

UCHI | SHETLAND

A **VR lesson** in

Aquaculture

STUDENT WORKBOOK

NAME

CLASS

TEACHER

DATE



3-Lesson Course

Name _____

Date _____

Class _____

Score _____

AQUACULTURE VR

MODULE -

CONTENTS

Un

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Name _____

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AQUACULTURE VR MODULE - BLUE SECTOR APP

Go

LESSON 1

RECEPTION

COMING SOON!

- Develop an understanding of the importance of the aquaculture industry in Scotland, the nutritional benefits of seafood, and the characteristics of Atlantic salmon including their lifecycle and production cycle.

FEEDING STATION



- Carry out remote feeding tasks from a salmon feeding station to ensure all cages receive adequate feed whilst also reducing wastage from overfeeding.

LESSON 2

WELFARE BOAT



- Recognise normal behaviour and appearance in salmon and learn about common diseases and parasites.
- Carry out work in line with animal welfare regulations.

MARINE CAGE SITE



- Carry out routine husbandry tasks relevant to salmon aquaculture such as checking net integrity, transferring fish into the cage and measuring environmental parameters.

LESSON 3

LABORATORY

SCREENSHOT

- Carry out water sample analysis to determine plankton and algae levels.
- Learn about salmon anatomy.
- Carry out routine measurement tasks.

PROCESSING

- Carry out tasks related to salmon processing in a factory setting in line with health and safety guidance.

Name

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AQUACULTURE VR MODULE - LEARNING OUTCOMES

Un

To develop an understanding of the importance of the aquaculture industry to Scotland

To learn about anatomy and life-cycle of Atlantic Salmon and Blueshell Mussels

To explore the conditions required to care for salmon and mussels

To find out more about careers in the aquaculture industry

AQUACULTURE VR

MODULE -

INTRODUCTION

Un

Why is aquaculture important to Scotland?

1. The farming of Scotland's seas contributes over _____ annually to the Scottish economy (Scottish Government 2021).
2. Salmon is the second largest food export in the UK, after whisky with _____ active farms harvesting _____ tonnes annually.
3. _____% of all Scottish Mussels are grown in Shetland.
4. By 2030 the number of jobs supported by the sector could reach _____. To thrive globally, the Scottish aquaculture sector needs a diverse workforce with the right skills - for 5 years' time, 15 years' time and beyond.

Nutritional benefits of seafood

5. How many portions of fish a week should a healthy, balanced diet ideally include?

A. 1

B. 2

C. 4

D. 6

6. What are fish and shellfish good sources of?

A. ZINC

B. OMEGA-3

C. IODINE

D. VITAMINS

E. OMEGA-3
AND VITAMINSF. OMEGA-3
AND IODINEG. ALL OF THE
ABOVE

Atlantic Salmon (*Salmo Salar*)

7. What is the nickname often given to Atlantic salmon?

A. PRINCE OF
THE WATERSB. SILVER
BELLYSC. KING OF
THE FISHD. SLIPPERY
FINS

8. Where can the species be found?

9. What do they feed on in the wild?

A. FAR
OFFSHOREB. COASTAL
SEAS

A. PLANKTON

B. PELAGIC
INVERTEBRATES
AND OTHER FISH

10. They are anadromous, what does this mean?

A. THEY MIGRATE FROM THE SEA
TO FRESH WATERS TO SPAWNB. THEY MIGRATE FROM FRESH
WATERS TO THE SEA TO SPAWN

11. They are an indicator species, what does this mean?

B. DECLINE IN WILD SALMON SPECIES
INDICATES WIDER PROBLEMSB. THE HEALTH OF SALMON POPULATIONS
CLOSELY REFLECTS THE STATUS OF THE
LARGER MARINE ECOSYSTEM

C. A & B

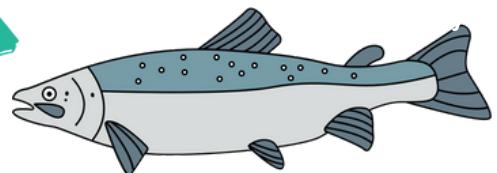
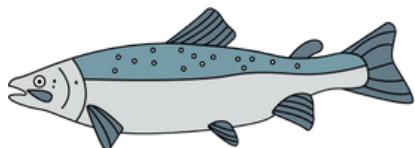
12. What was the weight of the heaviest salmon caught in the wild? Where was it found?

