Exploring Estuaries
A teacher’s guide to the estuaries in Victoria
Acknowledgements

Exploring Estuaries has been developed using the Water – learn it. live it. curriculum resource as a guide. Water – learn it. live it. is a joint initiative of City West Water, South East Water and Yarra Valley Water.

Produced by Corangamite CMA and EstuaryWatch Victoria: Sarah Bolus, Rose Herben and Kate Wynn

www.estuarywatch.org.au

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About this guide

One of EstuaryWatch’s primary goals is to increase public awareness and appreciation of our local estuaries.

This guide provides teachers and educators with a number of lesson plans linked to the Australian Curriculum. It supports estuary-related resources designed to enhance student understanding of estuaries and complements Interpreting Estuary Health Data and the Monitoring Your Estuary manual. Where referenced, readers are advised to visit organisations’ web sites to keep current, as content may change. There are also a variety of additional online sites not referenced that could be inserted as additional activities for your students to create their works, including flip-books, stop motion, animations, films and cartoons. Just use an online browser to find the information or program you require.

Using this guide

The activities within this guide investigate:

- What an estuary is and how they work
- What lives in an estuary
- Why estuaries are special
- Threats to estuaries
- How we can care for estuaries

Each topic has relevant lesson plans and activities for students from Foundation to Year 7 and includes a main activity and three options to explore the subject further.

The activity options are aimed at different levels of student ability, and are categorised as Engage (F-2), Connect (3-6) and Explore (7). Please note these are only to be used as a guide.

Supporting worksheets and thinking tools for each activity are in the appendices to assist students to clarify their processes and explore each topic. Lesson plans within the guide also refer to the EstuaryWatch education kit. The kit contains additional resources for educators such as props, craft supplies, posters and books relevant to lesson plans. Contact EstuaryWatch Victoria to book an EstuaryWatch education kit.

About the EstuaryWatch Program

In 2006, the Corangamite Catchment Management Authority and the Western Coastal Board set up EstuaryWatch, a community estuary monitoring program. The objective of the program is to increase the knowledge of the community and waterway managers to inform estuary management decisions and encourage waterway stewardship. EstuaryWatch groups are now active across Victoria, constantly watching our estuaries, collecting information to enter into an online database. Along with water quality monitoring, groups also photograph and record details of changing water levels, vegetation condition and the status of river mouths, i.e. whether they’re open or closed to the sea.

For more information about EstuaryWatch, visit www.estuarywatch.org.au or email us at: info@ccma.vic.gov.au
Introduction

What is an estuary?

Estuaries are an important link between the ocean and the land, where salty marine waters mix with freshwater from rivers and streams. Estuaries are dependent on fresh and saltwater to provide a healthy environment. The amount of freshwater flowing into an estuary can vary from season to season, year to year and location. These variations along with tide, sea state, light availability and even sediment in the water all contribute to creating unique environments.

Estuaries are as diverse in their physical form as they are in their state of health. However, they all share the distinction of being highly valued by the small communities living alongside them.

Estuary facts

• Estuaries rank along with tropical rainforests and coral reefs as the world’s most productive ecosystems.

• Many different habitat types are found in and around estuaries, including shallow open waters, freshwater and salt marshes, wetlands, sandy beaches, mud and sand flats, rocky shores, mangrove forests, tidal pools, and sea grass meadows.

• The protected waters of estuaries make them ideal breeding grounds for fish. Many fish species lay their eggs in estuaries or use them to migrate to freshwater. As a result, estuaries are often referred to as the nurseries of the sea.

• Estuaries are important filters in our environment. As water flows through estuarine wetlands, much of the sediment contaminants and pollutants washed from the land are filtered out by surrounding wetland plants, creating cleaner, clearer water.

• Estuarine wetlands act as storm buffers to prevent flooding, and minimise damage such as erosion caused by large storms.

• Estuaries play an important role in our economy. They provide tourism opportunities, attracting tourists who like fishing, boating and other recreational activities.

What are some of the problems facing estuaries?

• Urban development – housing, recreation and fishing.

• Habitat loss and degradation – clearing of vegetation, pollution or other sources.

• Agricultural activities – runoff from agricultural land can affect the health of estuaries. For example the use of certain fertilisers can increase nutrient levels and stimulate algal growth in estuaries.

• Damming and power stations – differences in water temperature can affect aquatic organisms. Cold water from dams and warm water from power stations are forms of thermal pollution that affect waterways.

• Industries – fishing and oyster farming can cause issues for water quality in an estuary. Over fishing and habitat loss reduces the number of fish and in turn affects the food chain.

• Boating – boating activities such as boat wakes, boat propellers and anchoring can cause bank erosion and damage fragile seagrass beds.

• Structures – breakwaters, drains, bridges, rock falls and other man-made structures affect the passage of water and conditions in an estuary. They can also have negative impacts on species that need to migrate from rivers to estuaries as part of their life cycle.

• Erosion – excess sediment in estuaries from erosion can smother seagrass and other aquatic vegetation. This reduces habitats and food sources.

• Litter – pollutants such as plastic and other non-biodegradable litter causes many issues in our marine and estuarine environments. For example, plastics can be mistaken by some marine species as food or it can entangle their appendages making it difficult to move.
**Estuary habitats and wildlife**

Thousands of species of birds, mammals, fish, and other wildlife depend on estuarine habitats. An estuarine habitat is a place within an estuary that provides food, shelter and a place to reproduce for living things. Habitat changes within an estuary occur due to the influence of fresh and saltwater.

There are two main habitat zones within estuaries:

- the **riparian zone** located above the high tide level
- the **intertidal zone** between the high and low tide levels, which includes mangrove and saltmarsh habitats.

**Intertidal zone habitat features**

**Seagrass beds/sand and mudflats**

Covered by tides for most of the time. May be uncovered twice each day for short periods

**Mangroves**

Covered by tides twice each day and exposed for greater periods of time.

**Saltmarsh**

Covered by tides for shorter periods less often.

**Riparian vegetation**

Rarely covered by tides unless from an extreme weather event e.g. floods. Typical habitat zones within estuaries are illustrated in the cross-section below.

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**Figure 1** Estuarine habitats
Introduction

Types of habitats:

Seagrass: salty and wet
Estuary species: many species of crab and fish, rays, birds, pipe fish and shrimp.

Seagrasses occur in the intertidal and sub-tidal zones of estuaries. The area of seagrass beds can be highly variable seasonally as seagrasses die back during the cooler months and re-establish in warmer months of the year.

Seagrasses are the only flowering plants that can live underwater.

Seagrasses are particularly valuable as nursery, feeding and shelter areas for many aquatic animals, including commercially and recreationally important fish, crabs and prawns. Seagrass meadows are renowned worldwide as rich and productive nursery areas for juveniles of economically important species. Research in the Mediterranean has found that 400 square metres of seagrass can support up to 2000 tonnes of fish a year.²

Like other estuarine vegetation, seagrasses contribute organic matter to the food chain, and remove nutrients from the water.

Seagrasses also baffle water currents, causing them to drop their sediment loads, thus maintaining water quality.

Seagrasses are, however, a fragile habitat. Some species can recolonise areas but others cannot and are particularly sensitive to disturbance or impacts.

