.

2009

Renamed – Scientists realised it wasn't as closely related to the Spotted Handfish as they previously thought, so the Red Handfish was reclassified from *Brachionichthys politus* to *Thymichthys politus*.

2012

Uplisted – Placed into the higher conservation status category of *Critically Endangered* under the EPBC Act.

2014

Seen again! – Scientists spot the Red Handfish again at Primrose Sands and consider the population may be 20–40 fish.

2016

Second recovery plan – A revised EPBC Act Recovery Plan was released for three Handfish species, including the Red.

2018

Hit the jackpot! – A dedicated survey finds a second population of about 40 Reds, further south.

2019–2020

Captive breeding – 2019, the first Red egg mass hatches in captivity. Mum and young on display at Seahorse World.
2020 – Listed as *Critically Endangered* on the IUCN Red List.

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