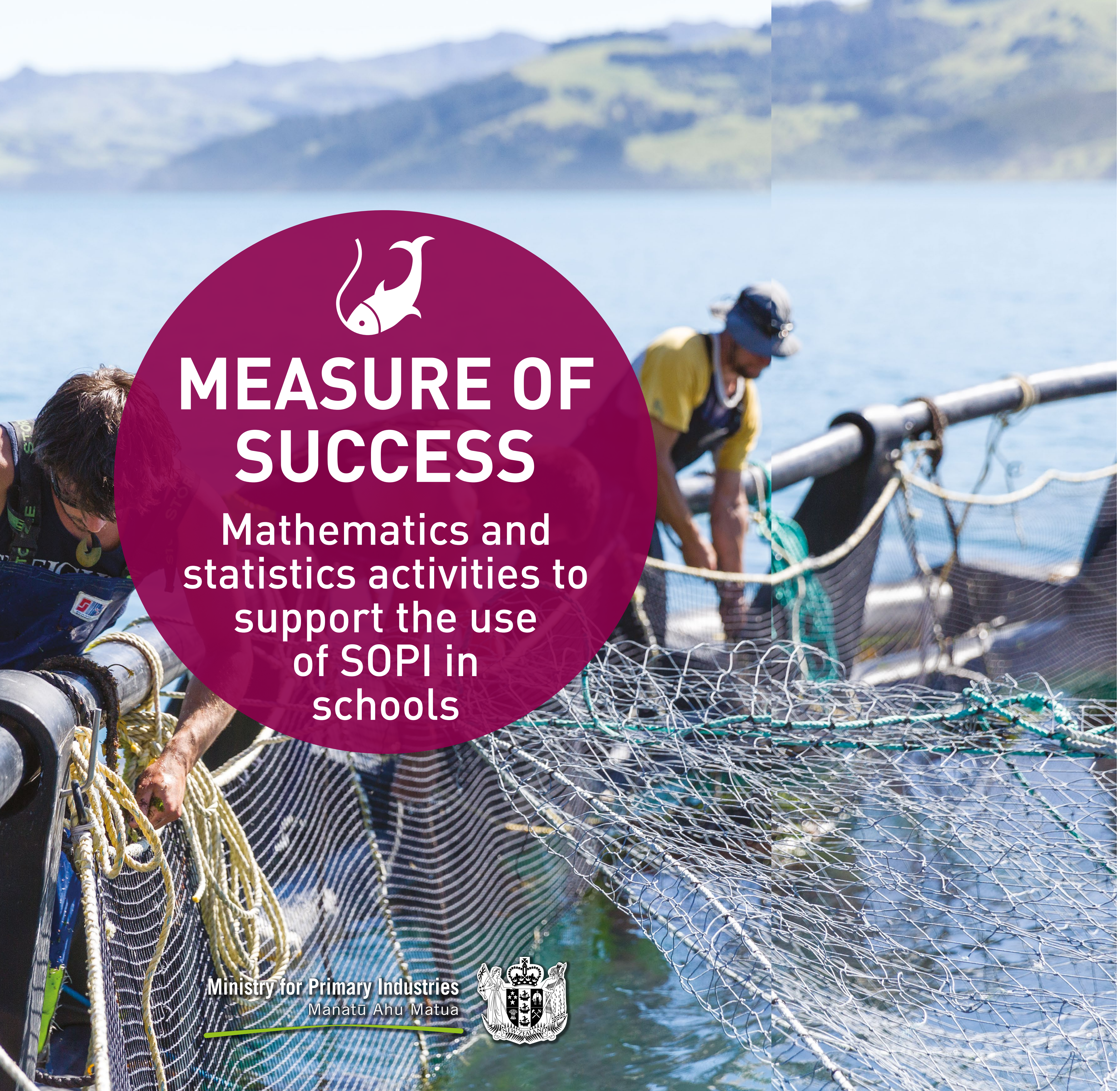

MEASURE OF SUCCESS

Mathematics and statistics activities to support the use of SOPI in schools

Ministry for Primary Industries
Manatū Ahu Matua

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CONNECTIONS TO THE NEW ZEALAND CURRICULUM

CURRICULUM PRINCIPLES

The learning activities in this resource have been developed to support these curriculum principles of The New Zealand Curriculum.

