An Educational Unit for Primary Schools

Salmon science - growing a leaper

Level

5-6

Curriculum Area

Science

Print Resource

Rationale

This resource material aims to help teachers and students in primary schools investigate and understand more about primary industries in Australia.

The objectives of the educational resources are to:

- Support Primary Industries Education Foundation Australia and its members in expanding awareness about primary industries in Australia by engaging and informing teachers and students about the role and importance of primary industries in the Australian economy, environment and wider community.
- Provide resources, which help build leadership skills amongst teachers and students in communicating about food and fibre production and primary industries in Australia.
- Develop educational resources that can be used across Australia to provide encouragement, information and practical teaching advice that will support efforts to teach about food and fibre production and the primary industries sector.

- Demonstrate to students that everyone can consider careers in primary industries and along the supply chain of food and fibre products.
- Develop engaging learning programs using an inquiry process aligned with the Australian Curriculum.
- Develop in school communities, an integrated primary industries education program that emphasises the relationship between food and fibre industries, individuals, communities, the environment and our economy. These educational resources are an effort to provide practical support to teachers and students learning about food and fibre production and primary industries in schools.

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About the approach

Several key principles underpin the theoretical and practical application to this unit. Students are guided to:

- Search for information using both digital and non-digital means
- Use research techniques and strategies
- Use thinking and analysis techniques
- Present findings to a real audience, and
- Reflect both on the product created and the process undertaken.

Rather than seeing knowledge as something that is taught, the emphasis in this unit is on knowledge and understanding that is learned. The unit involves students in:

- Working from a basis of their prior knowledge and experience
- Seeing a real task or purpose for their learning
- Being directly involved in gathering information firsthand
- Constructing their knowledge in different ways
- Presenting their learning to a real audience
- Reflecting on their learning.

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Resource description

This unit of work will provide students with content to explore how living things have structural features and adaptations that help them to survive. This unit will focus on farmed salmon. To farm salmon the optimal environmental conditions are replicated, to produce salmon as a good source of protein with high levels of omega-3 to form part of a healthy part of a human diet. The physical conditions of growing salmon will be explored and students will be provided with information on how these conditions are created in a managed environment.

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Curriculum focus

Students will:

- Explore the unique features of salmon and adaptations of salmon to their environment.
- Explore what physical conditions are required for growing fish in their environment
- Develop a basic understanding of diffusion and osmosis to help understand how salmon adapt to fresh and salt water
- How humans can replicate an environment to produce food
- Investigate what science is incorporated into fish farming to improve yield and sustainability
- Optional: Conduct a virtual salmon dissection as a class

Based on Australian Curriculum, Assessment and Reporting Authority (ACARA) materials downloaded from the Australian Curriculum website in February 2015. ACARA does not endorse any changes that have been made to the Australian Curriculum.

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Australian Curriculum content descriptors

Year 5/6 science:

Science Understanding - Biological sciences

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094)

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS231)

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086)

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Other Curriculum Capabilities/Priorities

General Capabilities

Literacy

This resource incorporates the two overarching processes of literacy: Comprehending texts through listening, reading and viewing; and Composing texts through speaking, writing and creating.

Numeracy

On the numeracy learning continuum, students will apply their understanding of patterns and relationships when solving problems in authentic contexts. In this resource students will recognise that mathematics is constantly used outside the mathematics classroom and that numerate people apply general mathematical skills in a wide range of familiar and unfamiliar situations.

Cross-curriculum Sustainability

OI.8: Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgments based on projected future economic, social and environmental impacts.

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Using this unit

This resource can be used in a number of ways. It will be of most benefit to teachers who wish to implement the sustained sequence of activities that follow the learning experiences around the content descriptors in year 5 and 6 Science in the Australian Curriculum.

You may add to or complement the suggested activities with ideas of your own activities or investigations.

The resources have been designed as a hyperlinked unit. This is to provide you with a digital format for your class's use on a website or wiki or provide them on your interactive whiteboard.

We encourage you to explore ways in which the content can be adjusted to the context in which you are working.

Resource sheets are provided for some activities. Most are for photocopying and distribution to students.

The resource sheets are designed to assist teachers to facilitate learning without having to access a range of other resources.

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Complementary VR Experience

This resource has supporting VR experience that complements the learning objectives of this topic. The VR experiences are represented throughout the resource. To access the VR experiences it is best to download the FarmVR app on your mobile device.

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Industry Contacts

Fisheries Research and Development Corporation http://frdc.com.au/ (http://frdc.com.au/)

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Assessment

Pre- and Post- testing is a measurement of the learning received during a class by comparing what the student knew before the lesson (pre-test) and after the lesson (post-test).

Students can complete pre-test (provided) before starting the unit of work to assess their prior knowledge of salmon. After completing the unit of work, students can re-take the test (post test) and a comparison can be made. Answer sheet provided.

Download Pre/Post test (pdf/18. Pre_Post test.pdf)

Download Pre/Post test answers (pdf/19. Pre_Post test_answer.pdf)

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Length of Unit

This will depend on your school program and classrooms particular circumstances but generally; a few weeks to a term are suggested.

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Learning Sequence

Learning Experience	Activities	Summary
1 2 x 60min lesson	Students will: ▪ explore their prior knowledge of salmon ▪ read and understand some facts about salmon ▪ use collective information from the class to collaboratively contribute to a list of adaptations by salmon to their environment.	Explore structural features and adaptations that help salmon to survive in their environment

2 1 x 60min lesson	Students will: ▪ Review the life cycles of both farmed and wild salmon ▪ Identify and make a comparison of the differences between wild and farmed life cycles of the salmon ▪ Understand the timings of both the wild and farmed salmon life cycles	Explore the growth and survival of salmon, affected by the physical conditions of their environment
3 1 x 60min lesson	Students will: ▪ Read information about growing salmon in a farmed environment ▪ Understand what is required to grow salmon in a farmed environment ▪ Reformulate information to complete a worksheet on physical conditions required at different stages of the salmon life cycle	Explore the growth and survival of salmon, affected by the physical conditions of their environment
4 2 x 60min lesson	Students will: ▪ Understand the basics of diffusion and osmosis ▪ Understand how diffusion and osmosis help fish to take up oxygen in water ▪ Understand the unique adaption of salmon to be able to move from fresh water to salt water ▪ Investigate salmon adaptations to move from fresh to salt water	Explore structural features and adaptations that help salmon to survive in their environment

5 1 x 60min lesson	Salmon dissection (optional) Students will: ▪ View a salmon dissection via Virtual Reality	Explore structural features and adaptations that help salmon to survive in their environment

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Teacher Background

In 2010 the Australian Council for Educational Research conducted a food and fibre survey with students in Year 6, Year 10, and Teachers. This survey was written as a report in 2011, called 'Food, fibre and the future'.
While the majority of teachers who responded to the surveys indicated that teaching students about food and fibre production was important, levels of familiarity with issues related to Primary Industries were not high, particularly in Fisheries.
Fisheries, in particular, appears to be an area in which teachers do not feel knowledgeable, with around 20% of teachers surveyed indicating that they were unfamiliar with any issues in the industry.

Grade 10 students were presented with several seafood species and asked to select which of these were farmed in Australia. All of these seafood species are currently farmed in Australia.

- 26% of students identified that eels were farmed.
- 82% of students identified that barramundi were farmed.
- 27% of students identified that salmon were farmed.
- 84% of students identified that prawns were farmed.
- 80% of students identified that oysters were farmed.

While the majority of Grade 10 students were able to identify barramundi, prawns and oysters as species that are farmed in Australia, only around one in four students were aware that salmon and eels are also farmed.
This survey has provided some insight as to the knowledge gaps in primary industries education and how these gaps may be bridged with educational resources such as this one.

Australian Fisheries overview

The Australian Government ensures Commonwealth fisheries are managed sustainably for the benefit of all Australians.

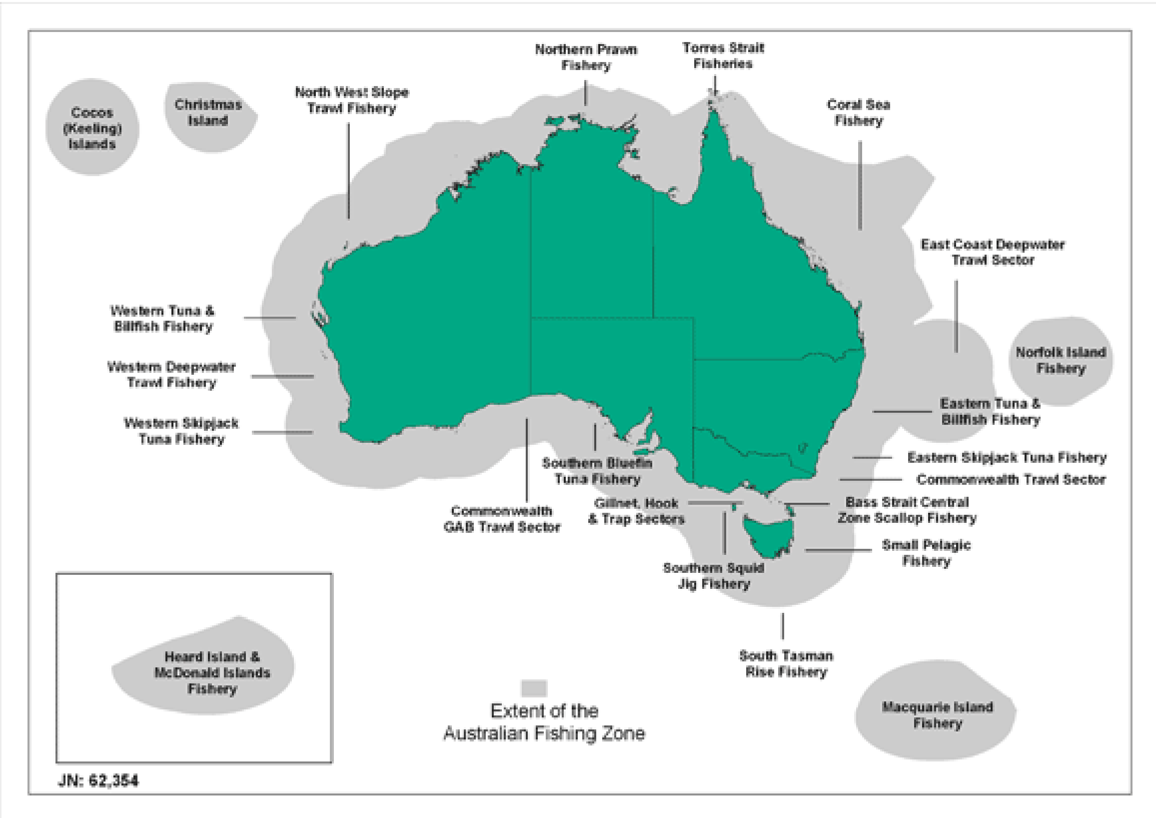
Fisheries are managed under the Australian Government Department of Agriculture and Water Resources. Australian produces a range of seafood products. These include approximately:

- 600 commercial species
- 1000 recreational species and
- 100 species from aquaculture

On a global scale Australia is a minor player in the seafood industry producing less that 0.15% of global seafood. Australia is a net importer of fisheries and aquaculture products, and since 2007/08 the gap between the value of fisheries and aquaculture products imported and exported has widened.

Commercial fishing is the harvesting of wild fish. Aquaculture is the raising of fish for harvest under controlled conditions.

The Australian Government manages commercial fisheries within the Australian Fishing Zone (which generally extends from three to 200 nautical miles off the coast), as well as the activities of Australian-flagged fishing vessels operating on the high seas.



Source: http://www.agriculture.gov.au/fisheries/domestic/managing-australian-fisheries (http://www.agriculture.gov.au/fisheries/domestic/managing-australian-fisheries)

A focus on Aquaculture

Aquaculture is defined by the United Nations Food and Agriculture Organisation as ‘the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants with some sort of intervention in the rearing processes to enhance production, such as regular stocking, feeding and protection from predators’.

There are various stages of aquaculture operations including:

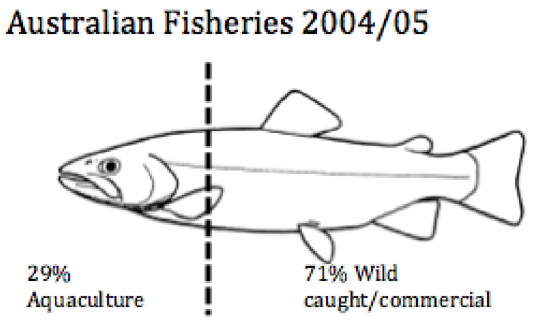
- a hatchery operation which produces fertilised eggs, larvae or fingerlings
- a nursery operation which nurses small larvae to fingerlings or juveniles
- a grow-out operation which farms fingerlings or juveniles to marketable sizes.

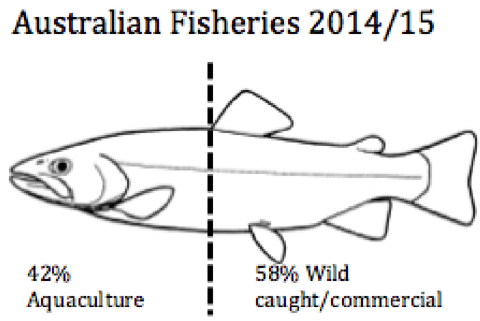
Depending on the species being farmed, aquaculture can be carried out in freshwater, brackish water or marine water. There are a number of different systems that can be used for aquaculture, including ponds, tanks, pens and floating cages.

Aquaculture can be extensive, semi-intensive or intensive, depending on the level of input and output per farming area and the stocking density. Intensive aquaculture involves intervention in the growing process, such as with supplemental feeding and water aeration (such as salmon or prawn farming), whereas extensive aquaculture allows the stock to grow on its own, using natural food sources and conditions (such as oyster farming).

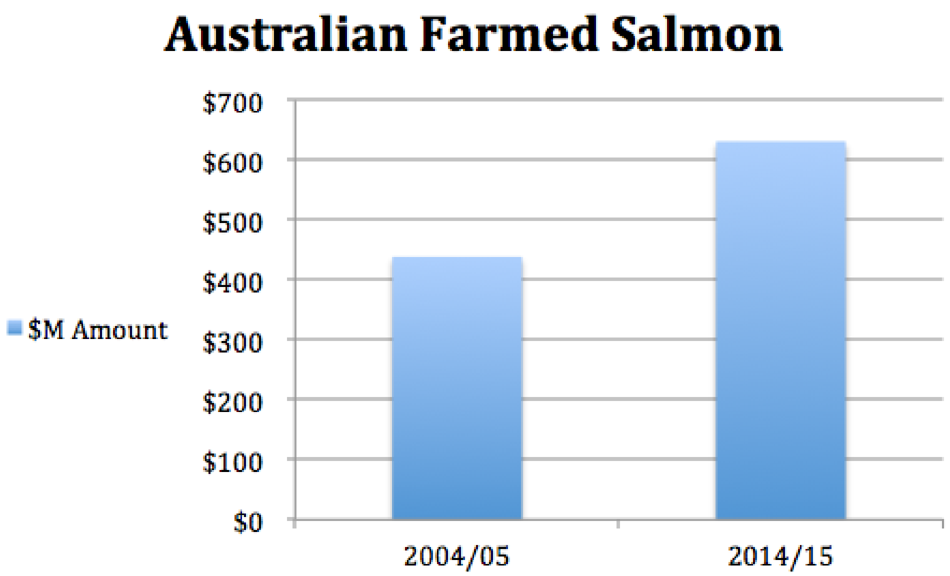
Aquaculture can also be operated with other agriculture activities forming an integrated aquaculture–agriculture system. An example of an integrated aquaculture–agriculture system is the farming of fish in a rice field, or an aquaponic system.

Trends in Aquaculture





% ↑ due mainly to Salmon in Tasmania



As a result, Tasmania became the largest Australian producer by value of fisheries and aquaculture products during this period, accounting for 30 per cent of gross value of productionin 2014–15, up from 16 per cent in 2004–05.

Other aquaculture sectors that grew significantly in real terms over this period:

- Prawn (up $20 million),
- Barramundi (up $17 million) and
- Abalone (up $12 million).

The volume of farmed aquaculture products grew at an average annual rate of5% from 2004–05 to reach 89,217 tonnes by 2014–15. Farmed salmonids drove most of this growth, growing by 185 per cent (up 31 551 tonnes) in this period, accounting for 74 per cent of growth in the volume of aquaculture products.

Since 2005, exports of Australia's fisheries and aquaculture products have shifted from Japan, to Hong Kong, China, and Vietnam region with the major export product being rock lobster.

Between 2004/05 and 2014/15 Australians consumption of seafood has increased at an average annual rate of 1.2%.

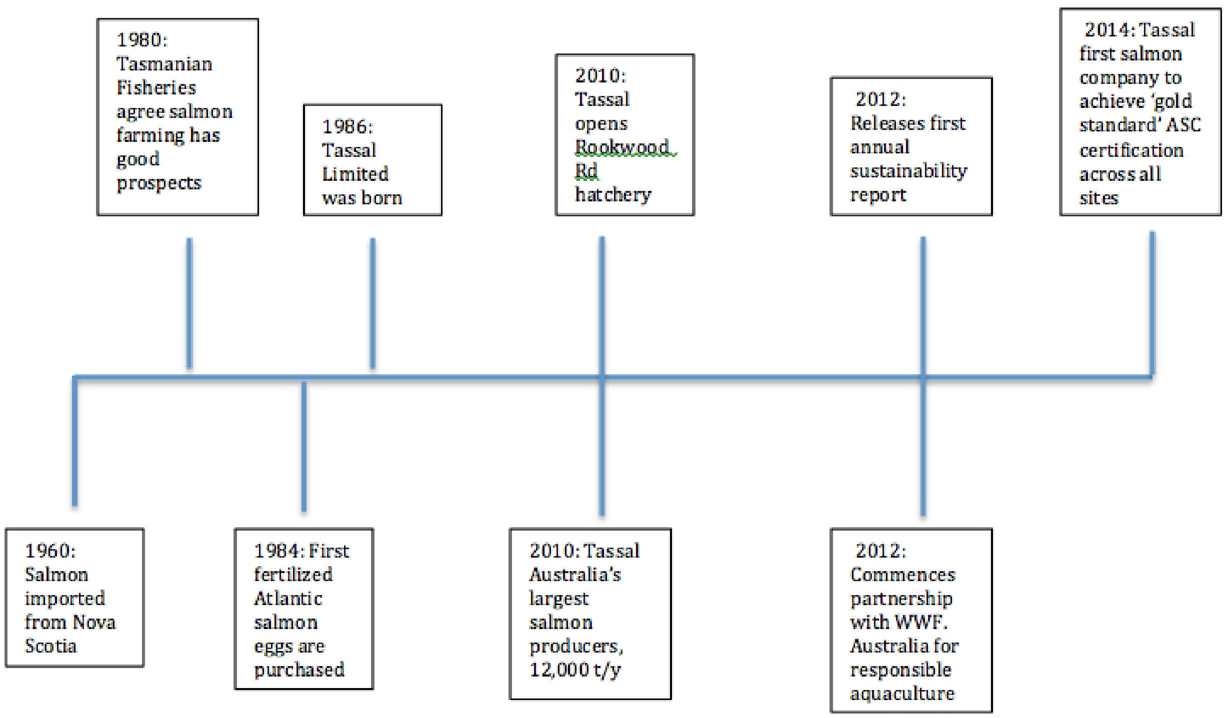
Comparison of actual and projected aquaculture production

