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Gelatinous Zooplankton in Biological Systems; Case Study: Salpa thompsoni in the Western Antarctic Peninsula

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GELATINOUS ZOOPLANKTON IN BIOLOGICAL SYSTEMS

Case Study: *Salpa thompsoni* in the Western Antarctic Peninsula

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Grade Level
7th Grade

Subject area
Life Science

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Title: Gelatinous Zooplankton in Biological Systems; Case Study: *Salpa thompsoni* in the Western Antarctic Peninsula

Focus: Teach about the importance of gelatinous zooplankton and examine their role in food webs, the biological pump, and the carbon cycle.

Grade Level: 7th Grade Life Science

VA Science Standards:
LS.5 The student will investigate and understand that biotic and abiotic factors affect an ecosystem. Key ideas include

a) matter moves through ecosystems via the carbon, water, and nitrogen cycles;
b) energy flow is represented by food webs and energy pyramids; and

LS.8 The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic and change over time. Key ideas include

a) organisms respond to daily, seasonal, and long-term changes;
b) changes in the environment may increase or decrease population size; and
c) large-scale changes such as eutrophication, climate changes, and catastrophic disturbances affect ecosystems.

LS.9 The student will investigate and understand that relationships exist between ecosystem dynamics and human activity. Key ideas include

a) changes in habitat can disturb populations;
b) disruptions in ecosystems can change species competition; and
c) variations in biotic and abiotic factors can change ecosystems.

Learning Objectives:

- ✓ Students will identify the role that gelatinous zooplankton serve in the food web, biological pump, and the carbon cycle
- ✓ Students will identify the climate gradient affecting the WAP and how it affects the animals
- ✓ Students will discuss the environmental conditions that are likely to increase or decrease salp populations
- ✓ Students will debate the consequences of different scenarios involving salps

Total length of time required for the lesson:
60-90 minutes total, 3 sections (~20 min, ~20 min, ~30 min respectively)
Optional Take Home Activity (20-30 min)

Key words, vocabulary:

- **Biological pump** – the process through which carbon is transported from the surface to the deep ocean by biological organisms
- **Bloom** – rapid increase in population size over a short period of time
- **Carbon cycle** – transformative cycle of a carbon molecule
- **Export** – sinking of particles out of the surface to the deep ocean
- **Food web** – describes the energetic pathway of nutrients and specific predator-prey dynamics that may occur in an environment

- **Gelatinous zooplankton** – zooplankton that have little to no hard parts of their body
- **Sequester** – when particles are exported deep enough in the ocean to stay at depth for an extended period of time (potentially hundreds of years)
- **Zooplankton** – any animal that cannot swim against an ocean current

Background Information

Gelatinous zooplankton refers to any animal that (1) has a jelly-like body form and little to no hard parts associated with themselves and (2) cannot swim against an ocean current. Historically scientists have assumed that gelatinous zooplankton play a relatively minor role in biological systems (i.e. the food web, biological pump, and carbon cycle). The food web describes all possible pathways of nutrient transfer in an environment through predator-prey interactions, the biological pump is the process through which carbon is transported from the surface to the deep ocean by biological organisms, and the carbon cycle is the transformative process of a carbon molecule. Evidence supports that gelatinous zooplankton are important contributors to these three biological processes.

A specific example of a gelatinous zooplankton playing a major role in its' environment is the salp, or *Salpa thompsoni*, in the western Antarctic Peninsula. The western Antarctic Peninsula is changing due to climate change and it is affecting the animal populations that live there. For the salp, climate conditions are favoring the increase of salp populations and this has had a notable effect on the biological systems in the region.

My overarching goal of this lesson is to teach students about gelatinous zooplankton and the impact they can have on their environments. This lesson plan also introduces the broader environmental topics of food web dynamics, the biological pump, the carbon cycle, and climate change in Antarctica. Also included in this lesson plan is a case study and associated game surrounding salps in the western Antarctic Peninsula.