Learning to learn: Encourages students to reflect on their own learning processes and learn how to learn.

Community engagement: Enables students to connect to wider aspects of their lives, their families, whānau, and communities.

Coherence: Provides identified links across the learning areas of science, technology, social sciences, and mathematics and statistics to support students to make connections within and across learning areas.

Future focus: Encourages students to look to the future by exploring such significant future-focused issues as sustainability, enterprise, and globalisation.

ACHIEVEMENT OBJECTIVES

The learning activities in this resource support these science achievement objectives of The New Zealand Curriculum:

Level 4

Students will solve problems and model situations that require them to:

Geometry and Measurement

- Use appropriate scales, devices, and metric units for length, area, and volume and capacity.
- Convert between metric units, using whole numbers and commonly used decimals.
- Interpret and use scales, timetables, and charts.
- Identify classes of two- and three-dimensional shapes by their geometric properties.

Number and Algebra

- Find fractions, decimals, and percentages of amounts expressed as whole numbers, simple fractions, and decimals.
- Understand addition and subtraction of fractions, decimals, and integers.

Statistics

Plan and conduct investigations using the statistical enquiry cycle:

- determining appropriate variables and data collection methods
- gathering, sorting, and displaying measurement data to detect patterns, variations, relationships, and trends
- comparing distributions visually
- communicating findings, using appropriate displays.

Level 5

Students will solve problems and model situations that require them to:

Geometry and Measurement

- Select and use appropriate metric units for length, area, volume and capacity, weight (mass), temperature, angle, and time, with awareness that measurements are approximate.
- Convert between metric units, using decimals.
- Deduce and use formulae to find the perimeters and areas of polygons and the volumes of prisms.
- Find the perimeters and areas of circles and composite shapes and the volumes of prisms, including cylinders.

Number and Algebra

- Use rates and ratios.
- Reason with linear proportions.
- Know and apply standard form, significant figures, rounding, and decimal place value.

Statistics

Plan and conduct investigations using the statistical enquiry cycle:

- determining appropriate variables and measures
- considering sources of variation
- gathering and cleaning data
- using multiple displays, and re-categorising data to find patterns, variations, relationships, and trends in multivariate data sets
- comparing sample distributions visually, using measures of centre, spread, and proportion
- presenting a report of findings.

KEY COMPETENCIES

These learning activities provide opportunities for:

Thinking

- use creative and critical thinking processes to make sense of information, experiences, and ideas
- ask questions and challenge assumptions
- problem-solve by actively seeking and using knowledge.

Using language, symbols, and texts

- interpret and use number, images, movement, and technologies in a range of contexts
- develop resourcefulness
- confidently and competently use information technologies to access and provide information and to communicate with others.