Sand and mudflats: salty and usually wet
Estuary species: snails, whelks, pipis, amphipods, flatworms, polychaetes, fish, many species of crabs and birds.

Mud flats and sand flats are the most common habitats in estuaries. They support a very diverse benthic (bottom-dwelling) community, including worms, crabs and yabbies. This, in turn, provides food for many fish species such as flathead and whiting.

Mangroves: salty and wet and occasionally dry
Estuary species: mangroves, snails, whelks, many species of crabs, barnacles, fish and birds.

Mangroves grow along the shores of many Victorian estuaries. Mangroves are important habitats for fish, crabs, birds and other animals. Mangrove trees provide large amounts of organic matter, which is eaten by many small aquatic animals. In turn, these animals provide food for larger fish and other animals. Mangroves also help maintain water quality by filtering silt from runoff and recycling nutrients.

Mangroves play a vital role in protecting foreshores from erosion due to storm surges and wind and wave conditions.
Saltmarsh: salty and fresh water, wet during high tide

Estuary species: snails, crabs, birds, including migratory birds and fish.

A saltmarsh is a community of plants and low shrubs that can tolerate high soil salinity and occasional inundation from salt water. Saltmarshes occur at the upper levels of the intertidal zone, often behind mangroves, and, while they're not subject to daily tidal inundation, they're flooded by larger tides and semi-permanent pools of brackish water.3

Did you know ...

41 fish species are known to use saltmarsh areas, including black bream, sand whiting and various mullets.4

Saltmarshes play an important role as a habitat for juvenile species such as bream and mullet. Crabs are common in saltmarsh communities, and are a significant food source for bream and other fish species. Some species, such as common galaxias (Galaxias maculatus), deposit their eggs in saltmarsh vegetation.

Saltmarshes also act as a buffer and filtration system for sediments and nutrients.

Importance of estuaries

Estuaries provide us with a suite of resources, benefits, and services. Some of these can be measured in dollars and cents, others cannot. Estuaries provide places for recreational activities, scientific study, and aesthetic enjoyment.

Thousands of species of birds, mammals, fish, and other wildlife depend on estuarine habitats as places to live, feed, and reproduce. And many marine organisms, including most commercially-important species of fish, depend on estuaries at some point during their development. Because they are biologically productive, estuaries provide ideal areas for migratory birds to rest and re-fuel during their long journeys. Because many species of fish and wildlife rely on the sheltered waters of estuaries as protected spawning places, estuaries are often called the “nurseries of the sea”.

Estuaries have important commercial value and their resources provide economic benefits for tourism, fisheries, and recreational activities. The protected coastal waters of estuaries also support important public infrastructure, serving as harbours and ports vital for shipping and transportation.

Estuaries also perform other valuable services. Water draining from uplands carries sediments, nutrients, and other pollutants to estuaries. As the water flows through wetlands such as salt marshes, much of the sediments and pollutants are filtered out. This filtration process creates cleaner and clearer water, which benefits both people and marine life. Wetland plants and soils also act as natural buffers between the land and ocean, absorbing flood waters and dissipating storm surges. This protects upland habitat as well as valuable real estate from storm and flood damage. Salt marsh grasses and other estuarine plants also help prevent erosion and stabilise shorelines.4

For further information and detailed notes on the above information and topics covered in the lesson plans refer to the following documents contained within the kit:

- Estuary Guide, Waterwatch NSW
- Interpreting Estuary Health Data, EstuaryWatch Victoria

References

1 Department of Environment, Climate Change and Water, NSW (2010), Waterwatch Estuary Field Manual. Department of Environment, Climate Change and Water, NSW.
The following section is a compilation of lessons and activities prepared by EstuaryWatch educators. They are intended to provide you with opportunities to include estuary education into your classroom.

The lessons are broken into three sections: introduction to estuaries, plants and animals of an estuary and caring for our estuaries. Each section provides a collection of relevant activities for students from Foundation to 7 and includes a main activity supported by three scaffolded options to explore the subject further.

The scaffolds are aimed at different levels of student ability, and are categorised as Engage (Foundation-2), Connect (3-6) and Explore (7). These categories are a guide only, and you may find an activity that suits your students in any of the sections.

Supporting materials such as worksheets, thinking tools and graphic organisers are also included in the appendices to assist students to clarify their processes and explore each subject. Further resources are also included in the EstuaryWatch education kit if you wish to explore additional topics related to estuaries.

Below are the unit lesson outlines. Icons have been used to indicate the subject area to which the activity belongs. An activity matrix has also been included to allow you to easily identify the learning style and area each activity belongs.

### Educational unit lesson outlines

#### Educational standards

The sample lesson plans in this kit can be related to F-7 curriculum standards for Australia. The links to relevant subjects are outlined in the table below. For specific learning strands and achievements, please refer to the Australian Curriculum online: [http://www.australiancurriculum.edu.au/](http://www.australiancurriculum.edu.au/)

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<tr>
<th>Part</th>
<th>Subject area</th>
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<td><strong>One: Introduction to estuaries</strong></td>
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<td><strong>Three: Caring for our estuaries</strong></td>
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<td>The secret life of eels</td>
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**Subject Key**

- ![Science]
- ![English]
- ![Environment]
- ![Geography]
- ![Maths]
# Activity matrix

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<th>Activity Name</th>
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**Activity Key**
- 🧠 Hands on Activity
- ⚡ ICT
- 🖋️ Pen and Paper
Estuaries are bodies of water and their surrounding coastal habitats, found where rivers meet the sea. Estuaries contain many unique plant and animal communities because their waters are brackish—a mixture of fresh water draining from the land and salty seawater.

Estuaries are some of the most productive ecosystems in the world. Many animal species rely on estuaries for food and as places to nest and breed. Human communities also rely on estuaries for food, recreation, and jobs. At the completion of this lesson students will be able to define an estuary and some of the influencing factors that make them unique environments.

Main activity

Materials:

In the EstuaryWatch education kit:
- Estuary mystery bag containing:
  - seagrass ball
  - cuttlefish bone
  - rubbish
  - estuary mud
  - shellfish
  - crabs
  - mangrove seeds and roots
  - silver gull feather
  - glasswort
  - black swan
  - black bream
  - stingaree
  - eel
  - flounder
- Lotus diagram worksheet (Appendix 1)
- blind fold
- The secret bay

To source/access:
- pens, pencils, workbooks
- internet

Method:
1. Introduce the topic of estuaries to the class with the help of the estuary mystery bag activity.
2. Read The secret bay.
3. Determine and define what an estuary is.
4. Use the lotus diagram template to create a list of inspiring words related to estuaries. Think about the story, also what they look like, what sounds you might hear, or what activities you might do when visiting them.
Engage

Use the words and imagery from the story *The secret bay* to inspire a piece of artwork.

Connect

Find an image of an estuary that inspires you. Try writing your own poem, song or Haiku, to reflect your chosen image. Collate all of the class work and present it as an anthology. Ensure you comply with any copyright restrictions for any images if you wish to publish this anthology for use outside your classroom.

Explore

Use some water images you have found to inspire your own story or poem, using descriptive language. Research how other authors and poets have used estuaries as a symbol in their writing to help you integrate it into your work.