Student Handouts

- Salp Game Events (1 for each group)
- Salp Game Team Sheet (1 for each group)

Materials and Supplies

- Printer and scissors for the student handouts
- Writing surface and utensil
- Computer and projector for accompanying PowerPoint

Teacher Preparation

- Students should work in groups of 4-5, set up classroom accordingly
- Teacher should print out the "events" and "team sheet" documents, each document is needed for every team. Printing out in color is preferred but not required. "Events" document should be printed single-sided. "Team sheet" document can be single- or double-sided.
- "Events" document needs to be cut on the dashed lines between each card.
- Download accompanying PowerPoint

Procedure

<u>Advance preparation of lesson materials – 10 minutes</u>

- Prepare lesson by printing out documents and cutting out cards on "events" document in advance
- Confirm that the PowerPoint has been downloaded and is displaying correctly

- Arrange students into groups of 4-5 (optional – not necessary until Lesson Part 3)

Lesson Part 1 – Gelatinous Zooplankton – 15-20 minutes

- With the class, go through the first part of the PowerPoint on gelatinous zooplankton
    - The PowerPoint can be read as is although recommended discussion points and questions have been added in the notes section

Lesson Part 2 – Case Study – 15-20 minutes

- Similarly to Lesson Part 1, for Part 2 go through the Case Study section of the PowerPoint
    - The PowerPoint can be read as is and optional additional questions and discussion points have been added in the notes section

Lesson Part 3 – Salp Game – 30-45 minutes

- Ensure students are in appropriate group sizes
- Read through the instructions with the class
    - The game should work best if the teacher dictates when each round starts/ends and facilitates the discussion time amongst each group and then debate time between groups.
        - At the beginning of each round groups can flip over their event card and discuss amongst themselves whether they want to debate for their own group. Then, the teacher can call on each group to read their event card to the class and announce if they have chosen to debate or not. Groups that have chosen to debate the effects of the event card can give their argument on what they believe to be a better effect and then other groups may give a counter argument. The teacher can decide whether either argument has enough reasoning and evidence based on the information in the first two parts of the lessons and whether the debate has been won or loss. Continue for up to 10 rounds (depending on time).
    - The teacher can also determine if you want their debates to only include what they have learned from this lesson or if knowledge from previous lessons or independent research may be also used as reasoning
    - Emphasize that students must back up their debate arguments with logical reasoning based on information from parts 1 and 2
    - Encourage unique arguments even if the same event card is played more than once
    - If a team has to subtract more solitary/aggregate buds than they have there is no effect
    - When teams have to draw in or cross out a salp they should do so in a manner so they can erase if their population changes in later rounds
- Pass out shuffled Events Cards (face down) and Team Sheet
- Recommended: Go through an example round with the students to make sure everyone knows how to play
- Play the game, slides of rounds 1-10 are provided to keep the students on track
    - Encourage debates to assess their understanding of what has been learned
    - Remind students to keep track of their population size on the team sheet
- At the end of the game tell students to add up all their points, solitary salps are 5 points each and each aggregate bud is 1 point
    - Example: If a team ends with 3 solitary and 4 aggregates with 3 buds each, points = 27

- Go over the end-of-game questions either as a group or students can write down their responses as an “exit ticket” for leaving class

Optional – Take Home Activity

- Instruct students to find another gelatinous zooplankton species and look up how they affect their ecosystem’s food web, biological pump, and/or carbon cycle
- Tell the students to prepare to hand in a written report or give an oral summary of what they learned from their independent research
- The report or summary should include:
    - The name of the gelatinous zooplankton they decided to research
    - A brief description of how they affect their environment’s food web, biological pump, and/or carbon cycle

Assessment

Teachers will be able to assess lesson effectiveness through each student’s engagement in the debate part of the game whether through discussion in their small group or amongst groups. Since all arguments in the debate should be assisted with evidence from the lesson the teacher should be able to determine which students were paying attention. Teachers could also tell which people were most engaged through the final questions and their reflection on the game.
If you decided to also give the students the optional take home activity you will also be able to assess what they have learned as they apply the lesson (what they have learned about food webs, the biological pump, and the carbon cycle) to their independent research into another type of gelatinous zooplankton.

References

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Condon, Robert H., et al. "Questioning the rise of gelatinous zooplankton in the world's oceans." *BioScience* 62.2 (2012): 160-169.
Steinberg, Deborah K., and Michael R. Landry. "Zooplankton and the ocean carbon cycle." Annual review of marine science 9 (2017): 413-444.

Acknowledgements

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Heat Wave!

Warmer waters lead to a huge salp bloom.

+3 solitary salps
+5 to all aggregate salps

Heat Wave!

Warmer waters lead to a huge salp bloom.

+3 solitary salps
+5 to all aggregate salps

Heat Wave!

Warmer waters lead to a huge salp bloom that increases your population.

+3 solitary salps
+5 to all aggregate salps

Microplastics!

Some of your salp population has ingested too much microplastic and they can no longer swim.

-2 solitary salps
-10 to three aggregate salps

Microplastics!