Managing self

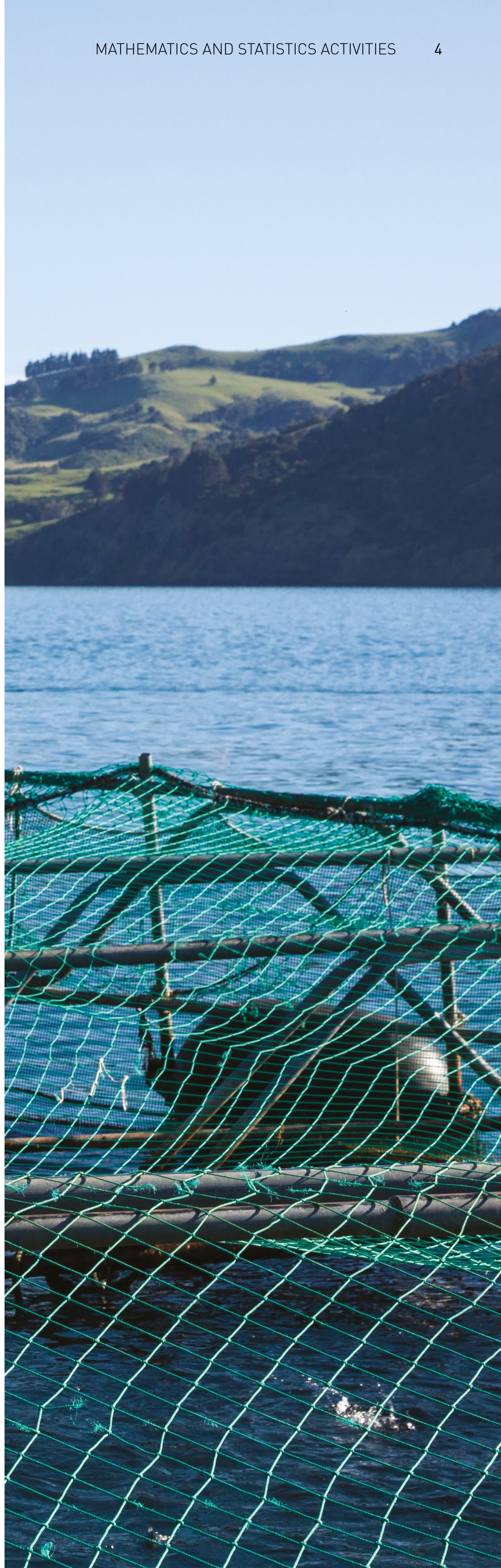
- develop a 'can-do' attitude
- make plans, manage projects, and develop strategies for meeting challenges.

Relating to others

- listen actively, recognise different points of view, negotiate and share ideas
- cooperate, and work effectively with others
- come up with new approaches, ideas, and ways of thinking.

KEY UNDERSTANDINGS

- The significance of aquaculture to the New Zealand economy.
- The relationship between the dimensions of containers (3D shapes) and their effect on volume and capacity.
- Metric conversions in context.
- How to estimate the size of a population based on proportional reasoning from a sample.
- Sample variation.
- Proportional reasoning and using rates and ratio in context.



TEACHING AND LEARNING PLAN

INTRODUCTION

The seafood industry, including aquaculture, is important to the New Zealand economy. Aquaculture is a relatively new industry in New Zealand, having started not much more than forty years ago. It is an industry where growth and development are expected in response to increasing worldwide demand for high quality seafood and the health benefits it provides. Aquaculturists need to undertake research in order to solve problems and retain market competitiveness.

The resource is designed so that a class may choose to do some or all of the activities.

One example of aquaculture in New Zealand is farmed King salmon. The salmon farming begins in on-land freshwater hatcheries, which are made up of a series of enclosed circular tanks and long rectangular 'raceways'. Fish eventually graduate to 'pens' that are located either in the sea or in alpine canals (see figure 1). Tanks and raceways utilise pumps to ensure a constant flow of water and use filters to remove wastes (such as uneaten food and fish faeces) and to maintain oxygen levels. The circular tanks employ centrifugal forces generated by water flow to extract wastes from a centrally located drainage hole at the bottom (see figure 2). In a raceway the water will enter the top of one end of the tank and filter out the other side.