AQUACULTURE VR

MODULE -

THE SALMON LIFECYCLE

Un



Juvenile salmon 1._____ only have the physiological mechanisms needed for surviving in 2._____. However, as 3._____ they migrate 4._____ to the estuary and ocean. They must therefore adapt their 5._____ function to cope with the salt-water conditions and develop 6._____

2

The Salmon Lifecycle

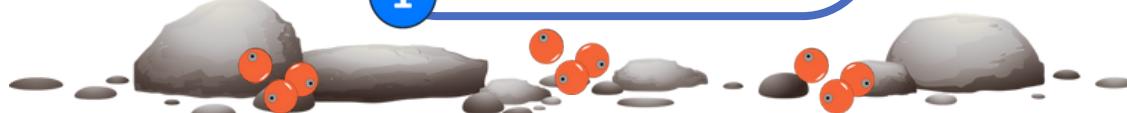
In the Wild

Most salmon spend the first part of their adult life in 1._____ waters, then migrate 2._____ where they spend from 3._____. They can travel up to 4._____ a day in a large school and return to 5._____ to breed.

3

Female salmon swim 1._____ to lay their eggs in cold 2._____ as their eggs, 3._____ cannot survive in the salty and unprotected conditions of the 4._____. They are buried in 5._____ and the flow of running water provides a source of 6._____.

1



Choose the correct answer to fill in the blanks of the salmon lifecycle.

STAGE 1

1. Upstream or Downstream
2. Freshwater or Seawater
3. Alevins and Fry or Parr and Smolt
4. Freshwater or Sea
5. Seaweed or Gravel
6. Oxygen or Nitrogen

STAGE 2

1. Parr or Smolt
2. Freshwater or Seawater
3. Parr or Smolt
4. Upstream or Downstream
5. Liver or Kidney
6. Protective Silvery Scales or Gill filaments

STAGE 3

1. coastal or offshore
2. further out to sea or towards the coast
3. 4 to 6 months or 1 to 7 years
4. 100 km or 50 km
5. to their home stream or to their home offshore

AQUACULTURE VR

MODULE –

SALMON PRODUCTION STAGES

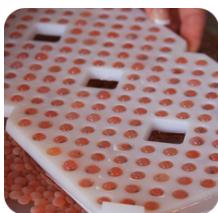
Match up the salmon production stage with the description.

INCUBATION
AND
HATCHING

MARINE
FARM

HARVESTING
PROCESSING

A



- Brood stock are manipulated to produce eggs. Fertilised eggs are transferred to trays and placed in the incubation room. This is the freshwater stage of salmon rearing to mimic real world conditions.

B



- When the salmon are ready to be transferred to the sea, they are kept in cages usually situated in sheltered sea locations. Feeding of the salmon is controlled remotely from a feed barge or hut and delivered through a system of pipes to the cages.

C



- Specifically designed “well boats” are used to transport the mature fish back to land for processing.
- Anaesthetic is pumped into the water to calm the fish before they are humanely killed by a machine which administers a blow to the head. Salmon are bled straight away by a cut to their gills.

D



- To distribute salmon to market it must be cleaned, gutted, graded, and packed in a factory setting to complete the process of primary processing. It may subsequently go through secondary processing to produce fillets for market..

AQUACULTURE VR MODULE – THE SALMON PRODUCTION CYCLE

Understanding the stages of the salmon production cycle in relation to the stages of salmon development is important for understanding the context of the workplace scenarios of the VR app and knowing when in the production process these tasks would be relevant.



1. _____



2. _____

3. _____

Growing salmon are sorted by size and kept in indoor tanks

4. _____



Some fish are selected as broodstock to provide the eggs and milt required to produce new generation.



7. _____

The Salmon Production Cycle



8. _____

When ready to harvest, adult salmon are transported by wellboats and taken to the factory for processing



6. _____



5. _____

When their bodies have matured enough to survive in saltwater they are moved to marine cages

Fill in the blanks for the above salmon production cycle from the following stages of salmon development or production process outcomes:

FRY

SMOLT

SALMON EGGS

PROCESSING

ADULT SALMON

PARR

ALEVINS

BROODSTOCK

AQUACULTURE VR

MODULE –

SALMON PRODUCTION

SUPPORTING ACTIVITIES

Match up the salmon production supporting activities with the description

FISH WELFARE

LABORATORY

FEED PRODUCTION

BROODSTOCK

A



- Good husbandry to promote fish welfare includes farming at locations with good quality water and oxygen content, stocking the cages in low densities, protecting the fish from predation and disease, and carrying out environmental monitoring. Fish welfare can be monitored by checking gill health and performing lice counts.

B



- Feed must be manufactured to meet the salmon's optimum requirements for growth and nutrition at each life stage. This is necessary for preventing deficiencies, malnutrition and disease

C



- Aquaculture laboratories perform microbiological and environmental testing of water samples which helps identify potential issues with salmon welfare, for example by identifying harmful species of jellyfish and plankton.

D



- Some salmon are chosen to produce the next generation. This selection is usually done based upon the physical characteristics such as growth, disease resistance, maturation rate and colour. In Scotland, fertilized eggs are imported to the hatcheries to produce larval and juvenile fish. This increases the population's genetic diversity.