Product	2006-2007 Production tonnes	2014-2015 Projection [1] tonnes	2014-2015 Production tonnes	Looking forward	2021-2022 Projection [2] tonnes
Fish					
Salmon and trout	25,253	40,000	48,614	Growth has continued with improved production from existing areas. This is expected to continue at similar rates and may accelerate if additional farming areas, likely to be offshore, are established.	60,000
Tuna	7,486	13,000	8,418	Tuna growth predicted in 2008 was based on a strategy to ranch fish for longer, growing them to a larger size, which would increase overall tonnage. This did not eventuate. No major increase likely other than from slight increases in quotas, allowing more fish to be ranched.	7,500
Silver Perch	322	361	314	Silver Perch likely to continue at similar levels.	350
Barramundi	2,590	7,000	3,772	Barramundi is likely to see more growth in production in the next few years due to new farms and expanded area on existing farms. Growth in production after industry consolidation and improved farming efficiency has already seen good growth, with preliminary estimates putting 2016 production at about 6000 tonnes.	8,000
Yellowtail Kingfish		5,000	1,200	Trials in Western Australia and New South Wales with more favourable growing conditions are expected to increase commercial production in 3-5 years. CleanSeas Tuna in South Australia also plans to increase its current 1200 tonnes production.	5,000
Other (including Kingfish)	450	397	484	Includes: Murray Cod, Cobia, Tropical Groupers. NSW in particular has seen significant growth in Murray Cod production. Cobia and Tropical Groupers may see some growth in coming years with potential new entrants and investment in RD&E through the new and emerging aquaculture subprogram.	600
TOTAL	36,101	65,758	62,802		81,450

Source: FISH, Volume 24, Number 4, December 2016, pg 14. http://www.frdc.com.au/Media-and-Publications/FISH (http://www.frdc.com.au/Media-and-Publications/FISH)

About Tassal

Tassal are the largest producers of Salmon out of the 4 companies operating in Tasmania. Tassal grow Atlantic Salmon, Salmo salar, originating from Nova Scotia in Canada in the 1960's. This is the Tassal timeline for working with salmon:



Source: Modified from http://www.tassal.com.au/our-history/ (http://www.tassal.com.au/our-history/)

Tassal recognises that responsible salmon farming requires the understanding and best practice management of the environment and ecological impacts on biodiversity. Tassal use sophisticated modelling and monitoring programs in collaboration with research groups such as CSIRO and Institute for Marine and Antarctic Science (IMAS), to investigate changes on farm and off farm sites to monitor water quality enabling adaptive farm management, and invest in further research into this area.

The salmon industry is strictly monitored and follows the guidelines of the Aquaculture Stewardship Council requirements. (Weblink: https://www.asc-aqua.org/what-we-do/our-standards/farm-standards/the-salmon-standard/ (https://www.asc-aqua.org/what-we-do/our-standards/farm-standards/the-salmon-standard/))

Under Principle 2 of the Aquaculture Stewardship (ASC) requirements, Tassal are required to address potential impacts from farming operations on biodiversity and ecosystem function. The criteria focus on benthic impacts, siting, effects of chemical inputs and effects of nutrient loading. In response to the criteria, Tassal have conducted Biodiversity Focused Environmental Impact Assessments (BFEIA) for all of grow out leases.

The assessments include habitat and species that could be reasonably impacted by the farm and incorporate:

- The identification of proximity to critical, sensitive or protected habitats and species
- The identification of potential impacts the farm might have on biodiversity with a focus on those habitats and species, and
- A description of strategies and programs to eliminate or minimise any identified impacts.

As with other food producing industries, Tassal is researching how to sustainably increase production through improved efficiencies. An increase in production does not necessarily require a matching increase in footprint (marine lease space). Tassal have already achieved significant production gains through improved animal husbandry, fish health, wildlife exclusion and selective breeding. The future for the sustainable production of salmon is with emerging and innovative technologies in engineering, selective breeding, and fish welfare. In comparison to other land based farming, salmon is one of the lowest carbon footprint proteins available, with one of the lowest rates of freshwater consumption per kilogram of production. Salmon has one of the highest feed input to growth conversion rates (1.35 to 1), with around 65kg salmon produced for every 100kg feed, compared to an equivalent 13kg of pork and 20kg of poultry.

Terminology:

Egg: unfertilised ovum

Embryo: after fertilisation, before hatching

Alevin: after hatching, before emergence from the gravel, not freely swimming

Fry: newly emerged juvenile, rearing in freshwater, freely swimming

Parr: juvenile, rearing in freshwater, dark pigment banding on body

Smolt: transitional stage to the marine form

Jack: mature male younger than the females

Redd: nest, including one or more egg pockets

Anadromous fish: born in fresh water, then living in sea-water for most of its life, before returning to fresh water to spawn.

Adaptations:

- any alteration in the structure or function of an organism or any of its parts that results from natural selection and by which the organism becomes better fitted to survive and multiply in its environment.
- a form or structure modified to fit a changed environment.
- the ability of a species to survive in a particular ecological niche, especially because of alterations of form or behaviour brought about through natural selection.

References:

Australian Fisheries information:
http://data.daff.gov.au/data/warehouse/9aam/afstad9aamd003/2015/AustFishAquacStats_2015_v1.0.0.pdf (http://data.daff.gov.au/data/warehouse/9aam/afstad9aamd003/2015/AustFishAquacStats_2015_v1.0.0.pdf)

A focus on aquaculture: http://www.agriculture.gov.au/fisheries/aquaculture (http://www.agriculture.gov.au/fisheries/aquaculture)

Trends in Aquaculture:
http://data.daff.gov.au/data/warehouse/9aam/afstad9aamd003/2015/AustFishAquacStats_2015_v1.0.0.pdf (http://data.daff.gov.au/data/warehouse/9aam/afstad9aamd003/2015/AustFishAquacStats_2015_v1.0.0.pdf)

Terminology:
http://courses.washington.edu/fish450/Lecture%20PDFs/salmon%20introduction.pdf (http://courses.washington.edu/fish450/Lecture%20PDFs/salmon%20introduction.pdf)
http://www.dictionary.com/browse/adaptation (http://www.dictionary.com/browse/adaptation)

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Learning Experience 1

Lesson overview

This learning experience will allow students to understand the appearance and adaptations of salmon. The experience will be in two sessions, the first to assess what is the students' prior knowledge and then the second session to add to their knowledge about salmon.

Lesson outcomes

Students will:

- explore their prior knowledge of salmon
- read and understand some facts about salmon
- use collective information from the class to collaboratively contribute to a list of adaptations by salmon to their environment.

Teacher Background information

In this unit of work students will focus on Salmon as a species that has particular adaptations that are useful to them as a species, and also allows humans to be able to farm them.

The salmon that are bred for consumption in Australia are Atlantic Salmon (Salmo salar). Its Latin name means 'the leaper'. It can be described as having a small head, blunt nose, small eyes, and a mouth that gapes back below its eye. The mouth contains a row of stout, conical teeth.

Salmon have a great sense of smell, hearing, and taste, which helps them find food and sense danger. Salmon are also able to sense danger by feeling the waves on their body. The Atlantic salmon's sense of smell is 1000 times greater than that of a dog.

Wild salmon:	Farmed salmon:
 Length: 71-76cm Weight: 3.6-5.4kg (after 2 years at sea, but can grow up to 13.6kg)	 Length: 65-80cm Weight: 3-6+kg (12-18 months at sea)

Salmon have three main parts:

The front section is called the **anterior**. The anterior includes the head as well as the gills, which consist of a **gill cover** and a **gill opening**.

The belly part of the fish's body is called the **ventral** section. The **pectoral fin** is near the beginning of the belly, behind the gills. The **pelvic fin** is near the centre of the belly.

Behind these two fins, in the **posterior**, or back, section of the salmon, is the **anal fin**. The salmon's tail is located in the posterior as well. The tail is where you'll find the **caudal fin**. The **dorsal fin**, is on the middle of its back. The much smaller soft dorsal fin is about three-quarters of the way from the dorsal fin to the caudal fin.

Atlantic salmon have large scales and slightly forked caudal fins. One distinguishing characteristic of Atlantic salmon is the presence of an adipose fin, a feature present in all species of trout.

An interesting fact: The major difference between Atlantic and Pacific salmon is that Atlantic salmon may spawn more than once while Pacific salmon die soon after one spawn.