STRUCTURES USED FOR AQUACULTURE

One structure is rarely used for entire lifespan

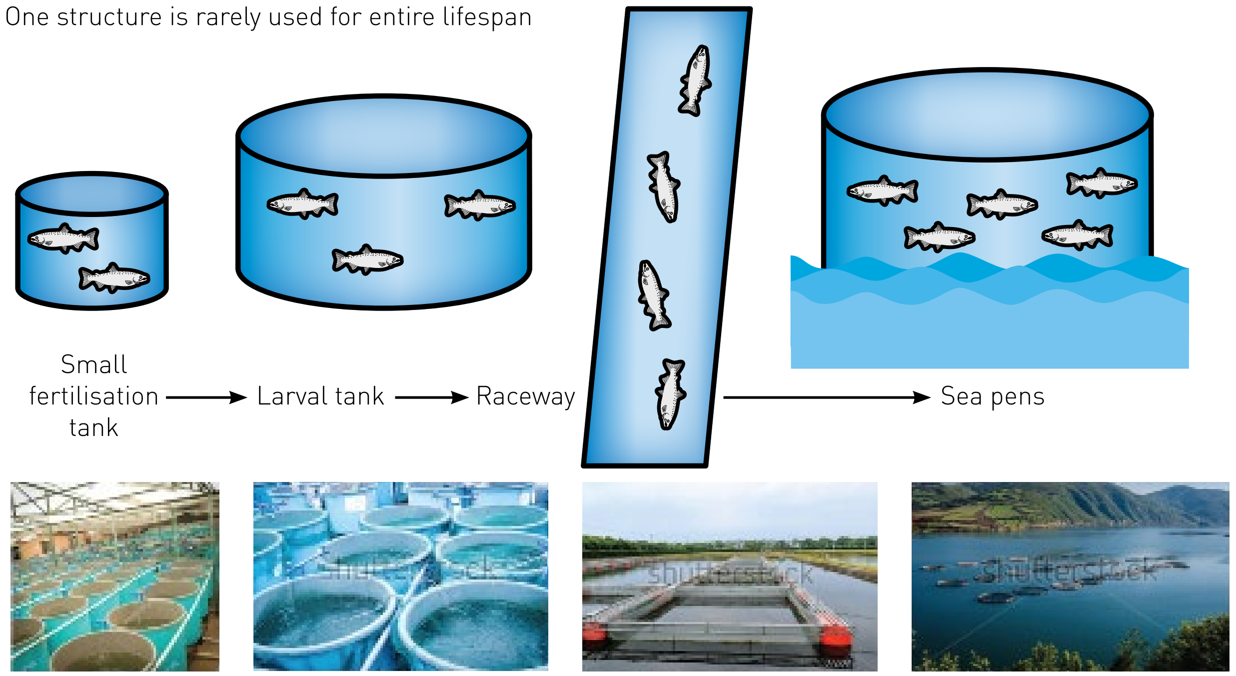
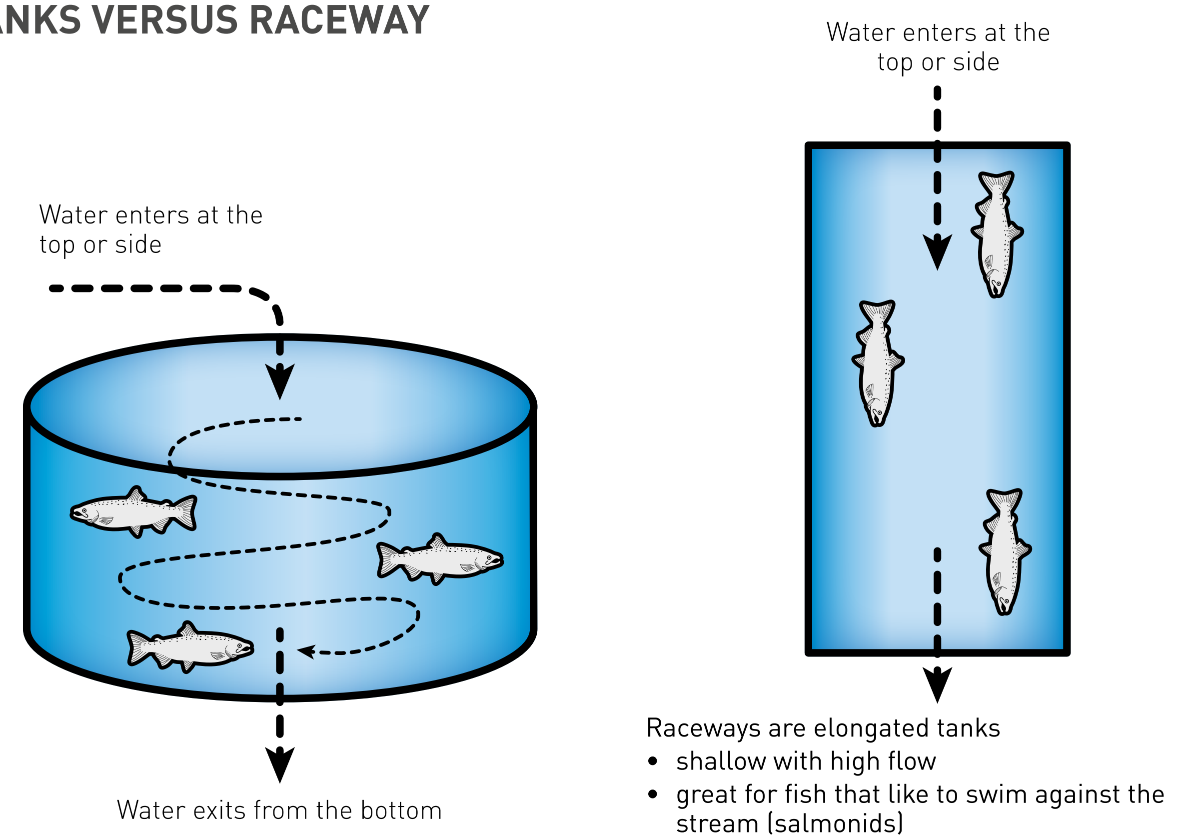