The estuary mystery bag instructions:

1. Call a volunteer to the front of the classroom. Blindfold the volunteer and ask them reach into the bag and remove one object, or place an object in their hands. The object should be held out for the class to see. Younger students may need reminding not to give away the objects identity.

2. Ask the volunteer to feel and smell the object and describe the sensations to the class. Provide descriptive words for the volunteer to choose from if needed. The volunteer then needs to guess what the object is. If unable, have the class assist.

3. Remove the blindfold so that the volunteer can see the object.

4. Repeat for several volunteers and objects. 

5. Ask students to review all the objects they felt in the bag. Which ones were plants? Which ones were animals? What was living? What were non-living components? etc.

6. Ask students where they think the objects are found? Do students have an estuary in their area, or have they ever visited one? Have them describe their experiences there and things they may have discovered – e.g. plants and animals.

Haiku’ is a traditional form of Japanese poetry. Haiku poems consist of three lines. The first and last lines of a Haiku have five syllables and the middle line has seven syllables. The lines rarely rhyme.

*Here’s a Haiku to help you remember:*

My / first / line / has / five
Then / se/ven / in / the / mid/dle
Five / a/gain / to / end
Main activity

Materials:

In the EstuaryWatch education kit:
- Two small clear screw top containers
- food colouring
- 1/4 teaspoon measuring spoon
- dropper/pipette
- student Mixology POE worksheet (Appendix 2)
- students Mixology lab report (Appendix 3)

Method:

1. Half fill a small clear screw top container with freshwater.
2. Add 1/4 teaspoon of salt. Put the top on the container and shake to mix well. This represents saltwater flowing into an estuary.
3. Fill another small clear screw top container with freshwater and add three drops of food colouring. This represents freshwater flowing into an estuary.
4. Hand out the student Mixology Predict, Observe, Explain (POE) worksheet. Explain that you are about to mix fresh and saltwater—something that occurs in an estuary when the river meets the sea. Have students record their prediction on the POE worksheet of what they think will happen.
5. Fill a dropper with the coloured freshwater from the container.
6. Unscrew the cap from the container of saltwater and tilt the container at an angle.
7. Hold the dropper so the open end touches the inside of the container and squeeze the dropper very slowly and carefully. Let the freshwater trickle down the inside of the container into the saltwater. Do not shake or move the container when you’re adding freshwater.
8. Continue adding freshwater until you have about a two centimeter layer on top of the saltwater. Allow the water in the container to sit for a few minutes.
9. Put the top on the container and shake. Observe what happens. Use the worksheet and have students record what they have witnessed.
10. Have students try to explain what occurred.

What happened when freshwater was added to saltwater in the experiment? Explain why. Hint: mention layers and water density

What happened when the container was shaken? Explain why. Hint: mention salinity (shown by colour) and layers

Because the densities between the water masses are different due to salinity. Density is a function of mass:

\[
\text{Density} = \frac{\text{mass}}{\text{volume}}
\]

The same way that sediment will form layers based on weight e.g. larger sand particles will form the bottom layer, water masses will form layers based on weight. The temperature and amount of salt in water determines its density. Cold, salty water has more mass per volume, therefore greater density, and will sink to the bottom.

These dynamics are important, for example:

In estuaries, fresh water from rivers and creeks meets salt water from the ocean. The fresh water tends to float above the salt water until it is mixed by wind or water currents. The stratification of fresh water and salt water affects the way organisms and sediments are distributed.

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**Engage**

Conduct or observe the experiments in the main activity, then record your observations in the Mixology POE worksheet.

**Connect**

Conduct or observe the experiment in the main activity then record your observations in the Mixology POE worksheet. Investigate the dynamics of water in estuaries further and present your results in a creative way such as a poster or informative video.

**Explore**

Conduct or observe the experiments in the main activity, then record your observations in the Mixology lab report template worksheet. The experiment outlined under the Main Activity explores the density and dynamics of water within an estuary, but water has a range of other amazing properties. Design another experiment that shows how estuaries work when saltwater meets freshwater or create a video to explain estuaries-where the river meets the sea to a younger audience.

* Lesson adapted from Waterwatch Estuary Guide: A guide to community monitoring of water quality and estuary health; Department of Environment, Climate Change and Water NSW 2010
A habitat is a place that provides food and shelter for living things. In an estuary habitat changes occur due to the influence of fresh and salt water. The salinity of the water determines whether the habitat provides food and shelter for fresh or saltwater species, or organisms adapted to both. Therefore, the influence of tides within estuaries affects the types of plant and animal species found.

There are three main habitat zones within estuaries:

- The riparian zone located above the high tide level.
- The intertidal zone between the high and low tide levels, which includes mangrove and salt marsh habitats.
- The marine zone which is covered by tides for most of the time.

### Habitat features

#### Marine zone

**Seagrass/mudflats**

Covered by tides for most of the time. May be uncovered twice each day for short periods

#### Intertidal zone

**Mangroves**

Covered by tides twice each day and exposed for greater periods of time

**Saltmarsh**

Covered by tides for shorter periods less often

#### Riparian zone

**Riparian vegetation**

Rarely covered by tides unless from an extreme weather event e.g. floods

### Main activity

**Materials:**

**In the EstuaryWatch education kit:**

- Fish models
- Estuary habitat posters
- Estuarine habitat cards (Appendix 4)

**To source/access**

- Pictures of estuaries (sourced from magazines or online)
- Craft materials (optional)
- Access to internet (optional)
- Access to PowerPoint (optional)

**Method:**

1. Determine what a habitat is, and what animals would need to survive in that habitat through either brainstorming as a class or researching online.

You may want to use the fish models contained in the kit to begin the discussion, i.e. ask students where a fish lives and what components it would need to survive e.g. food, water, shelter and space.

Do all fish live in the same type of environment? Have them imagine how it would be if all class members lived in the same house. Ask if they think animals could all live in the same type of habitat.

2. Re-define what an estuary is if needed. Explain that it contains many different habitats to allow a wide range of organisms to live there.

3. Undertake the estuarine habitat jigsaw activity using the habitat cards.
Estuarine habitats jigsaw instructions:

Divide students up into groups of four.

Appoint one student from each group as the leader.

Divide the habitat cards* up and place a different card in each corner of the room (see Appendix 4).

1. Seagrass beds
2. Sand and mudflats
3. Mangroves
4. Saltmarsh

Assign each student within the group, a different corner of the room.

Give students time to familiarise themselves with the habitat they have been assigned.

Form temporary ‘expert’ groups by having one student from each group join other students assigned to the same habitat.

Bring students back into their jigsaw groups.

Have students present their information to the group. Encourage others in the group to ask questions for clarification.

Float from group to group, observing the process.

At the end of the session, give a quick quiz on the types of habitats within an estuary.

Engage

Create a collage of photos and drawings to represent the different habitats in an estuary. Write some words and sentences to describe them. Present this information as a poster and display it in your classroom.

Or

As a class, discuss how you can identify the different habitats within an estuary. Hold a line race in your classroom. In heats, line up at the starting point. Students will be shown a picture of one type of habitat or an organism that can be found in a particular habitat found in an estuary. The first student to put their hand up and correctly name the type of habitat or organism will get to take a step forward. Bonus points can be given if they can add extra information. Repeat until a winner reaches the finish line. Have heat winners play off in a grand final.