Some of your salp population has ingested too much microplastic and they can no longer swim.

-2 solitary salps

-10 to three aggregate salps

Phytoplankton!

An increase in phytoplankton feeds salps, leads to an increase in your salp population.

+2 solitary salps

+5 to five aggregate salps

Phytoplankton!

An increase in phytoplankton feeds salps, leads to an increase in your salp population.

+2 solitary salps

+5 to five aggregate salps

Phytoplankton!

An increase in phytoplankton feeds salps, leads to an increase in your salp population.

+2 solitary salps

+5 to five aggregate salps

Clouds!

More cloud cover and less light leads to a decrease in salp food, leading to a decrease in your salp population.

-1 solitary salps
-5 to all aggregate salps

Clouds!

More cloud cover and less light leads to a decrease in salp food, leading to a decrease in your salp population.

-1 solitary salps
-5 to all aggregate salps

Clouds!

More cloud cover and less light leads to a decrease in salp food, leading to a decrease in your salp population.

-1 solitary salps
-5 to all aggregate salps

Research Vessel!

Scientists arrive and collect salps to experiment on. This removes some of your salps from your population.

-1 solitary salps
-10 to two aggregate salps

Whales!

Migrating whales come through and feed on some of your salp population.

-2 solitary salps
-5 to four aggregate salps

Whales!

Migrating whales come through and feed on some of your salp population.

-2 solitary salps
-5 to four aggregate salps

New friends!

Your population joins with another salp population.

+3 solitary salps
+5 to two aggregate salps

New friends!

Your population joins with another salp population.

+3 solitary salps
+5 to two aggregate salps

Salp Parasite!

A parasite has infected your population causing some to disintegrate.

-2 solitary salps

-15 to two aggregate salps

Salp Parasite!

A parasite has infected your population causing some to disintegrate.

-2 solitary salps

-15 to two aggregate salps

Separation!

Intense currents and winds separate some members of your salp population.

-1 solitary salps

-5 to two aggregate salps

Separation!

Intense currents and winds separate some members of your salp population.

-1 solitary salps

-5 to two aggregate salps

Penguin Encounter!

Your population encounters a flock of penguins. No effect.

+0 solitary salps

+0 to all aggregate salps

Penguin Encounter!

Your population encounters a flock of penguins. No effect.

+0 solitary salps

+0 to all aggregate salps

Scooping for Salps!

Humans have started to fish specifically for salps, leading to a decrease in your population.

-1 solitary salps

-15 to three aggregate salps

Scooping for Salps!

Humans have started to fish specifically for salps, leading to a decrease in your population.

-1 solitary salps

-15 to three aggregate salps

Fish Disease!

A disease has infected a nearby fish community causing them to die, so there are less predators to your salp population.

+1 solitary salps
+10 to one aggregate salp

Fish Disease!

A disease has infected a nearby fish community causing them to die, so there are less predators to your salp population.

+1 solitary salps
+10 to one aggregate salp

Cold Front!

Cooler waters lead to a decrease in your salp population that increases your population.

-3 solitary salps
-10 to five aggregate salps

Cold Front!

Cooler waters lead to a decrease in your salp population.

-3 solitary salps
-10 to five aggregate salps

Team Name:_____

Start of Game:

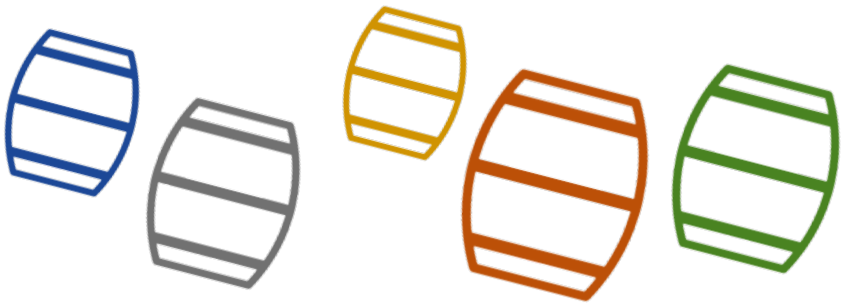
Solitary Salps	5
Aggregate Salps	10 (with 5 buds each)

Round #	# of Solitary Salps	# of Aggregate Salps
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Game End:

# of Solitary Salps (5 points each)	
# of Aggregate Salps (1 point per bud)	

Solitary Salps:



Aggregate Salp Tracker – Add or subtract new chains or buds as you go! Remember to add 2 buds at the end of each round!

1 2 3 4 5 6 7 8 9 10 …