Figure 1: Structures used for aquaculture

TANKS VERSUS RACEWAY



Raceways are elongated tanks
- shallow with high flow
- great for fish that like to swim against the stream (salmonids)
- require large volume of water per unit area

Figure 2: Tanks versus raceway

Another example of aquaculture in New Zealand is mussel farming, and more recently land-based mussel spat rearing. This innovative work has led to Greenshell™ mussels being raised from eggs in captivity on a large scale before being placed on sea-based mussel lines, something that has never been done before. The mussel spat (larvae) are tiny and require special equipment and special food.

This resource supports students to develop their understandings of a range of mathematical and statistical concepts, using aquaculture as a context. The practical nature of the suggested activities allows students to appreciate how mathematical skills can be transferred to real employment practices.

BACKGROUND RESOURCES

- This video, which shows geodesic-shaped sea pens, includes good background information on fish farming.
- This science and social studies educational resource from Aquaculture.org.nz has some useful information sheets.
- A good explanation of circular fish tanks
- NIWA: Northland Aquaculture has good footage of the farming of king fish, mussels, and oysters.
- American video of geodesic-shaped sea pens designed for deep sea aquaculture. This includes good background information on fish farming.

ACTIVITY 1:

WHO BUYS OUR SEAFOOD?

Initiate a class discussion.

- Who likes to eat seafood? Who likes fish, oysters, mussels, crayfish ...? (The class could do a survey).
- Where does our seafood come from?
- What is aquaculture?
- Who has been to a fish farm?
- Is aquaculture important to New Zealand?

Choose one of these videos to introduce the class to aquaculture. Have students in groups make summaries of the key points of the video. Have students list items they recognise as having a mathematical or statistical component.

- NIWA Northland Aquaculture video – This has good footage of king fish, mussels, oysters and other types of New Zealand aquaculture
- NIWA video about the fish research laboratory at Bream Bay in Northland

In this activity students will:

- Gain an appreciation of the significance of the aquaculture industry and how it fits into the New Zealand economy.
- Make sense of the data representations (graphs and tables) in the SOPI 2016 document.

Refer to the seafood section of SOPI (pages 56–60) and have the students read the 'Top 10 Seafood export markets by value' on page 57 to answer these questions.

- Identify the country that imported the greatest amount of seafood from New Zealand. What feature in the graph gives us this information? Locate and record the total revenue this country's import of seafood contributed to the New Zealand economy. What percentage of our export revenue does this represent? Identify this country's most popular New Zealand seafood product and calculate the amount of export revenue that it generated for New Zealand.

- Identify the country that imports the second-greatest amount of seafood from New Zealand. Locate and record the total revenue this country's import of seafood contributed to the New Zealand economy. What percentage of our export revenue does this represent? Identify this country's most popular New Zealand seafood product and calculate the amount of export revenue that it generated for New Zealand.
- Compare and contrast the two countries you have identified as New Zealand's top seafood export markets. Identify any similarities and differences between these countries' imports. Suggest some reasons for differences that you find and how they might impact on New Zealand's seafood exports.