Connect

In groups, use craft supplies to create an estuary with all the habitats contained. You may like to use the estuary habitat cards and marine discovery posters contained in the education kit to assist you. Annotate your model that include the most important features of your estuary. When you have finished, deliver a short presentation describing your estuary to the class.

Explore

In pairs, create a model of an estuary with all four habitats using craft supplies. Be sure to include and annotate the specific features of your estuary, and explain the role they play and what lives within them. Rotate through the class to see what other students have created.

Then, research the potential threats to each habitat. Who and what is impacted by them and how? Present your findings to the class with a short oral presentation using Power Point. You may also like to imagine you’re a local land owner, fisherman, tourist or the catchment manager, and hold a debate about one of the threats and the impact it would have on each of the user groups.

* The habitat card information contained within the following cards has been taken from the NSW Waterwatch Estuary guide, 2010.
Estuaries are important environments for a range of reasons. They support a diversity of wildlife, including shore birds, fish, prawns, crabs, oysters and other shellfish, marine worms, marine mammals and reptiles. These animals are linked to one another through complex food webs. Many fish species and crustaceans spend their early life stages in the protected, nutrient-rich waters of estuaries. Birds such as the white-bellied sea eagle, the pelican and silver gull also visit these areas to nest and feed.

Estuaries are important filters. Water from catchments carries sediment, nutrients and other pollutants that can be filtered by plants within the estuary. This creates cleaner water, which benefits both people and marine life.

Estuaries reduce the impacts of floods and storms
Wetland plants and soils also act as a natural buffer between the land and ocean, absorbing flood waters and reducing the impacts of storm surges. This protects land-based organisms. Saltmarsh grasses, seagrasses, mangroves and other estuarine plants also help prevent erosion and stabilise the shoreline.

Economic importance
Estuaries are a nursery for many commercially important fish and crustacean species. Important commercial and recreational fishing estuary-reliant species include king prawn, black bream, blue swimmer crab and yellow-eye mullet. The fishing industry relies on healthy estuaries.

Recreational benefits
Fishing, ecotourism, boating and swimming are important recreational activities in estuaries.

In this activity students will consider a selection of common objects as physical metaphors for natural estuary functions. Students should understand the benefits of estuaries as resources for both humans and other species. This activity brings those benefits to life and encourages an appreciation of the important roles estuaries play.

Main activity

Materials:

In the EstuaryWatch education kit:
The mystery metaphor box: (containing)
- Sponge
- Small pillow
- Egg beater
- Baby dummy
- Strainer
- Swim cap
- Toy boat
- Food wrapper

To source:
- Paper and pencils

Method:

1. Provide the class with background information on the natural functions of estuaries and their value as habitat. See fact sheets and other information contained in the education kit. Introduce estuaries through posters, pictures, stories etc. How do the students feel about estuaries? Do they think they are important/why? Discuss students answers and make a list of pros and cons on the board.

2. Explain that a metaphor is the use of another thing or idea that is symbolic or representative of it i.e. a tree is a home. Have students come up with other examples. The objects in this activity are tangible symbols of estuary benefits. Expand the pros and cons list through the use of metaphors.

3. Divide the class into groups of four or five. Ask a representative from each group to choose an item from the mystery metaphor box. Each group must decide how the object could represent what an estuary is or does. All items in the bag have something to do with estuaries.

4. Allow time for students to discuss their answers in groups before each group presents it’s object and ideas to the class. Examples are given in the table below, but students may come up with other clever ideas.

5. As students report to the class, discuss each idea and invite others to add their own ideas. Add to the list of pros on the board. At the end ask the class to summarise the major roles that estuaries perform.
<table>
<thead>
<tr>
<th>Object</th>
<th>Metaphoric function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sponge</td>
<td>Absorbs excess water caused by run off or is a buffer zone that helps prevent erosion</td>
</tr>
<tr>
<td>A pillow</td>
<td>A resting place for migratory birds</td>
</tr>
<tr>
<td>Egg beater</td>
<td>Mix of fresh and salt water (where the river meets the sea) or mixes nutrients and oxygen into the water</td>
</tr>
<tr>
<td>Baby dummy</td>
<td>Provides a nursery that shelters, protects and feeds young wildlife</td>
</tr>
<tr>
<td>Strainer</td>
<td>Strains silt, debris and other pollutants from the water</td>
</tr>
<tr>
<td>Swim cap</td>
<td>Provides recreational activities like fishing, canoeing, swimming and boating</td>
</tr>
<tr>
<td>Toy boat</td>
<td>Provides important infrastructure such as boating and shipping harbours</td>
</tr>
<tr>
<td>Food wrapper</td>
<td>Food production, many commercial fish species spend part of their lives in estuaries, or provides important food source for the organisms that live or use an estuary.</td>
</tr>
</tbody>
</table>

**Engage**

Have students prepare an estuary benefits booklet, each student contributing one page.

**Connect**

Make a sign with your own slogan about the benefits of estuaries.

**Explore**

Write an essay or create an interactive poster that explores the importance of estuaries. Visit the internet for some inspiration and some fascinating facts to include in your work.
Estuaries are the fish nurseries upon which larger ocean life depends. Fish like bream, eels and flounder and fauna like sponges, shrimp, oysters, pipefish are found throughout. Students will select organisms characteristic of the estuary. They will then draw life-size sketches, cut out and create magnets for a “fishing” game.

Main activity

Materials

In the EstuaryWatch education kit
- Fish models
- Field guides books
- Marine and estuary habitat posters
- Fishing rod (dowel with string and magnet attached)
- Puzzle template (Appendix 11)

To source/access
- Drawing paper, rulers, pens, colouring materials, laminator and laminating sleeves (or hard card if not accessible), magnetic tape, foil tray, note cards and ball of wool.
- Animal photos (can be sourced from the internet)
- Internet access

Method

1. Discuss the importance of estuaries as habitat for a variety of wild life.
2. Using the marine habitat posters from the education kit or the internet, have students select an organism found in one of the estuarine habitats.
3. Using field guides or undertaking an internet search, have each student draw and illustrate their chosen organism in life size on paper, as close as possible to the real thing. Many fish and other animals can vary in size according to age so there is some flexibility here, but older students should use rulers to measure height and width of their drawing for accuracy.
4. Once complete, laminate the drawings and then cut out each organism around its body outline.
5. Using magnetic tape on the animal, create a magnet out of the organism.
6. Discuss what a basic food chain is.
7. Using a magnet surface, arrange organisms in food chains according to predator prey relationships.
8. Discuss how humans can eventually be fed by the fauna of an estuary e.g. fish nursery.
9. Put magnet fauna in foil tray, or on “fishing area” designated on the ground. Have students fish for their organisms by using a magnet fishing rod. Have them identify their ‘catch’ and either something it eats or is eaten by. If they can’t identify the organism they “catch”, they must release it back into the estuary and lose a turn. The level of difficulty can be increased according to the amount of detail required to know the organism.

The student with the most organisms wins the game.
Engage

Have students create a classroom field guide of organisms of estuaries. Have each student submit one organism to the book.

