HS Polar Bear Literature Dive Lesson Plan

At a Glance

Students practice reading scientific articles to better understand the current scientific research related to the polar bear.

Advance Preparation

- Decide how you want students to view articles (on a computer/tablet or printed out).
- Follow the link below to an infographic on how to read a scientific paper. Decide whether you will have your students read the infographic individually or go through it as a class.
  https://www.elsevier.com/connect/infographic-how-to-read-a-scientific-paper

Objectives

- Learn the process of reading a scientific article
- Learn how to pull out relevant information from scientific articles to share with others

Materials

- PDF's of articles for each student to read
- "Check for Understanding" questions for each student (online or print-out)

Lesson

• Introduce your students to the process of reading a scientific paper utilizing the infographic provided or any other documents that you find helpful.

• Provide your students with the articles related to the polar bear. *There are 3 articles provided below, Whiteman (2018) is a shorter summary paper of the work in Pagano et al. (2018)*

•There are vocabulary words provided in the Teacher Summary section. You can introduce them before or after students read the articles, whenever you feel it fits best in the lesson for your students.

• Provide each student with the "Check for Understanding" questions. These questions could be done while reading the article (worksheet style) or after students are done reading the articles (quiz style). We suggest going through the "Check for Understanding" questions as a class after students have completed individually to see if there are any concepts in the questions that need more clarification.

Teacher Summary

Pre-Lesson Article 1: Whiteman (2018) Out of balance in the Arctic.[3]

This is a shorter summary of Pagano (2018) with a short intro about climate change

Vocabulary:

- Metabolic rate - the rate at which metabolism occurs in a living organism[4]
- Foraging - to search widely for food or provisions[4]
- Extrapolate - extend the application of (a method or conclusion, especially one based on statistics) to an unknown situation by assuming that existing trends will continue or similar methods will be applicable[4]
- Corroborate - confirm or give support to (a statement, theory, or finding)[4]
- Linear relationship - able to be represented by a straight line on a graph; involving or exhibiting directly proportional change in two related quantities.[4]
- *Primary productivity - the rate at which energy is converted by photosynthetic and chemosynthetic autotrophs to organic substances[6]
- Unabated - without any reduction in intensity or strength[4]
- Lactation - the secretion of milk by the mammary glands[4]

Check for Understanding Questions: (Answers are bolded for teacher reference)

1. What are the two terms typically used to describe animal energy? (Choose two)
   A. Sleeping metabolic rate (SMR)
   B. Resting metabolic rate (RMR)
   C. Measured metabolic rate (MMR)
   D. Field metabolic rate (FMR)
2. What did researchers find about polar bear energy expense during fasting?
   A. It declines significantly
   B. It increases significantly
   C. It does not substantially decline
   D. We can't measure it, so we don't know

3. What did researchers train a zoo polar bear to do?

    A. To touch a target with its nose

    B. To stand up on cue to give a voluntary blood draw

    C. To swim around enclosure for a set amount of time

    D. To sit quietly in a chamber while its oxygen consumption was being measured

4. What did Pagano et al. (2018) find about polar bear metabolic rates when food is scarce?

    Answer: Polar bears do not reduce their metabolic rates when food is scarce.

5. According to the researchers, why do some populations of polar bears experience population loss with loss of sea ice and others do not?

    Answer: Because it seems that population responses are primarily driven by local environmental factors like primary productivity or overlap of seal distribution.

Post-Lesson Article 1: Pagano et al. (2017). Using tri-axial accelerometers to identify wild polar bear behaviors.[1]

KEY POINTS:

- Once calibrated, tri-axial accelerometer data from wild animals can be used to remotely identify behaviors such as resting, walking, running, and even feeding events.
- Polar bears typically occupy remote environments, and few quantitative data exist on their behaviors or activity budgets. Much of what is known about polar bear behavior on the sea ice comes from coastal indigenous resident knowledge.
- Satellite telemetry has been used to track polar bears in some subpopulations since the late 1970s
- In order to better predict the impacts of projected sea ice loss on polar bears, it will be important to understand the behavioral and physiological mechanisms driving current declines
- Methods were created to quantify wild polar bear behaviors using accelerometers and conductivity sensor data, validated through animal-borne video camera data.
- Captive individuals may exhibit different behaviors and/or kinematics than wild counterparts, which could potentially influence accelerometer signatures
- They placed loggers on 3 adult female polar bears at the Alaska Zoo, Oregon Zoo and San Diego Zoo as well as 2 adult female brown bears at the Bear Research, Education and Conservation Center at Washington State University. They also placed GPS-equipped video camera collars on 7 female wild polar bears.
- Using the model from ice bears, eating had a high rate of false positive classifications resulting from digging behavior being incorrectly classified as eating as well as a high rate of false negative classifications with eating behavior incorrectly classified as either resting or walking (Table 5).
- The results show that tri-axial accelerometers in combination with measures of conductivity can reliably distinguish the 3 most common behaviors of wild polar bears (resting, walking, and swimming).
- The results highlight the value in linking observational and accelerometer data from wild subjects over multiple time periods and habitats, and the importance of accounting for as many behaviors as possible in training datasets. Knowledge of eating frequency and duration would provide insight in determining foraging success, an important determinant of individual reproductive success and survival.
- Measures of acceleration could be combined with measures of oxygen consumption from captive bears while resting, walking, and swimming to both quantify activity budgets and estimate the energetic costs of these behaviors.