Equipment:

- Print pre-test for each student
- Print student copies of Worksheet 1 for all students
- Print 1 copy of Salmon facts and cut each of the facts up to separate to give one fact per student
- 3 x Large print out (A3 or bigger) of salmon

Pre-test (pdf/Tassal/18. Pre_Post test.pdf)

Student worksheet 1 (pdf/Tassal/2. Student worksheet 1.pdf)

Student worksheet 1 - Answers (pdf/Tassal/3. Student worksheet 1 answers.pdf)

Salmon Facts (pdf/Tassal/4. Salmon Facts worksheet.pdf)

Session 1

Salmon diagram (A3) (pdf/Tassal/5. Salmon facts diagram A3.pdf)

Salmon diagram (answers) (A3) (pdf/Tassal/6. Salmon facts adaptaions answer.jpeg)

Lesson steps

1. Ask the students to complete pre-test. Give the students 10 mins to complete. Record their results.
2. Provide each student with a copy of worksheet 1
3. As an introduction, ask the students what they already understand of salmon? Record the students' answers using a smart board, white board, or butchers paper.
4. Ask the students to estimate the length of an adult salmon from head to tail. Ask the students to estimate the weight (in kilograms) of an adult salmon. For the length get students to use the distance between their two palms and then measure with a ruler. Record all students' guesses on the worksheet.
5. Using the salmon image provided in worksheet 1, discuss with the students about some of the parts of the salmon that the students recognise. Ask the student to verbally identify the parts that they recognise
6. Now ask the students to label the salmon as much as the can. Then read or display the following information to the students to help label the remainder of the salmon parts.

Salmon have three main parts:

The front section is called the **anterior**. The anterior includes the head as well as the **gills**, which consist of a gill cover and a gill opening.

The belly part of the fish's body is called the **ventral section**. The **pectoral fin** is near the beginning of the belly, behind the gills. The **pelvic fin** is near the centre of the belly.

Behind these two fins, in the **posterior**, or back, section of the salmon, is the **anal fin**. The salmon's tail is located in the posterior as well. The tail is where you'll find the **caudal fin**. The **dorsal fin**, is on the middle of its back. The much smaller soft dorsal fin (or adipose fin) is about three-quarters of the way from the dorsal fin to the caudal fin.

Source: https://www.eduplace.com/kids/hmr/gr4/activities/gr4_th6_sel1_diagram.html (https://www.eduplace.com/kids/hmr/gr4/activities/gr4_th6_sel1_diagram.html)

Session 2

Lesson steps

1. Provide each student with an individual fact cut out from the Salmon facts worksheet. This exercise helps transfer a large amount of information amongst the students.
2. Provide students with space to be able to move around.
3. Have the students to read their own fact about salmon. Ask them if they understand their fact. Clarify where needed.
4. Ask the students to move around the classroom and share their fact with other students.
5. It will be important to assess how the class is sharing their facts. After students have shared for an adequate amount of time (maybe sharing their fact 10 times), bring the students back and divide into 3 groups.
6. Provide the 3 groups with an A3 picture of salmon
7. Using their facts get the students to locate their salmon fact as close to the body part. Give the students 20mins to write out their facts
8. Put all 3 salmon pictures on the front board.
9. Ask 2 students from each group to share about their group's facts.
10. Compile a complete salmon fact diagram for the class (see example answer sheet)

Supporting Resources

Teacher background references

http://www.fishfiles.com.au/knowing/species/finfish/salmonid/Pages/Atlantic-Salmon.aspx (http://www.fishfiles.com.au/knowing/species/finfish/salmonid/Pages/Atlantic-Salmon.aspx)

http://animaldiversity.org/accounts/Salmo_salar/ (http://animaldiversity.org/accounts/Salmo_salar/)

http://www.edc.uri.edu/restoration/html/gallery/fish/salmon.htm (http://www.edc.uri.edu/restoration/html/gallery/fish/salmon.htm)

http://www.fisheries.noaa.gov/pr/species/fish/atlantic-salmon.html (http://www.fisheries.noaa.gov/pr/species/fish/atlantic-salmon.html)

Salmon biology

https://www.youtube.com/watch?v=CKQU8ex8ric&feature=results_video&playnext=1&list=PL6DB85A607BFA4B58 (https://www.youtube.com/watch?v=CKQU8ex8ric&feature=results_video&playnext=1&list=PL6DB85A607BFA4B58)

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Learning Experience 2

Lesson overview

This experience will provide students with the opportunity to compare the life cycle of salmon in a wild and farmed environment.

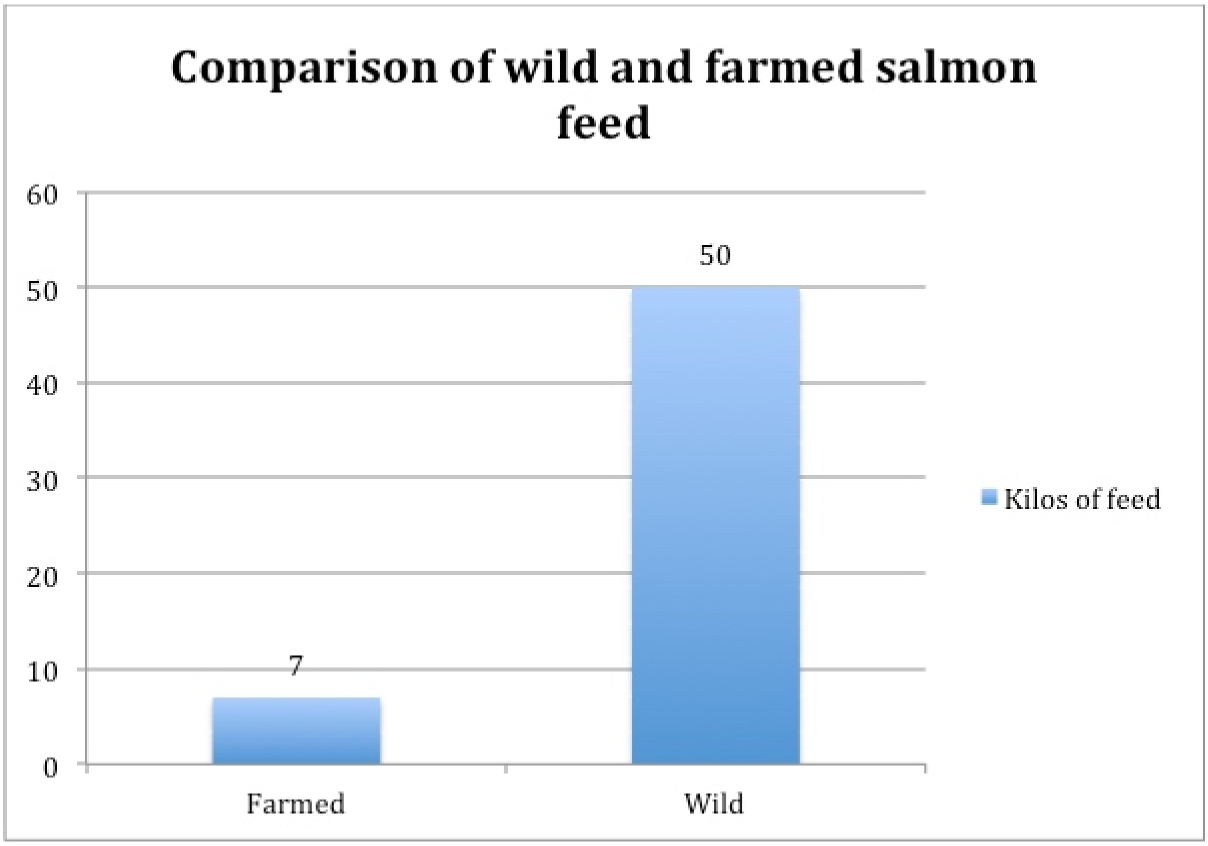
Lesson outcomes

Students will:

- Review the life cycles of both farmed and wild salmon
- Identify and make a comparison of the differences between wild and farmed life cycles of the salmon
- Understand the timings of both the wild and farmed salmon life cycles

Teacher Background information

There is a section in the overall teacher background that goes into detail about the fisheries industry, and aquaculture. Read that section to help with understanding of farmed species.
Tassal grow Atlantic Salmon, Salmo salar, originating from Nova Scotia in Canada in the 1960's.
The farmed species has remained the same, and in recent years a selective breeding program has helped produce salmon that are more resistant to diseases like Amoebic Gill Disease, and are more suited to growing conditions in Tasmania.
In the wild, Atlantic salmon will spend the first 2-3 years of life in fresh water before migrating to the sea. They enjoy the cool rivers with gravelly bottom for the early years. As salmon grow and change into smolts, they start to migrate to the sea to continue to grow into adults. In the sea, salmon seem to prefer water temperatures of between 4 and 12 degrees Celsius. They can tolerate lower and upper limits of temperature -0.7 up to 27.8, but only for short periods of time.
A wild salmon can take 5 or more years to reach maturity. An adult salmon weighing 5 kilos will have consumed more than 50 kilos of food to reach maturity; this is compared to 7 kilos of food to grow a 5 kilo farmed salmon (NB. it takes approximately 4kg of wild fish (Peruvian anchovies) to convert to 1kg of fish meal; of this approx. 200g is used to produce 1 kg of salmon pellets.
Approximately 20% of salmon feed consists of wild fish meal, and the remainder is sourced from terrestrial animal by-products (including feathers from the poultry industry) and plant-based protein and carbohydrate sources. Over time there has been a shift in reducing reliance of wild fisheries in formulated salmon feed to meet sustainability outcomes.