ACTIVITY 2:

TANKS FOR ALL

Introduce this topic by having the students view this video and examine this map of aquaculture in New Zealand. If your school is in an area with aquaculture industries, arrange a class visit. Alternatively invite an industry representative to talk to the class through skype or arrange for students to view a video of an aquaculture farm. Focus on:

- How fish farms are structured and the process of transferring fish from hatcheries to tanks and sea pens as they grow.
- How and why waste is filtered from tanks.
- How the water is oxygenated. Explore the advantages of circular tanks with central extraction drains over rectangular raceway tanks.

PART 1: TALL AND THIN VERSUS SHORT AND SQUAT

In this activity students will explore the relationship between volume, capacity and surface area of cylinders.

Note: This applet is useful for students who need to review their understanding of volume.

1. Roll a piece of A3 or A4-sized paper into one of two types of cylinder, tall and thin, or short and squat. Have the students predict which type will have the greatest capacity. Record their predictions.

Tall and thin has greatest capacity	Short and squat has greatest capacity	Both have same capacity

2. Have the students in pairs make one of each type of cylinder, taping where the paper joins so that the cylinders hold firmly. They can now fill these cylinders with small objects (for example, polystyrene beads or Smarties lollies) and count and record the number that fit into each to find out which shape had the greatest capacity. Have them discuss in their pairs how the capacities compared and how they could measure their capacities more accurately.

3. Have the students calculate the volumes of each cylinder using formulas.

Cylinder	Circumference in cms	Height in cms	Diameter in cms	Radius in cms	Volume in cm^3	Capacity in litres
Tall						
Squat						

4. Have the students explain why the squat tank would have a larger capacity, despite being constructed from the same-sized piece of paper. (The circumference being larger has a greater effect due to the radius being squared.)

EXTENSION INVESTIGATION

This investigation can be extended by repeatedly making more and more 'squat' containers by tearing the piece of paper in half (longwise to halve the cylinder's height) and attaching the short ends to double the circumference. A spreadsheet can then be manipulated to demonstrate how an A4 piece of paper could theoretically contain a 'mind-blowing' amount of water. Would it be able to hold the contents of an Olympic-sized swimming pool?

Summarise what has been learnt and explain to the students that the depth of ponds does not usually exceed two metres. This is so that the water does not stratify into different layers of oxygen concentration.

PART 2: FOOD FOR MUSSEL SPAT

In this activity students will:

- learn how to determine the amount of cleaning solution required to ensure containers and tanks remain clean
- gain a deeper understanding of the conversions in the metric system.

SPATnz is raising Greenshell mussel spat (baby mussels) from eggs in New Zealand's first large-scale mussel hatchery. SPATnz wants to ensure that the hatchery remains free of disease so it has a wide range of precautions to minimize disease risk. One of these is to disinfect equipment that could bring diseases to the hatchery or spread them within the hatchery. This is done by bathing equipment in dilute solutions of household bleach. (The bleach contains 10% sodium hypochlorite as an active ingredient.) Our target concentration is 2000 parts per million of bleach solution (which is the same as 200 parts per million of sodium hypochlorite).

PARTS PER MILLION (PPM)

Present a single centicube (cube of 1 cm) to the students and explain that the metric system has been well thought out. 1 cm of water equals 1 ml and it weighs 1 gram. Pose these questions.

- How much liquid (in litres) would be contained in a cube 10 cm x 10cm x 10cm?
- How much would this 10 x 10 x 10 cm cube weigh?
- Draw a sketch of a cubic metre, or make one with metre rulers and hold the cubic centimetre next to it. How many cubic centimetres are in a cubic metre?
- How many milliliters (mL), Litres (L) and Kilolitres (kl) are in a cubic metre of water?
- How much would a cubic metre of water weigh in grams (g), kilograms (kg) and tonnes (t).
- If the required concentration of bleach solution is 2000 ppm, how many mL of bleach solution would be required for one cubic metre of water?
- How many mL of bleach solution would be required for a 200 L disinfection tank?

Have the students work out the following calculations.

Bleach can be broken down by sunlight, so for the outdoor tank where field equipment is disinfected, we increase the target dose to 2500 ppm. Calculate the tank volume and dosage of bleach solution required to give 2500 ppm in:

- a tank that measures 1.95 m long, 0.9 m wide and 75 cm deep
- a tank that is 4 metres diameter and 0.95 m deep

RESOURCES

- Ministry for Primary Industries Primary Growth Partnership Programmes – SPATnz
- LEARNZ virtual field trip – Our Primary Industries
- Nelson mussel hatchery research bears fruit with first harvest.