Name _____

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LESSON 1

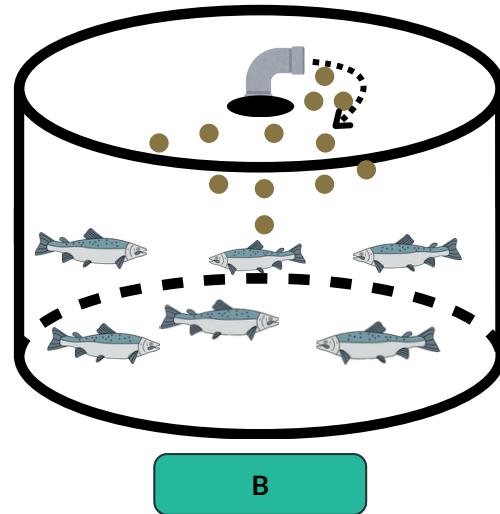
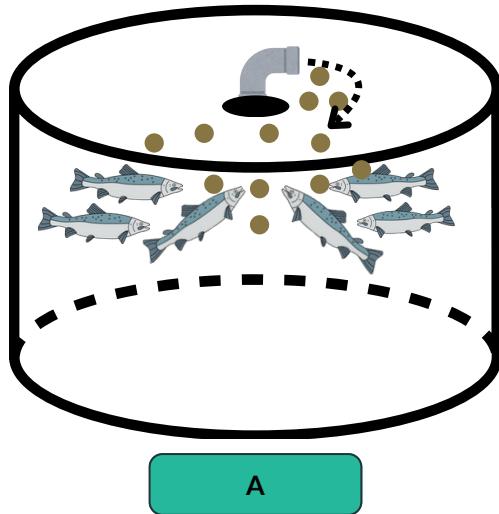
AQUACULTURE VR MODULE - FEEDING SALMON

Un



Feeding behaviour as an indicator of health

The appetite of a salmon is linked to its health meaning that changes in feeding behaviour can be an early sign of stress or disease. Closely monitoring and understanding their behaviour when conducting feeding is essential to ensure salmon well-being and productivity.



Which cage diagram likely indicates good health of the salmon in response to feed being given? A or B?

Which diagram may indicate a change in water quality or the presence of a pathogen? A or B?

Remember that a high concentration of fish near the feeding area is a good indicator that the fish have a high motivation to feed and aren't stressed.

<https://www.therokter.com/aquaculture-blog/salmon-farming-understanding-feeding-behaviors>

[https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3276765/#:~:text=A%20common%20indicator%20of%20good,schooling%20activity%20\(Juell%20et%20al.](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3276765/#:~:text=A%20common%20indicator%20of%20good,schooling%20activity%20(Juell%20et%20al.)

Name _____

Date _____

Class _____

Score _____

LESSON 1

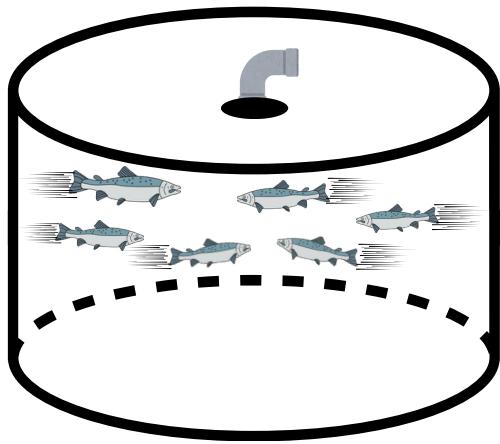
AQUACULTURE VR MODULE - FEEDING SALMON

Un

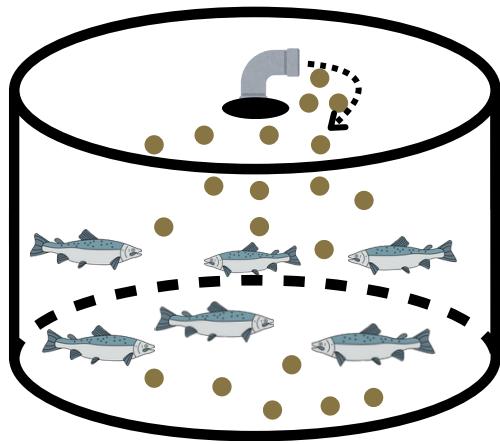


The importance of giving salmon the right amount of feed

Overfeeding and underfeeding of salmon can both lead to problems. Too much feed can cause water quality issues by increasing ammonia levels which is harmful to fish. It can increase stress, harm their gills and make them more susceptible to disease. It can also encourage the growth of harmful bacteria. Too little can stunt growth and weaken the fish, slow growth also means an increased number of production days to reach the optimum weight before harvesting. By carefully calibrating feeding practices, farmers can ensure their fish get the right amount of nutrition without wasting resources. <https://www.therokter.com/aquaculture-blog/salmon-farming-understanding-feeding-behaviors>



C



D

Which cage diagram represents increased swimming activity prior to feeding which may indicate underfeeding? C or D?