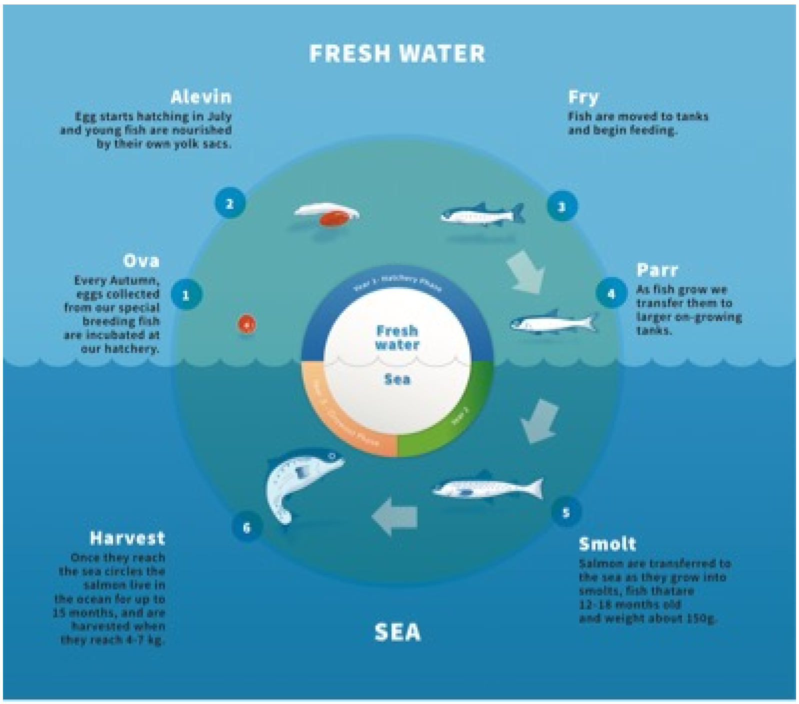


Farmed salmon due to the very nature that this is a managed species, incorporates a greater degree of control regarding growing conditions. This is especially true in the early part of their life within hatchery from egg through to juvenille stages and grow out tanks, prior to transfer to sea as Smolt.

In the wild 15-35% of salmon make it to fry stage. Alternatively with farmed salmon there is approximately 95% make it to fry stage. When Salmon are in the sea, approximately 90% survive to harvest, and like other farmed species on land, there are some stock losses due to stress, health and general genetic predisposition to disease.

The efficiencies of farming salmon in the hatchery part of the life cycle can be as quick as 10 months, or can be slowed to 15 months. Salmon grow best at optimum temperatures (depending on the life cycle stage), and if needed this can be sped up or slowed down based on temperature, depending on production demand at different life cycle stages.

The following diagram outlines the Tassal salmon life cycle.



Equipment:

- Copy of **Worksheet 2** — Download Worksheet 2 (pdf/Tassal/7. Student worksheet 2.pdf)
- Copy of — Download Worksheet 3 (pdf/Tassal/8. Student worksheet 3.pdf)

  Download Worksheet 3 Answers (pdf/Tassal/9. Student worksheet 3_Answers.pdf)

  Tassal salmon flashcards (pdf/Tassal/10. Salmon Life cycle_flashcards.pdf)

  Tassal lifecyle puzzle (pdf/Tassal/11. Tassal-Salmon Life Cycle Jigsaw Puzzle.pdf)

  Worksheet 3
- Print out copies of Tassal salmon flashcards
- Internet
- Digital device
- YouTube
- Optional: Tassal Salmon life cycle jigsaw

Lesson steps

1. Discuss with the students their understanding of wild and farmed salmon.

   a. Ask the students what they understand about fish/seafood that are farmed. Try to get them to talk about the different ways seafood could be housed to be farmed for consumption
2. Provide the students with student worksheet 2 (life cycle) and student worksheet 3.

3. With the students, read around the life cycle of the farmed salmon as represented in the diagram.
4. Read with the students the table on worksheet 3 on the comparison of wild and farmed salmon life cycles. Read both sides of each stage of the lifecycle, before moving to the next stage (ie read wild and farmed eggs/ova, then move on to Alevins)
5. Watch the following video on the life cycle of a wild Atlantic Salmon: https://www.youtube.com/watch?v=2fGLzEvWuYA (https://www.youtube.com/watch?v=2fGLzEvWuYA)
6. Using worksheet 3, get the students to record one element that is the same between the stages in blue, and in red, record one of the differences at each of the stages. This will need to be a student directed activity due to the amount of content.
7. Using the arrows and Tassal salmon flash cards showing the different stages of the Salmon life cycle, get students to organise the salmon into a cycle. They may like to work in pairs or small groups.

Optional exercise:

Print out the Tassal salmon life cycle jigsaw. Cut out the jigsaw pieces and provide for the students as an exercise.

Supporting resources

Lifecycle

http://www.arkive.org/atlantic-salmon/salmo-salar/video-09a.html (http://www.arkive.org/atlantic-salmon/salmo-salar/video-09a.html)

https://www.marine.ie/Home/site-area/areas-activity/fisheries-ecosystems/salmon-life-cycle (https://www.marine.ie/Home/site-area/areas-activity/fisheries-ecosystems/salmon-life-cycle)

http://www.nasco.int/atlanticsalmon.html (http://www.nasco.int/atlanticsalmon.html)

http://www.miramichisalmon.ca/education/atlantic-salmon/ (http://www.miramichisalmon.ca/education/atlantic-salmon/)

http://www.asf.ca/life-cycle.html (http://www.asf.ca/life-cycle.html)

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Learning Experience 3

Lesson overview

This learning experience will provide students with an understanding of what salmon need to survive in a farmed environment.

Lesson outcomes

Students will:

- Read information about growing salmon in a farmed environment
- Understand what is required to grow salmon in a farmed environment
- Reformulate the information provided to complete a worksheet on some physical conditions at different stages of the salmon life cycle

Teacher Background information

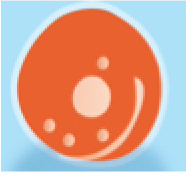
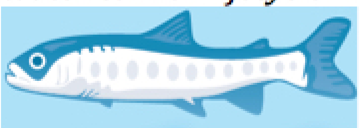
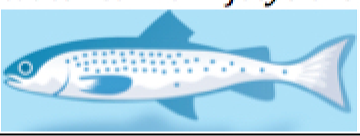
Farmed fish offer a reliable source of protein. With seafood consumption increasing in Australia annually by 1.2%, salmon is an efficient source of protein. It also offers other health benefits including a rich source of Omega 3 (higher than other common terrestrial based protein sources), and other vitamins and minerals.

The following section describes how farmed salmon is produced and found in your supermarket fridge.

Salmon are a fish that can be farmed, growing best in cooler waters (~8-20 degrees celcius (deg C), but ideally 14-16 deg C). In Australia, Salmon are predominantly farmed in Tasmania, with a smaller operation in South Australia.

Farmed salmon start their life in a hatchery. Salmon farming in recent years have used selective breeding programs, with salmon selected for certain traits, including resistance to diseases, such as Amoebic Gill Disease, overall health and growth.

Salmon farming is an intensive operation, with high labour and scientific input especially in the first year of life. All of the following stages of the salmon life cycle are in water, and they are unique in that their life cycle sees them move from fresh water to salt water. Salmon grow in fresh water from egg to just when they change to smolt (approximately 1 year), and then when salmon have developed in to the smolt stage, they are moved to a salt-water environment, to finish growing (approximately 18-months).

Tassal Salmon Life cycle	What happens at the Tassal hatchery and sea cages?
Eggs/Embryos *Watch Salmon lifecycle: 1* 	Selective breeding to produce fertilised embryos. 'Green eggs' are what salmon start out as, they become 'eyed eggs' when a dark spot appears. The 'eyed eggs' are an embryo at this stage. Embryos are kept in fresh water Embryos are kept in the dark at approximately 8°C They hatch after approximately 6 weeks
Alevin *Watch Salmon lifecycle: 1* 	After embryos hatch, they become Alevins Alevins have a yolk sack which they feed on for approximately 6 weeks (no food at this stage) Alevins stay in fresh water with a temperature of about 11°C
Fry *Watch salmon lifecycle: 2*  	Fry are moved in to larger fresh water tanks They are introduced to feeding on small pellets The water temperature of Fry increases from 12°C to 14°C. Fry have 24hrs of light for 3 months Fry grow from about 2cm up to 10cm, when they are considered Parr
Parr *Watch salmon lifecycle: 2*  	Fry grow into Parr Pellet size of the salmon feed increases in size with salmon Parr start to have light changes especially 10weeks prior to moving to next stage. Parr are exposed to 10hours of light, and then 14hours of darkness
Parr to Smolt *Watch salmon lifecycle: 3* 	To test if Parr have become smolt a small sample of salmon are taken out of fresh water, and placed in salt water. After an hour in salt water, their blood is tested to see if they have become smolt
Smolt to adult *Watch salmon lifecycle: 4* 	Smolt spend up to 2 years in sea water growing to their adult weight of approximately 5.5kg Salmon feed is delivered via a spinning pipe Salmon feed increases in size as the salmons mouth grows in size Seawater is varies in temperature from 8.5°C - 20°C

The water is checked daily when the salmon are embryos and as Alevins for Oxygen saturation and ammonia. In the first 12 weeks, there is little waste because the embryos and Alevins are not feeding on anything, relying on their yolk-sac energy reserves.