Connect

Using the puzzle template worksheet (Appendix 9) create a set of match cards that could be used by the younger students, to teach them about the different organisms in estuaries. Each card should include an image (drawn or sourced) and set of features for that organism.

Or

In groups have students design their own estuary game that allows them to identify animals within an estuary environment and how they connect with each other in a food chain. Have groups test each other’s games.

Explore

Have students research and design a estuary food web that includes their organisms. Play the estuary food web game.

Food web game instructions:

Write the names of organisms from the estuary food web on note cards. If there are more students in the class than species, duplicate lower level species, there are generally more plants, insects, bacteria, and small animals in an ecosystem than large animals.

Each student draws one organism note card. Students announce their organisms to the class and discuss the roles they play within the ecosystem.

Have one student start with the ball of wool. Using the food web diagram as a guide, this student will hold the end of the wool and toss the ball to a classmate, explaining how the two organisms interact.

The recipient of the ball will keep hold of the wool strand and toss the ball to another student, explaining their connection. The wool toss will continue until every student in the circle is holding at least one strand of wool.

When all organisms are connected, observe the complex “web” that has been formed by the wool. Are there even more connections than students expected?

Single out a particular species, and cut the wool strand(s) that are being held by that student. This represents extinction. The species has been removed from the ecosystem forever.

Discuss how the web collapses when the yarn is cut, and identify which species appear to be most affected. Speculate about what might happen to other species in the web when one organism is extinct. For example, if the extinct animal was a predator, its prey may become overpopulated and deplete other organisms in the web. If the extinct animal was a prey species, then predators that relied on it for food may also become extinct.
Section 1

Lesson 6: Monster mash*

How can animals live in such different habitats? Animals and plants are adapted to the conditions of the habitats where they live. Animals can be found in all habitats within an estuary. Animals can live in these environments because they have special adaptations to the area they live in. An adaptation is a way an animal’s body helps it survive, or live, in its environment.

Examples of the basic adaptations that help creatures survive:

- Shape of a bird’s beak
- Colour of the fur or feathers
- The thickness or thinness of the fur
- The shape of the nose or ears.

Animals can also use mimicry adaptation. Mimicry is adapting to look like something else. An example would be the hawkmoth as it looks just like a dead leaf, tattered and veined.

Students will engage in a class discussion about why animals have certain features, and why they need them to survive. Following the discussion students will be given the opportunity to create their own estuarine animals using recyclable materials. Students are responsible for designing and constructing their animal, as well as writing about where it lives, what it eats, and what essential features their animal has in order for it to survive in its estuary habitat.

Main activity

Materials

In the EstuaryWatch education kit:
- Fish models
- Field guides
- Animal life in an estuary worksheet (Appendix 5)

To be sourced:
- Recyclable craft materials e.g.
  - Paper towel rolls, toilet paper rolls, cereal boxes,
  - tissue boxes
  - Construction paper, straws,
  - Egg cartons, string, newspaper, cardboard,
  - buttons, feathers, etc.
- Glue, tape, scissors, markers, crayons
- Chart paper and post-it notes for graphic organisers
- Pictures of estuary animals (internet or use field guides contained)

Preparation before class:

This lesson require some preparation before class. Create an estuary mythical being from recyclable materials that demonstrates various adaptations for living in an estuary.

Method:

1. Open up discussion to the class: What is the strangest looking animal you have ever seen? How do you think it got that way? Why does it have those specific features e.g. fins, claws etc? Discuss generally what an adaptation is.

2. Divide students up into groups and provide students with models and pictures of real animals provided in the education kit or sourced from the internet. Have students read the accompanying information about their animal and complete the animal life in an estuary worksheet, recording various details about their animal and the different features they have to survive in an estuarine environment.

3. With the class make a list of animal features so students have a visual aid.

4. Discuss how these can be combined to create a new estuarine animal.

* This lesson is follow up to lesson 5
5. Following the discussion with the class, and why animals have certain features, introduce an animal you have created to the class. Describe to students what the animal is, its name, where it lives in the estuary, what it eats, and why it has certain features. For example, the animal has claws because it lives in the mudflats and needs claws to protect itself from predators and catch its food.

6. Answer any questions the students may have about the animal.

7. Inform students that they will be designing and constructing their own animal.

8. Remind students of the different features we’ve been talking about, and how different animals have different characteristics. Ask students for a few examples.

9. Create a graffiti wall/board with the class:
   Have students write different animal characteristics and materials they can use from the recycled materials in the classroom to create their animal on post-it notes.

10. Have students place their post-it notes on posters with the headings “Materials” and “Characteristics”.

11. Have students talk about what they wrote, why etc. You don’t have to go through everyone.

12. With the class, create a checklist of things they have to do so the expectations are clear.
   Each student will:
   • Draw a picture/sketch of what they want their animal to look like. Students will show this drawing to the teacher before they move on to creating their animal.
   • Label the picture and identify body parts, special features and jot down ideas about what materials would be best for creating their animals/which materials they want to use for each part.

   Students will consider the following questions before creating their animals:
   • Where does your animal live in the estuary?
   • What physical features (body parts, behaviours) does it need in order to survive in that environment? e.g. Wings, fins, claws, patterns on its skin etc.
   • What does your animal eat?
   • What is your animal’s name?

13. Based on the sketch/picture of their animals, students will begin constructing their animal with the recyclable materials that have been provided or with materials they have brought in from home.

14. Monitor students and provide assistance where necessary

15. Remind students their animal’s features/body parts have to serve a purpose – what will help the animal survive in the estuary habitat e.g. mangroves, saltmarsh, mud flats e.g. they have chosen?

16. Have students complete another animal life in the estuary worksheet, using their own created animal to fill in the boxes.

17. Students can also record how they made their animal, what materials they used on the back of the worksheet.

18. After students have finished, have them pair up with an “elbow partner” and present their animal to their classmate. Have students tell their partner everything about their animal, how they made it and how they came up with the idea.

19. After students have finished discussing in partners, conduct a “popcorn discussion” (pop around the class and have individual students explain their created animal) as a class. Ask students something they found interesting about their partner’s animals.

---

**Engage**

Have students create a story using their animal as the main character, students could also incorporate their classmates’ animals. Stories could be undertaken using a “Choice Board” (students choose a way to represent the story based on the way they like to learn):

- **Kinesthetic**: kinesthetic learners will create a dramatic presentation using their creatures
- **Visual**: visual learners will create comic strip involving their creatures
- **Linguistics**: linguistic learners will write a short story about their animals

**Connect**

Students can link their animal to the life cycle – how would your animal grow?

**Explore**

Students can discuss how their animals positively or negatively affects the environment, and how the environment affects their animal.
Exploring Estuaries
A teacher's guide to the estuaries in Victoria

Section 1

Lesson 7: Rusty loses his loop

The human use of catchments has modified the natural environment. This has changed both the quality of our water, and the way that water flows (quantity), effecting the native vegetation, animal life and soils. Human impacts upstream have a flow-on effect downstream in estuaries.

Most of the Australian population lives on or near the coast. This means that most people live near an estuary. The continuous urbanisation and development of our coastal environments directly affects the health of our estuaries.

Main Activity

Engage

As a class, discuss the themes in the story about Rusty. Create a four to six frame comic strip reflecting what happened in the story. You may like to turn this into a short play to present to the class.