Vocabulary:

- Accelerometer - an instrument for measuring acceleration, typically that of an automobile, ship, aircraft, or spacecraft, or that involved in the vibration of a machine, building, or other structure[4]
- Surrogate - a substitute, especially a person deputizing for another in a specific role or office[4]
- Calibrate - correlate the readings of (an instrument) with those of a standard in order to check the instrument's accuracy[4]
- Quantitative data - data relating to, measuring, or measured by the quantity of something rather than its quality[4]
- Physiology - the branch of biology that deals with the normal functions of living organisms and their parts; the way in which a living organism or bodily part functions[4]

Check for Understanding Questions: (Answers are bolded for teacher reference)

1. What were the three most common behaviors that researchers were able to properly distinguish between with tri-axial accelerometers?

   E. Resting, walking, and swimming

   F. Resting, walking, and pouncing

   G. Walking, pouncing, and eating

   H. Walking, swimming, and eating

   I. I don't know

2. Digging behavior in polar bears was frequently falsely classified as:

   A. Walking

   B. Eating

   C. Resting

   D. Pouncing

   E. I don't know

3. According to Table 4, the behavior that was identified with accelerometer data most accurately was:

A. Walking

B. Rolling

C. Running

D. Resting

E. I don't know

4. Why did the researchers put accelerometers on the polar bears in the zoo and research facilities?

   Answer: Researchers wanted to learn what certain polar bear behaviors looked like with accelerometer data in order to learn what polar bears are doing in the wild. They wanted to compare the data they received from captive bears and see if they were similar enough to those received on wild polar bears.

5. Why did researchers put GPS-equipped video cameras on wild polar bears?

   Answer: Researchers put GPS-equipped video cameras on wild polar bears to compare the data they received from wild polar bears and see if it was similar to data received from captive polar bears. The video was necessary as well to calibrate the accelerometers.

Post-Lesson Article 2: Pagano et al. (2018). High-energy, high-fat lifestyle challenges an Arctic apex predator, the polar bear.[2]

ABSTRACT: Regional declines in polar bear (Ursus maritimus) populations have been attributed to changing sea ice conditions, but with limited information on the causative mechanisms. By simultaneously measuring field metabolic rates, daily activity patterns, body condition, and foraging success of polar bears moving on the spring sea ice, we found that high metabolic rates (1.6 times greater than previously assumed) coupled with low intake of fat-rich marine mammal prey resulted in an energy deficit for more than half of the bears examined. Activity and movement on the sea ice strongly influenced metabolic demands. Consequently, increases in mobility resulting from ongoing and forecasted declines in and fragmentation of sea ice are likely to increase energy demands and may be an important factor explaining observed declines in body condition and survival.

KEY POINTS:

- This paper focused on measuring field metabolic rates of polar bears on the sea ice.
- Resting Metabolic Rates (RMR) seem to go up as body mass of the organism goes up.

Vocabulary:

- Metabolic rate - the rate at which metabolism occurs in a living organism[4]
- Body condition - a person's or animal's state of health or physical fitness[4]
- Foraging - to search widely for food or provisions[4]
- Apex predator - a predator considered to be at the top of a food chain because it has no predators of its own[4]
- Ursid - a member of the Ursidae family, which includes polar, brown, and black bears among many others[5]
- Adaptation - a change or the process of change by which an organism or species becomes better suited to its environment[4]
- Locomotion - movement or the ability to move from one place to another[4]
- Archival logger - A device or computer program for making a systematic recording of events, observations, or measurements[4]

Check for Understanding Questions: (Answers are bolded for teacher reference)

1. At what rate is ice being lost per decade?

    A. 5%

    B. 8%

    C. 14%

    D. 20%

    E. Ice isn't being lost

2. What is the primary tactic that polar bears use to hunt?

    A. Opportunistic hunting

    B. Ambush hunting

    C. Sit-and-wait hunting

    D. Persistence hunting

3. How frequently have polar bears typically been observed killing seals?

    A. Every day

    B. Every 5 days

    C. Every 7 days

    D. Every 10 days

4. How do polar bears manage to balance their high metabolic demands?

    Answer: They eat the blubber of animals like ringed seals.

5. What equipment was placed on the polar bears in the wild to see what they were doing? How does this help researchers?

    Answer: GPS equipped video camera collars and accelerometers. These help researchers measure field metabolic rates, daily activity patterns, body condition, and foraging success of polar bears moving on the spring sea ice, which can help us observe how climate change is impacting polar bear movement/energy expenditure.

References

1. Pagano, A. M., Rode, K. D., Cutting, A., Owen, M. A., Jensen, S., Ware, J. V., ... & Middel, K. R. (2017). Using tri-axial accelerometers to identify wild polar bear behaviors. *Endangered Species Research, 32*, 19-33.

2. Pagano, A. M., Durner, G. M., Rode, K. D., Atwood, T. C., Atkinson, S. N., Peacock, E., ... & Williams, T. M. (2018). High-energy, high-fat lifestyle challenges an Arctic apex predator, the polar bear. *Science, 359*(6375), 568-572.

3. Whiteman (2018) Out of balance in the Arctic. http://science.sciencemag.org/content/359/6375/514/tab-pdf

4. https://en.oxforddictionaries.com/

5. https://www.collinsdictionary.com

6. www.britannica.com