From the fry stage onwards, the water needs to be closely monitored. The water filtration system for Fry and Parr is quite specialised. The water is tested daily and is continually filtered every 45 minutes. The water is tested for the following:

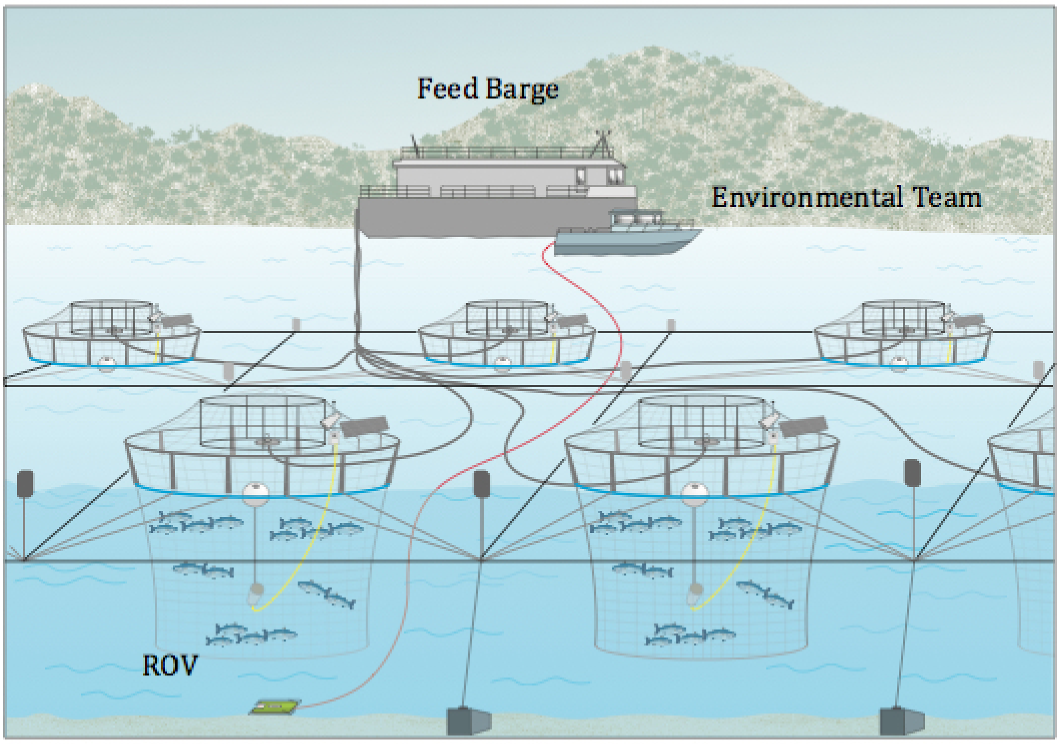
- Dissolved oxygen
- Ammonia
- Nitrate
- Nitrite
- CO2
- Heavy metals

All solid waste from the Salmon (at Fry and Parr stages) are collected continually, with the solid waste being converted onsite to a product that will then form part of an agricultural fertiliser. Water recirculation technology at the hatchery ensures that 99% of bore water is filtered and re-used each day.

At sea, the water quality is tested every two weeks in summer and monthly during winter. These are the things they are testing in the water:

- Nitrogen
- Nutrients
- Algae and Phytoplankton (microscopic organisms, that convert nutrients and light into energy (photosynthesis) like plants)
- Salinity
- Turbidity (water clarity)

Feed is delivered to each salmon sea cage via compressed air through pipes from a central feed barge. Each sea cage contains cameras above water and at depth - capable of moving vertically and rotating 360 degrees. This camera vision is sent to monitors at the feeding station where the feeder observes fish feeding response to minimise feed waste and maximise fish growth.



All salmon are fed using feed that is size appropriate for their mouth gait (how wide their mouth opens). Pellet size increases as the salmon grows and the mouth gait grows wider.

Advantages to farming salmon

- Salmon in sea circle have reduced stressed, as they are not under natural threat of survival from predators.
- Healthy and efficient growth from egg to adult
- Excellent survival rates
- Reducing pressure on wild caught fisheries
- Employment
- Community participation
- Local providence – knowing where your food comes from

Student worksheet 4 (pdf/Tassal/12. Student worksheet 4.pdf)

Equipment:

Student worksheet 4_answers (pdf/Tassal/13. Worksheet 4_answers.pdf)

- Copy of

  the **student worksheet 4** for each student
- Internet
- IPad
- Virtual Reality Goggles
- Download Farm VR
- Download VR experiences:

- Salmon Lifecycle : 1. Egg to Embryo to Alevin
- Salmon Lifecycle : 2. Fry and Parr
- Salmon Lifecycle : 3. Smolt
- Salmon Lifecycle : 4. Smolt to Adult
- Salmon Weighing
- Salmon Hatchery Water Treatment

Lesson steps

1. Review with the students the life cycle of the salmon from the previous learning experience. Using their understanding of the salmon life cycle, ask them to write a list of 'what do salmon need to be farmed?'
2. Provide students with an opportunity to watch the Lifecycle and other VR experiences. These experiences can be watched on an iPad.
3. Talk to students about what are the physical things that are needed to farm salmon. Write a class list of these physical requirements for salmon in a farmed environment. Here are some ideas for you to talk to them about:
   i. Water (fresh and Salt)
   ii. Temperature
   iii. Oxygen (dissolved in water)
   iv. Space
   v. Something to contain the salmon (hatchery/pen)
   vi. Location
   vii. Health protection
   viii. Stress free away from predation
4. Print a copy of student worksheet 4 for each student. Get the students to draw (or cut and paste) each of the salmon life stages in the correct spaces on the worksheet.
5. The worksheet lists some of the physical requirements of a farmed salmon. Go through each of the stages and answer for each life stage:
   a. Water type (fresh or salt)
   b. Temperature (optimal water temperature)
   c. Food (do they require food, and type and size)
   d. Light (do they have light, and if so, how long?)
   e. Time (approximate length of time spent in that life stage)

Supporting resources

Information about wild Atlantic salmon

http://www.miramichisalmon.ca/education/atlantic-salmon/

(http://www.miramichisalmon.ca/education/atlantic-salmon/)

http://www.asf.ca/life-cycle.html (http://www.asf.ca/life-cycle.html)

https://www.marine.ie/Home/site-area/areas-activity/fisheries-ecosystems/salmon-life-cycle

(https://www.marine.ie/Home/site-area/areas-activity/fisheries-ecosystems/salmon-life-cycle)

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Learning Experience 4

Investigation: Salmon adaption to fresh and salt water

Lesson overview

Session 1

Students explore the idea of diffusion and osmosis

Session 2

Students work in teams to investigate water movement in and out of cells

Session 3

Students explore how salmon have adaptations to move from fresh water to salt and back to fresh.

Lesson outcomes

Students will:

- Understand the basics of diffusion and osmosis
- Understand how diffusion and osmosis help fish to breathe oxygen in water
- Understand the unique adaptations of salmon to be able to move from fresh water to salt water

Teacher Background information

This unit is looking at the adaptations that salmon make to breed in fresh water, but spend their adult life in salt water. Salmon are unique in their ability to do this.

The science that will be examined:

- All fish require oxygen to survive
- Fish breathe in oxygen and release CO2

- Most fish spend their life in either fresh or salt water.
- Some fish (like Salmon) have unique adaptations to be able to move between fresh and salt water

There are a couple of science ideas in this lesson that would be good to discuss with the class, diffusion and osmosis.

Session 1:

Teacher background:

Diffusion

Diffusion is defined as the passive movement of molecules or particles along a concentration gradient, or from regions of higher to regions of lower concentration

Reference: http://www.biology-online.org/dictionary/Diffusion (http://www.biology-online.org/dictionary/Diffusion)

This is not an easy concept for teachers and students, so it would be good to look at how a few different people explain this idea.

Recommend watching: https://www.youtube.com/watch?v=eGCQwvIndMU (https://www.youtube.com/watch?v=eGCQwvIndMU)

There are many good examples of diffusion:

- Placing a teabag into a warm glass of water
- A sugar cube in a glass of water
- Leaving a can of soft drink open
- Spraying perfume in a room

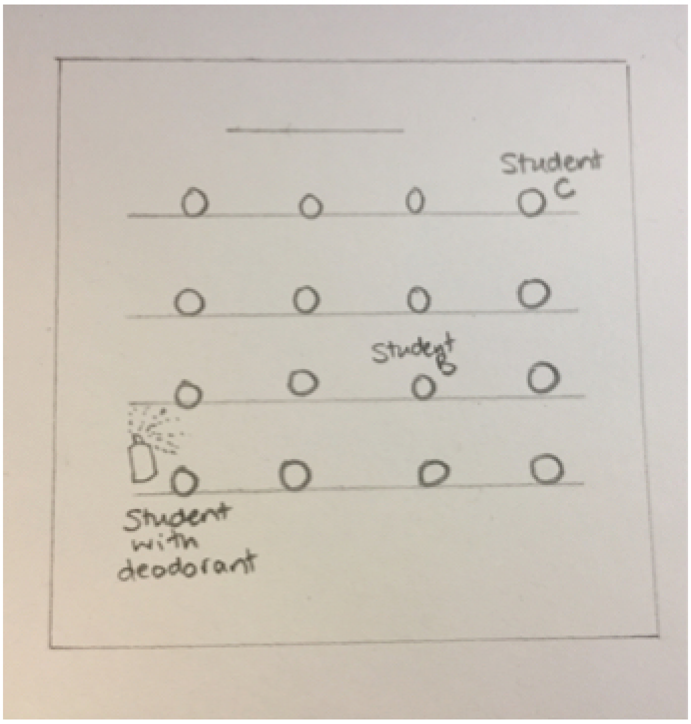
Equipment:

Download Worksheet 5 (pdf/Tassal/14. Student worksheet 5.pdf)

- Provide a copy of **worksheet 5** to all students

Lesson steps

1. Print a copy of student worksheet 5 for each student.
2. Provide the students with a definition of diffusion. Discuss with the class a couple of ideas about diffusion.
   a. If a student was to spray a can of deodorant as in the diagram below, ask the students to describe what might happen in terms of diffusion
   b. Would Student C be likely to notice something before or after Student B



3. Talk to the student about the following examples of diffusion:
   a. Placing a teabag into a warm glass of water
   b. Leaving a can of soft drink open
4. Can the students think of any other examples?

Extension:

Talk to the students about how humans breathe. See if they can explain the process of how humans can use oxygen in the air to survive. Ask students where diffusion may occur, what part of the human body?