Connect

Discuss the story as a class, what are some of the issues that faced Rusty and the Coorong estuary. Do you think it is realistic? What other issues might estuaries face—pollution, development etc. Create four images showing the different stages of the story start, middle, end and insert one with an action you could do to help Rusty and your local estuary, with captions for each. Alternatively, read the human impacts in estuaries fact sheet and use the story map template to help you write a re-telling of the story, choosing another impact facing estuaries e.g. pollution, development, and include a happy ending with a solution to the issue written about.

Explore

Conduct a discussion about the issues raised in the story Rusty Loses His Loop. What other issues might estuaries face? (Use human impacts in estuaries fact sheet for guidance).

Allocate an issue to each student. Using the ripple effect worksheet and other resources (online search, library or other), determine the consequences of the particular issue for the organisms that live in, around or use an estuary and humans.

Finally have students come up with potential solutions to the issue raised.

Students can now begin with brain-storming potential conservation messages and designs for a poster, bag, banner, badge or other material you have decided upon. They can then use a range of materials to create them.

Display your posters, bags or other created items in the school or local community.

Materials:

In the EstuaryWatch education kit
- Rusty Loses His Loop
- Human impacts in estuaries fact sheet (Appendix 6)
- Story map template (Appendix 7)
- Ripple effect worksheet (Appendix 8)

To source/access
- Craft materials

Method:
1. Read Rusty Loses His Loop to the class.
Lesson 8: The secret life of eels

The common eel is not thought of often. However they live an extraordinary secret life. These snake-like fish spawn thousands of kilometres north in the warm waters of the Coral Sea. The tiny babies, called glass eels because they are transparent, are carried by currents down the east coast of Australia until they reach Port Phillip Bay. Then the sense the freshwater and follow it, moving upstream, and travel as far inland as they can reaching farm dams and small streams in the upper catchment.

When they enter freshwater they turn black and become juvenile elvers. They live there just feeding themselves until they get to 1 kilogram and mature, which takes between 10 to 35 years. Then the eels start the long trip back to the sea and migrate north to complete their amazing life cycle.

Short-finned eel were once widespread and common in many of our waterways, however their numbers are declining. Human impacts such as increases in population and urbanisation in our community have had a negative effect on water quality and quantity. Many streams in our community are no longer able to support the healthy eel populations it once did. Water flowing over impervious surfaces – roads, parking lots, driveways, and roofs collects and carries contaminants such as oil, petrol and pet wastes into the creeks and rivers. In residential areas, high levels of nutrients from lawn and garden fertilisers, and pesticides can seep into rivers and streams. Native plants and trees along stream corridors have been destroyed. Culverts, dams and weirs block downstream migration making it harder or impossible to reach their breeding ground. The result has severely impacted eel and other migratory fish habitats.

Organisations such as catchment management authorities are helping to restore migratory routes of species such as the short-finned eel by installing fish ladders over barriers, undertaking revegetation projects and monitoring the health of waterways.

Main activity

Materials:

In the EstuaryWatch education kit:
- Incredible life cycles of eels poster
- Life cycle of an eel worksheet (Appendix 9)

To source/access
- String or pipe cleaners
- Coloured beads (12 beads per student – beads of at least 8 different colours)

Bead color suggestions:
- White – eel egg
- Clear – Glass eel
- Green – Elver
- Brown – Adult eel
- Pink – Ocean/Vanuatu
- Light Blue – Estuaries
- Dark Blue – Freshwater
- Black – people/human impacts

Special bead – pledge
- Red – other threats/predators etc;

Picture puzzle template (Appendix 11)

Method:

Preparation:

Create an eel life cycle bracelet to use as an example.

1. Explain that each student is going to create a story about the life of an eel. Show the bracelet/lanyard (you can mention that if they don’t want to keep it on their wrist they can hang it off of their backpack or somewhere else). Explain that the bracelet forms a circle like the life cycle of the eel. The bracelet, which is a form of art, can be used to tell a story about the eel.

Briefly discuss how throughout time people of all cultures have used art to tell stories and to teach. Ask if anyone knows a culture that uses storytelling and/or art to teach.

2. Explain that each bead will tell a part of the story about the eel as it grows, changes, and travels and you will tell them the story of your bracelet later.
3. Using the mysterious incredible life-cycle of Short-finned eels poster for discussion or conducting an online search. Have students research the life cycle of an eel. The level of detail discussed will depend on the age level. You may wish to also include discussion around habitat needs, food chains, ecosystems etc; as an added activity.

4. Discuss threats and hazards in the eels life cycle journey—both natural and man-made e.g. elicit pollution predators, people. Ask if there needs to be people in their stories. Are the people helping or hurting the eels? Specifically what things might people do that might harm the eels. Brainstorm a list on the board.

Have students also come up with solutions.

5. Tell the students that now they are going to use the eel lifecycle and habitat elements to create their stories and make bracelets to help remember them. Walk them through the colours assigning each to a stage of the life cycle. Have them also add additional elements such as human threats as discussed, and solutions. Show the students the sample bracelet and use it to tell them an eel story.

6. Using the student worksheet - lifecycle of an eel, have students designate colours of beads for life cycle stages, habitat requirements or obstacles or hazards that the eels encounter during its life. Explain to the students that the worksheets will help them build their stories, and also help them remember what the colours in the bracelets mean.

7. Give students eight to 12 beads of different colours to represent the elements they will use for their story. (Make a plan for distributing beads that will work for your classroom, for example, pass out cups then select students to help distribute beads). Hand out pipe cleaners or string.

Beads need to go onto the bracelet in the order of the story.

8. After having completed their bracelets or lanyards, have students share their stories first in small groups of two to five, then select volunteers to share with the class.

Encourage students to share the story bracelet with their family, or someone outside of school. Discuss why they should tell the story to others.

9. As an extension, you may want to pose the question as to what other actions can students do to help eels and the health of our estuaries and rivers. Tell each student you will give them each a special bead to add to the bracelet to remind them that their job is not over, if they will make a specific pledge about what they will do to help our eels and catchments. Ask for volunteers to share their pledge.

Engage

Have students play out the life cycle of an eel. Use music or props, include some threats and solutions.

Connect

Use the puzzle template to create a life cycle puzzle.