ACTIVITY 3:

ONE FISH, TWO FISH... HOW MANY FISH?

In this activity students will learn how to use samples and proportion to estimate the population of a fish pond or determine fish stocks in the wild.

Explain to the students that you are going to demonstrate how to use a capture and recapture method to determine the number of fish in a pond. Have them imagine that you took a sample of 12 fish from a pond and tagged them so that they could be identified if they were caught again at another time. The fish were released and 12 more fish are caught some time later.

Have the students, in small groups, discuss these questions.

- How could this activity be used to calculate the number of fish in the pond?

  (We use the proportion of fish in the second sample to estimate the number of fish in the pond. For example, if the second sample had 3 tagged fish, we can do this by solving an equation

  $\frac{3}{12} = \frac{12}{x}$, $3x=12\times12$, $x=\frac{144}{3}$ so $x=48$

  or by comparing ratios 3:12=12:x. $3\times4=12$ so $x=12\times4=48$).
- What assumptions does this method of estimating the fish population rely on?

  (We assume that the fish swim around randomly and each one has an equal likelihood of being sampled.)
- How could we improve the accuracy of this estimate?

  (By taking a larger sample or taking many samples and using an average of these.)

PPDAC EXPERIMENT

PROBLEM

To check the accuracy of the resampling method for estimating the number of fish in a pond.

PLAN

Group the students. Have each group represent the number of fish in a pond by using counters in a bag. The group will then follow this process.

1. Take a sample of counters from the bag by grabbing a small handful of counters (simulating a net catching a sample of fish from a pond).
2. Record the size of the sample and tag each of the counters by marking them with a felt pen and then putting them back into the bag with the other counters.
3. Shake the bag and, without looking, take out another handful of counters. They then record the total size of the sample and the number of marked counters on a table before putting the counters back in the bag.
4. Repeat this process nine more times.
5. Calculate the average number of marked counters and the average size of the sample and use these numbers to estimate the number of fish in the pond.
6. Count the actual total number of counters in the bag.
7. Subtract the estimated number of fish in the pond from the actual number and display this on a dot plot with the data collected from the other groups in the class.

DATA

Number of tagged fish in pond = ______________

Sample	Tagged fish	Sample size
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Total		
Average		

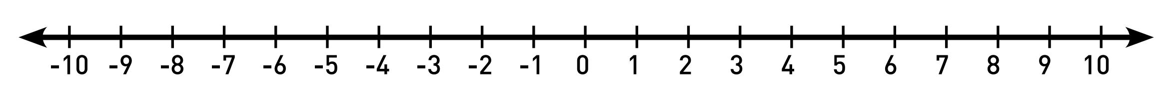
Calculation for estimated number of fish

$\frac{\text{Average of tagged fish}}{\text{Average of sample size}} =$	$\frac{\text{Original amount of tagged fish}}{\text{Estimated population}} =$

Dot plot of class data for differences in real and estimated numbers of fish in ponds.

Real number of fish ________, estimated number of fish = ________.

Have the students plot a dot for every groups difference on the number line below.



ANALYSIS

Students can analyse their results by individually completing the statements.

I notice that ... ____

____

____

I wonder ... ____

____

____

CONCLUSION

Students can record their conclusions by completing the following statements.

Based on the data from the simulation that my group carried out, the accuracy of the method was ... ____

____

____

When looking at the data from all the groups I would conclude ... ______________________

____

____

I could improve my method of estimation by ... ______________________________

____

____

SUMMARY AND DISCUSSION

Students can discuss the differences (variation) in their samples and in the results of different groups. They can investigate the technology used to count fish in the aquaculture industry. In seawater pens counting is carried out by pumping fish through a pipe. As each fish breaks a light sensor, software counts the fish. The freshwater counting system is different – it uses video analysis to identify and then count each fish. This system has an error rate of about 2%.

FURTHER INVESTIGATION

Students could calculate the average percentage error of the class data.