Which diagram may indicate overfeeding and could lead to feed wastage and pollution of the environment? C or D?

<https://www.therokter.com/aquaculture-blog/salmon-farming-understanding-feeding-behaviors>
[https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3276765/#:~:text=A%20common%20indicator%20of%20good,schooling%20activity%20\(Juell%20et%20al.](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3276765/#:~:text=A%20common%20indicator%20of%20good,schooling%20activity%20(Juell%20et%20al.)

Name

Date

Class

Score

AQUACULTURE VR

MODULE –

FISH WELFARE

Good husbandry to promote fish welfare includes farming at locations with good quality water and oxygen content, stocking the cages in low densities, protecting the fish from predation and disease, and carrying out environmental monitoring. Fish welfare can be monitored by checking for scale loss, observing gill health and performing lice counts.

SALMON LICE CHECK



- Sea lice infestation can lead to reduced salmon welfare and lower productivity at farm level through low feed efficiency or growth reduction.
- Control measures include in-feed medication, fresh water baths, physical removal, and biological control using cleaner fish.

SALMON GILL HEALTH CHECK



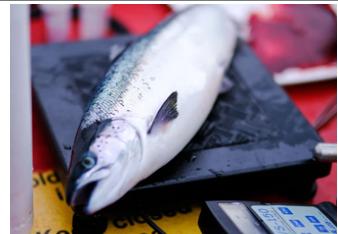
- The gills of salmon are responsible for many physiological processes relevant to the maintenance of fish health including respiratory function.
- Caused by amoeba, parasites, viruses, bacteria, plankton and algae, symptoms include white spots and eventual deterioration of the gill tissue.

SALMON SCALE LOSS CHECK



- Scale loss is a key welfare indicator in salmon and may look like dark patches on the skin.
- Handling procedures may be a cause in addition to netting abrasion due to overcrowding.
- This may weaken the physical barrier which protects the salmon from parasites.

GENERAL SALMON HEALTH CHECK



- Weighing and measuring of salmon is important for monitoring the growth and development of the fish.

Choose one of the following Operational Welfare Indicators in Salmon farming and discuss with your seat partner reasons why it would be important and ways of monitoring your chosen indicator. Be prepared to feed back to the class what you discussed.

MORTALITY RATE

GROWTH RATE

SEA LICE LEVELS

FISH BEHAVIOUR

CONDITION FACTOR

FIN DAMAGE



Name _____

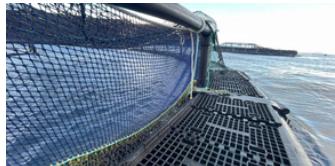
Date _____

Class _____

Score _____

AQUACULTURE VR MODULE – MARINE CAGE SITE

When the salmon are ready to be transferred to the sea, they are kept in cages usually situated in sheltered sea locations. Routine measurements of relevant environmental parameters must be carried out to monitor the cage conditions and welfare of the fish.

**NET
INTEGRITY
CHECK****WATER
TURBIDITY
CHECK****OXYGEN
LEVEL
CHECK****OBTAINING
A WATER
SAMPLE**

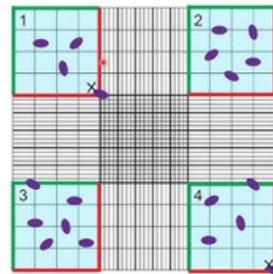
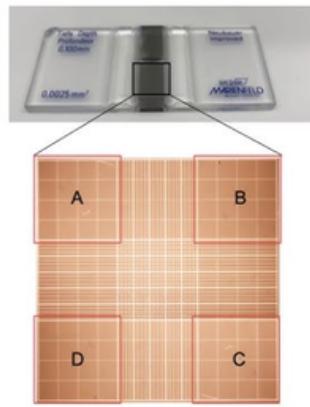
AQUACULTURE VR

MODULE –

LABORATORY

Monitoring water quality is of great importance to the management of an aquaculture facility. A variety of variables are measured such as plankton and algae levels, temperature, salinity, dissolved oxygen, alkalinity and nitrite levels. A good laboratory setup is critical for conducting these tests.

PLANKTON COUNT

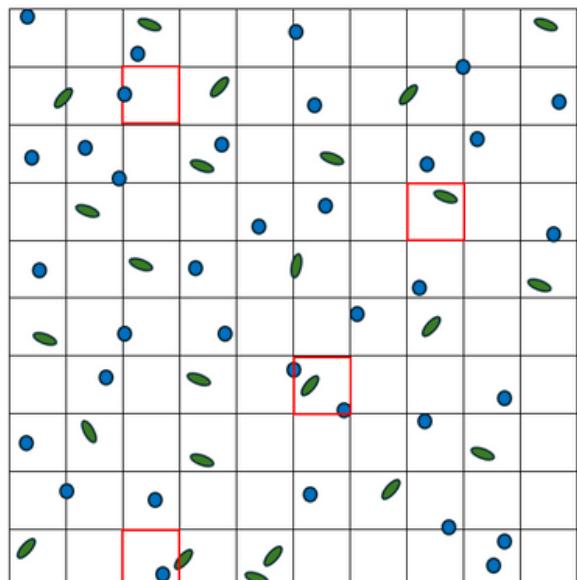


A counting chamber observed via a microscope is a commonly used tool for water sample analysis. It allows for algae and plankton suspended in water to be counted and identified. Some types of these organisms are toxic to salmon and can cause fatal gill damage, it is therefore important that these organisms are classified and their levels are known.