Session 2

Osmosis

The second science idea relates to osmosis. Osmosis is about the movement of water. Osmosis is defined as the movement of a solvent (such as water) through a semipermeable membrane (as of a living cell) into a solution of higher solute concentration that tends to equalise the concentrations of solute on the two sides of the membrane

Ref: https://www.merriam-webster.com/dictionary/osmosis (https://www.merriam-webster.com/dictionary/osmosis).

- A membrane is a thin barrier
- Permeable means allowing liquids and gases to pass through it, so a semi-permeable means allowing certain types of particles through it.

  There are many examples of osmosis in nature. Here are a few examples:

- Plants and roots drawing up water for plant survival
- Animals drinking water (hydration and dehydration)
- Taking a bath and getting 'prune like' skin
- Fish breathing in fresh and salt water

Here is an example to talk about with students that they can relate to. A human drinks water to keep hydrated (each cell in a human body needs water to survive). If a human does not drink enough water, the body will produce more concentrated urine (looks darker yellow). When a person is hydrated, their urine is usually a light yellow or has no colour.

Watch the following YouTube clip on osmosis and diffusion https://www.youtube.com/watch?v=PRi6uHDKeW4 (https://www.youtube.com/watch?v=PRi6uHDKeW4)

Equipment:

- Small electronic scales
- Sultanas
- Water

Lesson steps

1. Ask the students the following questions:

   a. Why do humans drink water?

   b. How many glasses of water do you drink a day?

   c. Approximately how many times do you urinate a day?

   d. Have you ever noticed that if you have forgotten to drink throughout the day what colour your urine is?

2. Talk about the process of Osmosis. Conduct the following experiment to help show osmosis.

   Sultana experiment!

   a. Look at sultana and record your observations – what does it look like?

   b. Put a sultana on the scales and record weight

   c. In a cup of water, drop the sultana in the water

   d. Leave sultana in water for 1hour

   e. Remove sultana from water and place on scales and re-weigh

   f. Record what the sultana looks like.

   Explaining this:

   Something such as a raisin will have a very, very high concentration of sugars and water (do not confuse concentration with quantity; the raisin has little water, but it is highly concentrated). Thus, the water flows from a point of low concentration (the cup or bowl of water) to one of high concentration (the raisin). In this way equilibrium is achieved.

3. Get the students to determine the direction of movement from the following diagrams. Remembering osmosis is about the movement of water.

Figure 1: Water and sugar solution

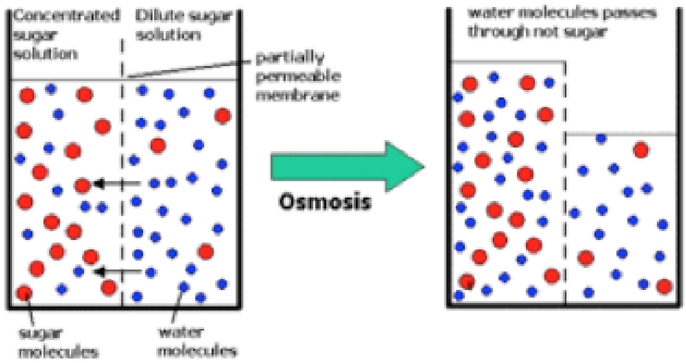


Figure 1: There is a higher concentration of sugar on the left side. The water will move from the right across the membrane to the left. You can see water has moved because there is a change in the level of solution.

Figure 2: Water and solute (like salt)

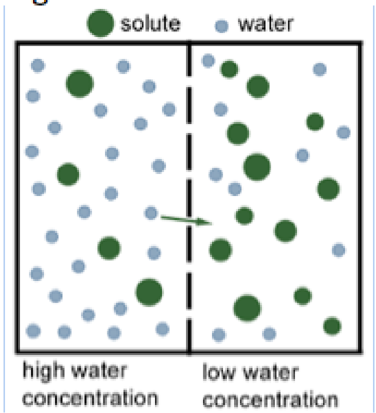


Fig 2: There is a higher concentration of solute on the right hand side, so the water would move across the membrane to the right until it balances in concentration

Figure 3: Water and sugar solution

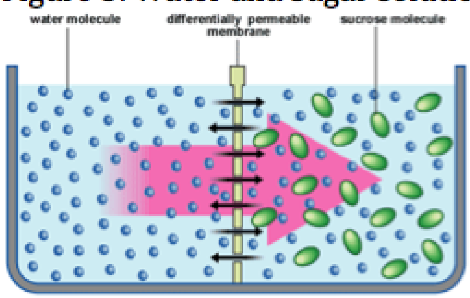


Fig 3: There is a higher concentration of sugar on the right, so water will move from the left across the membrane to the right. You would expect that the right side would rise in level

4. Ask the students to research how much water humans should drink in one day. What do they think would happen if they drank 2 more glasses of water than the recommended? What if they drank 4 less glasses than the recommendation? Hint: some of the students may talk about the concentration/colour of their urine.

Session 3

Teacher background

Three main things must occur for the young salmon, called a smolt, to prepare for life in the salty ocean. First, it must start drinking a lot of water. Second, the kidneys have to drop their urine production dramatically. Third, and very important, molecular pumps in the cells of the gills have to shift into reverse, pumping sodium out instead of in. All these physiological changes have to change back when then the mature fish re-enters the freshwater river on its way to spawn. The fish will spend a few days in the intertidal zone as these changes are made automatically. https://evolutionnews.org/2015/08/how_salmon_adju/ (https://evolutionnews.org/2015/08/how_salmon_adju/) To check if the Parr have moved into the Smolt stage of their life cycle, a sample of about 24 salmon are taken and exposed to seawater for an hour. The individuals have their blood tested before and after the exposure to seawater to see if the salmon have made changes in their body to be able to survive in seawater. If they have, the salmon are moved to the sea.

Fresh water bathing

In the production of farmed salmon, fresh water is used to bath adult salmon (in sea cages) from time to time. Fresh water bathing helps to remove amoeba from the gills of salmon. Numbers in amoeba can rise in salmon, which cover the gill surface and reduce the amount of oxygen that can be absorbed by the salmon. This can make them slow, cause stress, and if not treated cause them to die. Salmon are closely monitored for signs of Amoebic Gill Disease (AGD) and they are treated in fresh water baths (usually sea circles that have been filled with freshwater, and salmon are then pumped from one pen to another for a period of several hours).

Adaption of salmon to fresh and salt water – helps them to get rid of parasites in farmed salmon

Salmon and osmoregulation (pdf/Tassal/15. Salmon and osmoregulation.pdf)

Student worksheet 6 (pdf/Tassal/16. Student worksheet 6 Fresh water salmon.pdf)

Student worksheet 7 (pdf/Tassal/17. Student worksheet 7 Salt water salmon.pdf)

Post-test (pdf/Tassal/18. Pre_Post test.pdf)

Equipment:

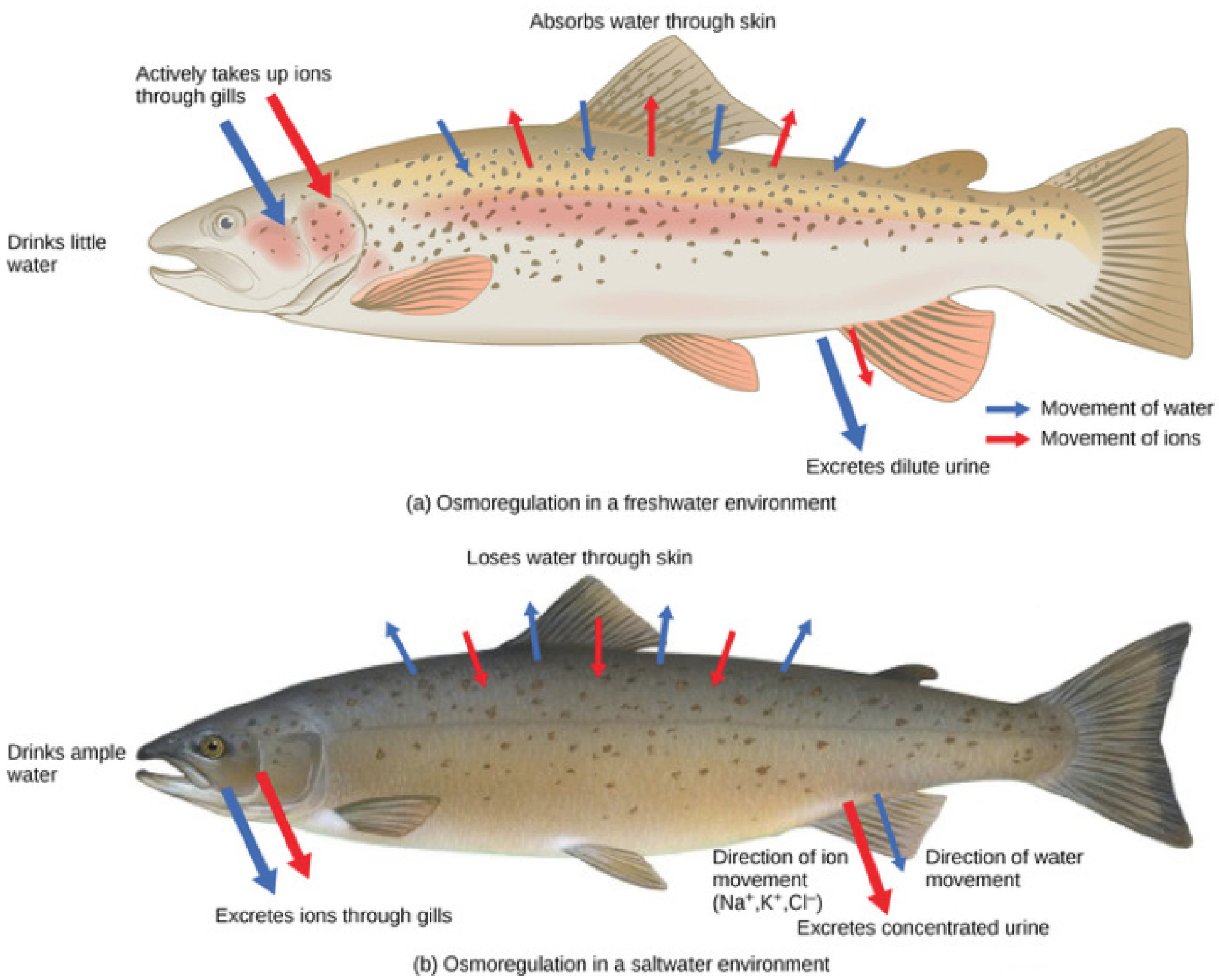
- Print copy of Salmon and osmoregulation information (1 between 2)
- Print copies of student worksheet 6, and 7
- Post-test copy for each student