Explore

Research and create a thorough list of threats to estuaries. Select one from your list and research it further to explain why such a thing might occur and how its impact could be minimised. Find a relevant example of your threat to support your findings. Present your results as an oral presentation with images or a filmed documentary.
Section 2

Additional resources and organisations

**Education programs/organisations:**

Queenscliff Marine and Freshwater Discovery Centre
Queenscliff
Phone: 03 5258 3344

Ecologic Environmental & Interpretation Services
Anglesea
Phone: 03 5263 1133
Email: tours@ecologic.net.au

Habitat Connection
Port Campbell
Phone: 0407 165 125
Email: motoole@hotkey.net.au

Bunurong Environment Centre
Inverloch
Phone: 03 5674 3738
Email: bce@sgcs.org.au

Port Phillip EcoCentre
St Kilda
Phone: 03 9534 0670
Email: schools@ecocentre.com

The Lobster Pot – The Barwon Estuary Heritage Centre
Barwon Heads
Phone: 03 5254 1118

**Useful websites:**

**Victorian Estuaries and data:**
EstuaryWatch Victoria online database. Lots of information about current health of Victorian estuaries
www.estuarywatch.org.au

**Estuarine habitats:**
Information on various estuarine habitats in NSW (applicable to Victorian estuaries).

**Native plants, animals and weeds**

**Salinity indicator plants**
Information on and photos of a wide range of salt-tolerant plants (indigenous and weeds), including those found in the areas of salt marsh in the Balcombe Estuary Reserves. Part of the Victorian Department of Primary Industry’s collection of Victorian Resources

**Invasive plants**
Information on weeds, and links to other weed websites. Part of the Victorian Department of Primary Industry’s collection of Victorian Resources Online

**BirdLife Australia**
A national organisation dedicated to achieving outstanding conservation results for Australia’s native birds and their habitats. BirdLife Australia, launched in January 2012, brings together two existing organisations: Birds Australia and Bird Observation and Conservation Australia.
Section 2  Additional resources and organisations

**Action and support groups/ programs and supporting materials**

**Corangamite Catchment Management Authority**  
www.ccma.vic.gov.au

**Glenelg Hopkins Catchment Management Authority**  
www.ghcma.vic.gov.au

**Melbourne Water**  
www.melbournewater.com.au

**West Gippsland Catchment Management Authority**  
www.wgcma.vic.gov.au

**East Gippsland Catchment Management Authority**  
www.egcma.com.au

**Interpreting Estuary Health Data**

This manual has been prepared to assist EstuaryWatchers and estuary managers to understand and interpret the data collected through the EstuaryWatch program.  

**Coastcare Victoria**

Coastcare is a coastal community program that supports coastal and marine based volunteer community groups and their activities.  

**Corangamite CMA Knowledge base**

The Corangamite CMA Knowledge base is a storage and retrieval facility that has a range of capabilities and geographic features, including information on our local estuaries.  

**Victorian Waterway Management Strategy**

The Victorian Waterway Management Strategy provides the policy direction for managing Victoria's waterways over an eight-year period.  

**Oz Coasts & Oz Estuaries**

This is a publicly accessible online database with a web based interface that provides comprehensive information about Australia's coast, including its estuaries and coastal waterways.  
http://www.ozcoasts.gov.au/about/about.jsp
Friends groups and environmental organisations

**Victorian Landcare**
Landcare and related networks and groups in Victoria
www.landcarevic.net.au

**Victorian Coastal Council**
The Victorian Coastal Council is appointed by the State Government of Victoria in accordance with the *Coastal Management Act 1995*

**Parks Victoria**
Parks Victoria is the custodian of a diverse estate of significant parks in Victoria, including coastal and marine areas in the Corangamite region.

**Fishcare**
Fishcare Victoria is a community based not-for-profit organisation promoting responsible and sustainable practices amongst recreational anglers and the wider community.
http://www.fishcare.org.au/

**Waterwatch Victoria**
Waterwatch Victoria is a successful community engagement program connecting local communities with river health and sustainable water issues and management.

**Conservation Volunteers Australia**
Involves the community in conservation projects in urban, regional and remote Australia. The site provides information on the program and how people can become involved.

**Field Naturalists Club of Victoria**
A vigorous and practical advocate of conservation and the study of natural history. The site provides information on the special interest groups within the FNCV, the club’s program of meetings and excursions, a report of recent meetings and an outline of ongoing research activities.
http://home.vicnet.net.au/~fncv

**Greening Australia – Victoria**
Works in partnership with landholders, the community, government and business to tackle environmental degradation in a practical, apolitical, scientific way. The site provides information on Greening Australia’s activities, including their education and training.

**Landcare**
There are over 5000 Landcare groups around Australia funded by the Commonwealth Government. The Landcare program aims to balance the needs of farming productivity and nature conservation. This site contains information about Landcare and the groups involved.

**Trust for Nature**
A non-profit organisation which aims to conserve remnant bushland on private land through conservation covenants. The site contains information about the organisation and its programs.
http://www.tfn.org.au

**Victorian National Parks Association**
Provides a wide range of information on aspects of the environment and Victoria’s parks and wilderness areas.
http://www.vnpa.org.au
Bibliography


Coleman, P and Cook, F 2003, Waterwatch South Australia guidance manual: estuarine monitoring, Delta Environmental Consulting, St Kilda, South Australia.


Department of Environment Western Australia 2005, A field guide to common estuarine invertebrates of Southwestern Australia, Ribbons of Blue, Waterwatch WA.


Estuary Watch, 2015 EstuaryWatch Program Monitoring, Evaluation and Reporting Plan. Rivers Pty Ltd, Geelong


Appendix 1 – Lotus Diagram

Start with your main idea in the centre square before using the surrounding squares to break your idea into subtopics, and explore them further.

Teacher Tip: Print this page in colour to help students follow the lotus format more easily!
### Appendix 2 – Mixology

<table>
<thead>
<tr>
<th>Predict</th>
<th>Observe</th>
<th>Explain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before you complete the experiment, think about what might happen. Write a sentence of what you think you will see.</td>
<td>During your experiment, use your senses to observe what is happening. Record your observation below and include a diagram.</td>
<td>After you have finished your experiment, try to explain what happened. You may need to do some research.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>When the saltwater was mixed with the freshwater I noticed that ...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I think this is because ... <em>(hint: mention layers and water density)</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>When the container was shaken I noticed that ...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I think this is because ... <em>(hint: mention salinity shown by colour and layers)</em></td>
</tr>
</tbody>
</table>
## Appendix 3 – Mixology

<table>
<thead>
<tr>
<th>Mixology lab report</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use the numbered titles and instructions below to assist in writing your laboratory report. Ensure you include the appropriate information under each heading.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1. <strong>Title</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your experiment about?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. <strong>Introduction/Purpose</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you want to learn during this experiment?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. <strong>Hypothesis</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you think will happen during your experiment?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. <strong>Materials</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Use dot points to list all the equipment you will need.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. <strong>Procedure</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What steps did you take during this activity?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. <strong>Results</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What did you observe during your experiment? Use diagrams Hint: What happened when you mixed freshwater with saltwater, mention layers and water density. What happened when the container was shaken, mention salinity shown by colour and layers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7. <strong>Discussion</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Use your own words to describe what happened and how this might compare to what happens in an estuary (hint-source of freshwater in an estuary, source of saltwater in an estuary, how the mixing of freshwater and saltwater occur. What factors would contribute to changes in water depth? What impact would salinity levels have on plants and animals within and estuary?)</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>8. <strong>Conclusion</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What did you learn? Compare the results of your activity with your hypothesis.</td>
</tr>
</tbody>
</table>
Appendix 4 – Estuarine habitat cards

Seagrass beds

Seagrass is a flowering plant that lives in marine (very salty) and brackish (slightly salty) water. Seagrass is usually found in sheltered bays, lagoons, lakes and estuaries. It needs sunlight, good water quality and nutrients to grow.

Seagrass plants take their nourishment from the sediments they live in and drop their leaves at certain times of the year. They use nutrients to grow and when their leaves drop, they take some of these nutrients with them. Fish and crustaceans use seagrasses much the same way as birds and insects use the trees and plants in your garden. Without these plants, the animals will go elsewhere, or may even die.