The chamber holds a known volume of liquid which is intended to be representative of the sample. Using the grid of the chamber, the number of algae and plankton can be counted and the population estimated.

For example, if you have 1 ml of water split across a 1000 square grid, each square will contain 1 μ L of water. For organisms lying on the boundary of a square, only those on 2 of the 4 sides will be counted. In the example above this is the top and left side.

If you observe an average of 4.5 organisms of a particular species per square over 4 squares randomly chosen across the sample you can estimate that 1 ml of water will contain 5000 organisms or 5 million in a litre of sea water.



Calculate the number of plankton (green) and algae (blue) organisms present in 1 litre of water based upon the squares marked in red. Consider that this is a 1ml sample with each square therefore representing 10 μ L.

A 75,000 plankton per litre, 100,000 algae per litre

B 5,000 plankton per litre, 7,500 algae per litre

C 50,000 plankton per litre, 75,000 algae per litre

D 7,500 plankton per litre, 10,000 algae per litre

Do you think the answer is an accurate representation of the sample? What could be done to improve accuracy?



AQUACULTURE VR

MODULE -

SALMON EXTERNAL ANATOMY

Understanding the anatomy of the atlantic salmon is important for developing background knowledge of the species

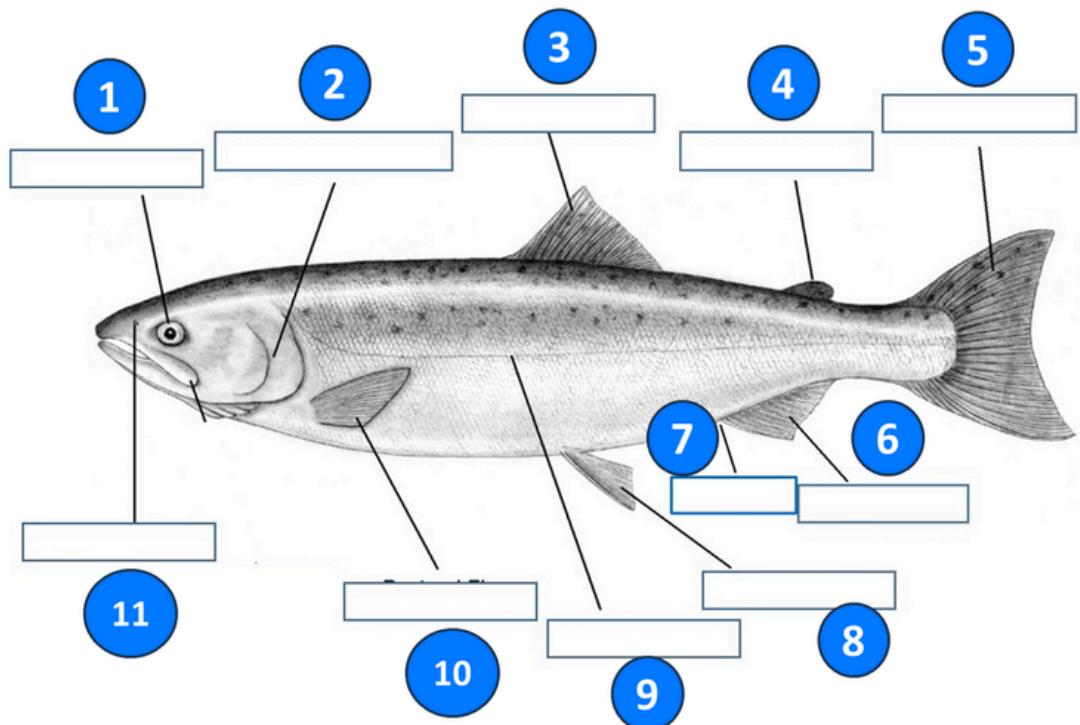


Illustration: Karen Undall-Ekann

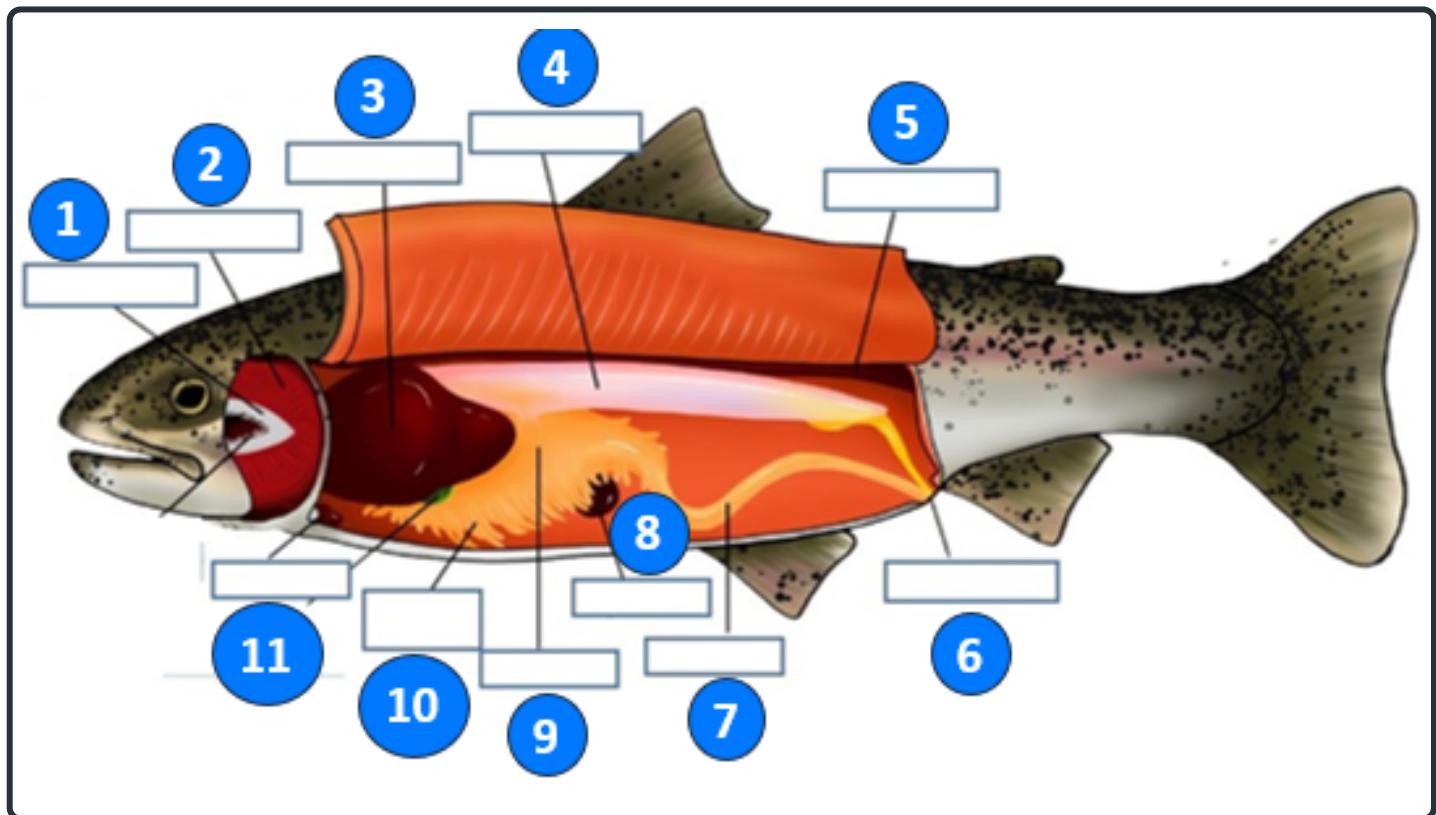
Image source: Fisheries and Oceans Canada, Salmonid Enhancement Program

Fill in the blanks for the above salmon external anatomy diagram from the table below:

Body Part	Description
Lateral line	Specialised cells which detect low frequency sound waves to sense water current and other fish
Dorsal fin	An upper fin, helps fish turn quickly and stop and prevents rolling
Adipose fin	An upper soft and fleshy fin, acts as a flow sensor
Caudal fin	Tail fin, like a motor, creates forward motion and acts as a rudder
Anal fin	A lower fin, used for stability and controls rolling
Pelvic fin	A lower fin, helps stabilise and slow the fish down, used to move up and down
Pectoral fin	A lower fin, create lifts, helps to turn fish left or right
Gill cover	A hard protective plate to cover the gills
Maxillary bone	The upper jaw
Nostrils	Helps the fish to navigate back to the streams they were born in
Eyes	Used for sight and to navigate their aquatic environment, some can see 5m or more

AQUACULTURE VR MODULE - SALMON INTERNAL ANATOMY

Understanding the anatomy of the atlantic salmon is important for developing background knowledge of the species



Fill in the blanks for the above salmon internal anatomy from the table below:

Body Part	Description
Gill Arch	A series of bony loops which support the gill filaments
Gill Filaments	The site of gas exchange, contain many capillaries
Liver	Essential for digestion and maintaining blood chemicals
Air Bladder	Helps the fish to stay buoyant, can acclimate to changes in water pressure by adjusting the air
Kidney	Removes waste from the bloodstream, plays a vital role in osmoregulation
Vent	Where fish eliminate waste. Female fish lay eggs from here and milt is released by males.
Intestine	Extends from the pyloric caeca to the vent, absorbs nutrients from food and transports waste
Spleen	Makes white blood cells and recycles red blood cells.
Stomach	Uses digestive enzymes to break down food
Pyloric Caeca	A blind sac, connected with the alimentary canal, absorbs nutrients into the blood
Gall Bladder	Stores bile used to digest fats, attached to the liver
Heart	Circulates blood through the body
Gill Rakers	Help to filter out debris that would otherwise damage the gill filaments

Name _____

Date _____

Class _____

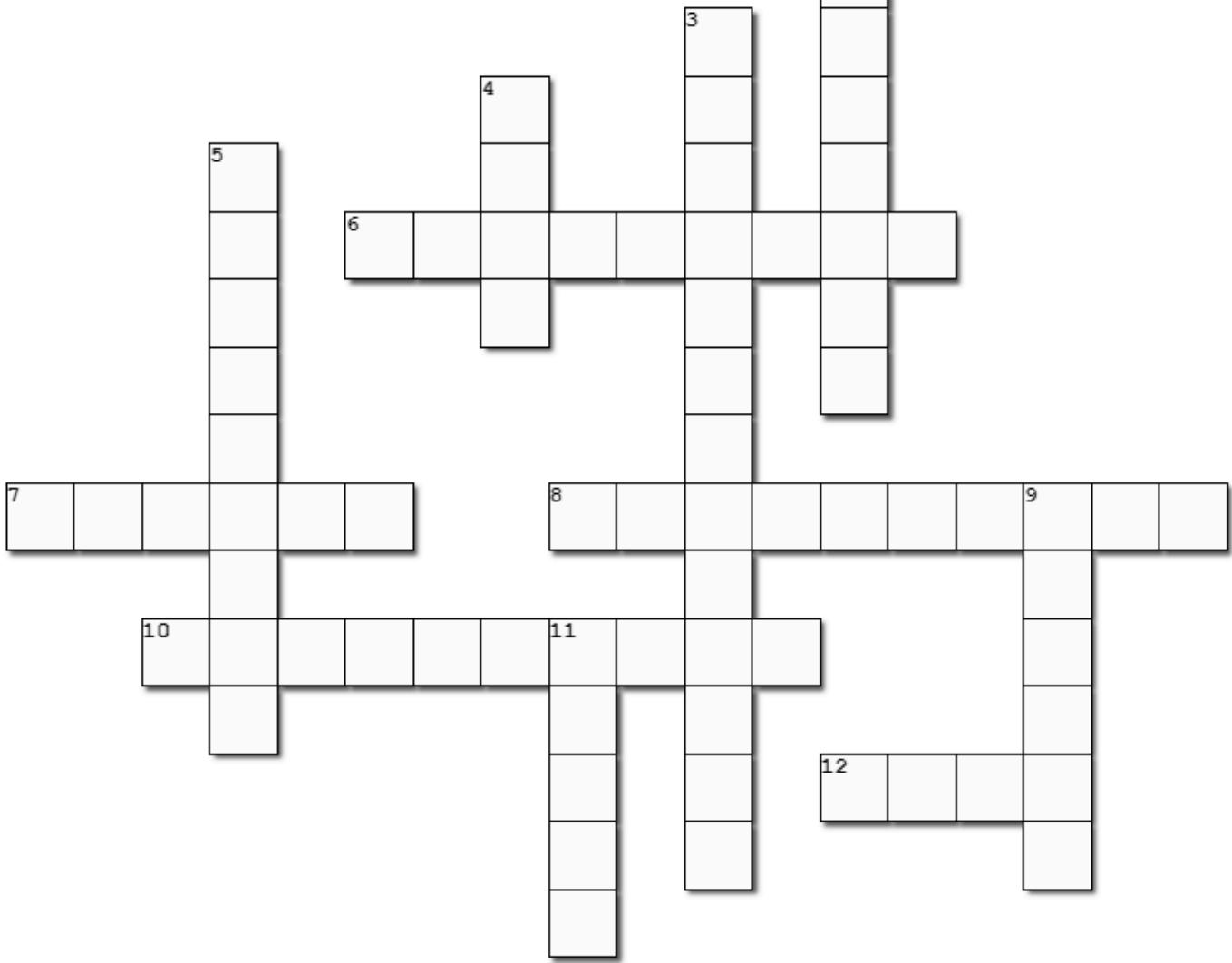
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AQUACULTURE VR