Lesson steps

1. Watch this video on how fish breathe: https://www.youtube.com/watch?v=zj5v3n6Nlm8 (https://www.youtube.com/watch?v=zj5v3n6Nlm8)

In this YouTube video watch from 2.49 about the explanation of different of fish in fresh and salt water: https://www.youtube.com/watch?v=UA6FeVHAqoc (https://www.youtube.com/watch?v=UA6FeVHAqoc)

2. Fish use osmosis to breathe. Whether they are in fresh or salt water will determine how much urine output they have and whether it is concentrated or dilute.
3. In pairs and as a class read through the salmon and osmoregulation worksheet.
4. Provide the students a copy of the worksheets of salmon in fresh and salt water. Get the students to fill in the answers of water movement.
5. Ask students to complete post-test. Give the students 10 mins to complete. Record results.



Source:

https://www.boundless.com/biology/textbooks/boundless-biology-textbook/osmotic-regulation-and-the-excretory-system-41/osmoregulation-and-osmotic-balance-228/osmoregulators-and-osmoconformers-859-12105/ (https://www.boundless.com/biology/textbooks/boundless-biology-textbook/osmotic-regulation-and-the-excretory-system-41/osmoregulation-and-osmotic-balance-228/osmoregulators-and-osmoconformers-859-12105/)

Supporting resources

http://www.science-sparks.com/2015/04/18/osmosis-made-easy/ (http://www.science-sparks.com/2015/04/18/osmosis-made-easy/)

http://www.science-sparks.com/2011/08/29/shrinking-eggs/ (http://www.science-sparks.com/2011/08/29/shrinking-eggs/)

https://blog.udemy.com/osmosis-experiment/ (https://blog.udemy.com/osmosis-experiment/)

http://homeostasisinhumans.weebly.com/osmoregulation.html (http://homeostasisinhumans.weebly.com/osmoregulation.html)

http://www2.ca.uky.edu/wkrec/vertebratefishevolution.pdf (http://www2.ca.uky.edu/wkrec/vertebratefishevolution.pdf)

https://www.youtube.com/watch?v=H7dH5i9dHXY (https://www.youtube.com/watch?v=H7dH5i9dHXY)

https://www.youtube.com/watch?v=UA6FeVHAqoc (https://www.youtube.com/watch?v=UA6FeVHAqoc)

http://www.bbc.co.uk/bitesize/higher/biology/genetics_adaptation/maintaining_water_balance/revision/2/ (http://www.bbc.co.uk/bitesize/higher/biology/genetics_adaptation/maintaining_water_balance/revision/2/)

http://www.unm.edu/~toolson/salmon_osmoregulation.html (http://www.unm.edu/~toolson/salmon_osmoregulation.html)

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Learning Experience 5

Content in this lesson should be viewed and taught with respect of the possibility that parents/guardians may have various opinions on viewing content that is dissecting a salmon. It will be up to the school to gain access if permission is needed by parents to view and complete the lesson.

Note: the salmon in this video was euthanised humanly before dissection.

Lesson overview

Students will observe a dissection of a salmon to understand the structures of the salmon that have appeared in theoretical lessons above

Lesson outcomes

Students will:

- Observe a dissection of a salmon
- View the identification of structural features of the salmon
- List any interesting differences they observe from the dissection and what they have learnt

Teacher Background information

External Anatomy Structures and Their Functions:

Salmon body part	Adaptation (boost ideas)
Eyes	- Almost at top of head, for nearly 180^0 vision. - Used to see food, avoid predators and find their way - Constantly bathed in water, do not have eyelids or produce tears
Nose	Salmon can smell extremely well. - Finding their way back to the river they were born by smell - Smell small amounts of chemicals and pollutants - Smell prey or food - Smell potential threats/predators
Lateral line	- Pink line down middle of salmon - Contains cells to help in feeling vibrations in the water (sense other fish, danger and food)
Mouth	- Used to catch and hold food - Teeth used to hold food (do not chew food) - Salmon swallow food hole - Water is gulped into mouth to draw into and forced over their gills
Gills	- Composed of gill cover and gills - Gill cover protects delicate gills - Gills are far more efficient than human lungs, because they can extract up to 80% of the oxygen dissolved in water, while human lungs only extract up to 25% of the oxygen in the air. - Blood flowing through gills allow the surface of gills to pick up oxygen and remove carbon dioxide - Gills have many blood vessels which accounts for their red colour
Scales	- Protection, protective cover - Scales grow in regular concentric patterns (determine age) - A layer of mucous covers scales, which protects from diseases, fungi and viruses. - Mucous helps fish to slide through water, and escape from predators
Fins	- 8 fins - Caudal (tail) fin – moves side to side to move fish forward, acts as a rudder - Dorsal Fin – controls direction - Lower side fins – used for balance, direction, moving, slowing down. - The caudal fin is also used by female salmon to dig the redd, in which eggs are deposited.
Fish shape	- Fusiform (reducing in size at both ends) - Salmon shape is streamline to be able to move through the water

Salmon anatomy / function (pdf/Tassal/External Anatomy Structures and Their Functions.pdf)

Equipment:

- Internet
- Ipad
- Virtual Reality Goggles
- Download Farm VR
- Salmon External Anatomy and Dissection (3min58)
- Dissection (4mins30)

Lesson steps

1. There are two VR experiences. The first experience outlines the External Anatomy of a salmon with a brief view of the dissection, and the second is the entire salmon dissection.
2. As a class discuss and list some of the new information your students learnt from the experience/s
3. Revisit the salmon drawing in Learning Experience 1 and see if the students can further add to this diagram.

Supporting resources

This is a good example of a fish/trout dissection

https://www.youtube.com/watch?v=oNeWCmwWqlQ (https://www.youtube.com/watch?v=oNeWCmwWqlQ)

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Overall supporting resources

Comparison of the natural life cycle of the Salmon to the Tasmania pen produced salmon. http://animaldiversity.org/accounts/Salmo_salar/ (http://animaldiversity.org/accounts/Salmo_salar/)

Australian Fisheries Management Authority (AFMA) responsible for commonwealth fish resources http://www.afma.gov.au/about/about-afma/ http://www.agriculture.gov.au/fisheries/aquaculture (http://www.afma.gov.au/about/about-afma/ http://www.agriculture.gov.au/fisheries/aquaculture)

CSIRO

https://www.csiro.au/en/Research/AF/Areas/Aquaculture/Diseases/salmon-gill-disease-AGD (https://www.csiro.au/en/Research/AF/Areas/Aquaculture/Diseases/salmon-gill-disease-AGD)

UN FAO

http://www.fao.org/fishery/statistics/en (http://www.fao.org/fishery/statistics/en)

http://www.fao.org/3/a-br186e.pdf (http://www.fao.org/3/a-br186e.pdf)

Tasmanian salmonoid growers association

http://www.tsga.com.au/salmon-farming/ (http://www.tsga.com.au/salmon-farming/)

Tassal video

https://www.youtube.com/watch?v=dWtNZ5xUNNY (https://www.youtube.com/watch?v=dWtNZ5xUNNY)

https://www.youtube.com/watch?v=IV4zF4biK38 (https://www.youtube.com/watch?v=IV4zF4biK38)

Salmon feeding

https://www.skretting.com/en-AU/faqs/whats-in-fish-feed/ (https://www.skretting.com/en-AU/faqs/whats-in-fish-feed/)

https://www.youtube.com/watch?v=CKQU8ex8ric&feature=results_video&playnext=1&list=PL6DB85A607BFA4B58 (https://www.youtube.com/watch?v=CKQU8ex8ric&feature=results_video&playnext=1&list=PL6DB85A607BFA4B58)

North American sites

https://www.ncbi.nlm.nih.gov/books/NBK223897/ (https://www.ncbi.nlm.nih.gov/books/NBK223897/)

http://www.bcsalmon.ca/wild-bc-salmon/biology-lifecycle (http://www.bcsalmon.ca/wild-bc-salmon/biology-lifecycle) http://www.adfg.alaska.gov/index.cfm?adfg=invasiveprofiles.atlanticsalmon_characteristics (http://www.adfg.alaska.gov/index.cfm?adfg=invasiveprofiles.atlanticsalmon_characteristics)

http://www.fisheries.noaa.gov/pr/species/fish/atlantic-salmon.html (http://www.fisheries.noaa.gov/pr/species/fish/atlantic-salmon.html)

http://animaldiversity.org/accounts/Salmo_salar/ (http://animaldiversity.org/accounts/Salmo_salar/) https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=926 (https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=926)

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