Seagrass is important as it provides:

- habitat
- food
- shelter
- a nursery area for fish and other marine animals
- nutrient absorption and exchange
- a good indication of environmental change.

Seagrass also stabilises marine sediments, lowers turbidity by settling sediment and improves water quality by removing nutrients.
Habitat characteristics and estuary species

Seagrass beds: salty and wet

Estuary species: many species of crab and fish, rays, birds, pipe fish and shrimp.
Sand and mudflats

Sandy and muddy sediments occupy large areas of most estuaries. The sediment type may vary considerably and can range from marine sand, in areas exposed to wave action, to silty mud in more sheltered areas.

Sandy sediments have spaces between sand particles and provide habitat for small invertebrates. These coarser sediments are also more readily oxygenated than muddy sediments and invertebrates such as molluscs, bivalves and polychaetes (worms) can therefore burrow to a greater depth. Silty mud areas provide habitat for bivalves, polychaetes and small crustaceans which feed on the bacteria and algae that grow on top of the sediment.

Many of the bird species found on the mud and sand flats are adapted to feeding on animals living under the ground. The White Ibis and the Eastern Curlew for example both have a long thin beak perfect for probing into the sand or mud to find food.
Habitat characteristics and estuary species

Sand and mudflats: salty and usually wet

Estuary species: snails, whelks, pipis, isopods, amphipods, flatworms, polychaetes, fish, many species of crabs and birds.
Mangroves are specially adapted trees that grow in soft sediments within the intertidal zone and support productive ecosystems.

The litter from mangroves provides food for invertebrates such as crabs, but is mostly decomposed by fungi and bacteria. As this material is broken down, small crustaceans, molluscs and other invertebrates consume the particles. The complex aerial root systems of mangrove trees provide a home and shelter for barnacles, snails and crabs.

The White Mangrove (*Avicennia marina*) is the only mangrove species found in Victoria. Mangroves are usually found in sheltered bays and inlets like Western Port and Corner Inlet, and larger estuaries like the Yarra and Barwon Rivers. These small trees called mangroves protect the coast from erosion caused by waves and storms. Mangroves are well adapted to being inundated by salt water and growing in mud that contains no oxygen.
Habitat characteristics and estuary species

Mangroves: salty and wet and occasionally dry

Estuary species: mangroves, snails, whelks, many species of crabs, barnacles, fish and birds.
Plants living in the saltmarsh can tolerate high soil salinity and periods of inundation with salt water. Sometimes the shallow pools found in the saltmarsh can be saltier than the sea. Saltmarsh plant communities are dominated by herbs and low growing shrubs. These plants die and regenerate, adding large amounts of decaying plant matter or detritus to the food chain. Scavengers and bacteria break down the decaying plant matter which provides nutrients and minerals for further plant growth. This process forms the basis of a complex food web including fish, crabs, shellfish and birds.

Saltmarsh is generally flooded with saltwater during high tide. At low tide, land becomes exposed and it is possible for freshwater to flow into the saltmarsh. This means that species living in the saltmarsh are exposed to variations in temperature and moisture, and they are also subjected to large changes in salinity. Some species like crabs burrow into the mud at low tide. Some saltmarsh species, like snails, move away from the incoming water. Species that live in this zone have adapted to both aquatic and terrestrial conditions, as changes can occur within the same day. The changes that occur within a saltmarsh are called zonation.

It is often described as:

- **high marsh** – covered briefly each day by tides
- **low marsh** – beneath the level of the tide for many hours each day.
Habitat characteristics and estuary species

Saltmarsh: salty and freshwater, wet during high tide

Estuary species: snails, crabs, birds including migratory birds and fish.
Appendix 5 – Animal life in the estuary

Select an animal that lives in one habitat in the estuary and fill in the boxes below:

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<th>Lives in:</th>
<th>Eats:</th>
<th>The animal is:</th>
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<tr>
<th>Eaten by:</th>
<th>Adapted to life by:</th>
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Appendix 5 adapted from Waterwatch Estuary Guide: A guide to community monitoring of water quality and estuary health; Department of Environment, Climate Change and Water NSW 2010
Appendix 6 – Human impacts in estuaries

- **Urban development** – housing development, recreation and fishing will change the environment and impact on estuarine habitats.

- **Agricultural activities** – runoff from agricultural land can affect the health of estuaries. For example, the use of superphosphate on farms can increase nutrient levels and stimulate algal growth in estuaries.

- **Industries** such as fishing and oyster farming can impact on water quality and the movement of water in estuaries. Over-fishing and habitat loss reduces fish stocks and disrupts the food chain.

- **Boating** can damage seagrass, reducing or degrading habitat and disrupts the food chain.

- **Structures** such as sea walls, bridges, drains, jetties, marinas, levy banks, rock walls and breakwaters all affect the passage of water and can alter the conditions within an estuary.

- **Erosion** and build-up of sediment in estuaries can smother seagrass and other aquatic vegetation and this reduces habitats and food sources.

- **Dams** and **power stations** can change water temperatures and affect aquatic ecosystems. Cold water from dams and warm water from power stations are forms of thermal pollution that affect waterways.

- **Litter** on our beaches and floating in Australian marine and estuarine waters is a problem, particularly non-biodegradable litter. It tangles in the appendages of our marine life and is harmful to divers and beach users.

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Appendix 6 adapted from Waterwatch Estuary Guide: A guide to community monitoring of water quality and estuary health; Department of Environment, Climate Change and Water NSW 2010. Illustration: Billington Prideaux Partnership
Appendix 7 – Story Map

Title:

Scene
- Where:

When:
- 

Characters
- Major:

Minor:
- 

Challenges
- Event 1
- Event 2
- Event 3

How the challenges are overcome

Now that you’ve completed your plan, fill in the details and write your full story!
Appendix 8 – Ripple Effect

Write your issue in the centre of the drop and consider all the potential consequences. Write down each consequence in a ripple. See how many ripples you can fill in—you may need to add some of your own!

Activity adapted from Water Learn it Live It Resource Vol 1.
Appendix 9 – Life cycle of an eel

Think about what you have learned about Short fin Eels and what it takes for them to hatch, grow into juveniles, and return to spawn as adults.

Consider the Short fin Eel ecosystem and all of the different habitats they depend on during their life cycle. Also consider the human impacts that have made many of our estuaries and rivers uninhabitable to eels.

Now, think about representing the Short fin Eel life cycle and their environment as a bracelet, with different coloured beads representing different stages of the life cycle, different habitats the eel lives in, and other events that might play a part in the story of an eel’s life. For example, the colour white might represent the eel eggs. You may either use real beads to make your bracelet, or design it on paper using coloured markers.

Use the chart below to tell what the colours of your beads mean.

Using your bracelet, tell:
- your story to someone else in your class. Take home your bracelet and tell someone in your family the story of your eel.

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<tr>
<th>Colour</th>
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*Exploring Estuaries A teacher’s guide to the estuaries in Victoria*
Appendix 10 – Match up puzzle

Photocopy this template onto paper that is heavy enough to make puzzle pieces. You may like to enlarge it to A3 size for a jumbo puzzle.

When you are finished, cut out the pieces of the puzzle and give them to another student to match up and put together.