MODULE -

KEY TERMS

1				2



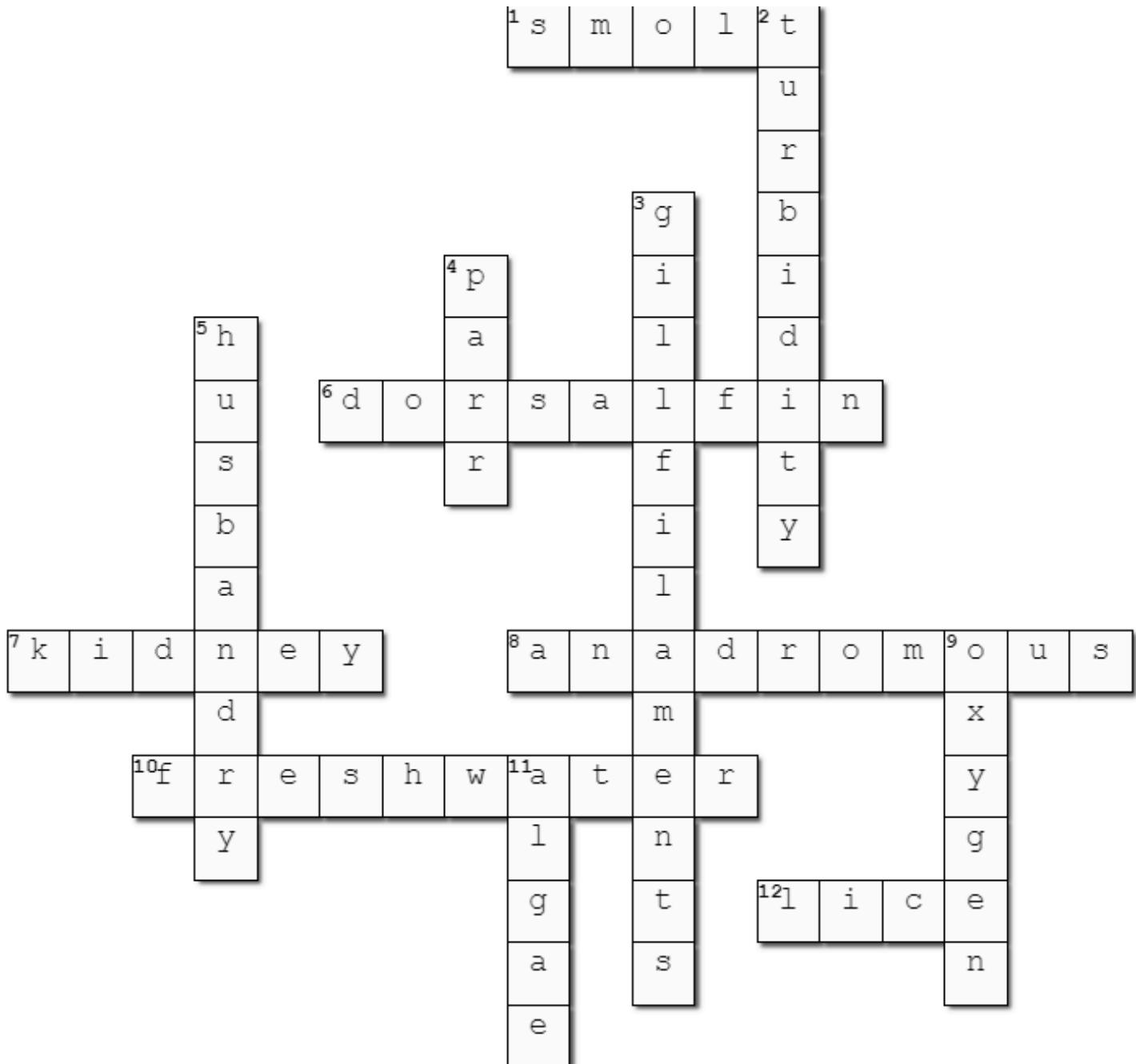
ACROSS

1. The name for salmon which are 30-50 weeks of age and have adapted to the marine environment.
6. Helps the fish to turn quickly and stop and prevents rolling.
7. The organ which must adapt to allow the salmon to survive in seawater.
8. The term for a species which migrates from freshwater to the sea to spawn
10. Where wild salmon spend their early life.
12. A parasite which is found on the scales of salmon.

DOWN

2. A measure for water clarity.
3. The site of gas exchange.
4. A juvenile developmental stage.
5. Care of the salmon.
9. An important gas for raising salmon, the levels of which are checked regularly.
11. An organism which can harm salmon gills and must be managed appropriately.

AQUACULTURE VR MODULE – KEY TERMS



AQUACULTURE VR MODULE – CAREERS

- There are a wide range of interesting jobs available within Scotland's aquaculture sector breeding, rearing and harvesting fish and shellfish species for consumption.
- Many of the tasks are done by farm workers, however, specialized work in areas such as stock health, veterinary practitioners, laboratory services and engineering usually have dedicated staff with higher skill levels.

