Carrying Capacity and Bears in Alaska

Student Activity Packet

Contents

Lesson Overview

Bears are an important part of the Lake Clark ecosystem. The bears that call this park home are treated to salty marshes full of sedge, which is very rich in protein early in the year, bivalves along the beach in the summer, and salmon headed to their spawning grounds in the late summer early fall.

Not all bears live in areas as rich in food sources as Lake Clark. This lesson examines the concept of "carrying capacity," to help students understand that natural wildlife populations depend on a variety of factors – many of which vary greatly from place to place.

Carrying Capacity and Bears in Alaska: Student Information Sheet

Read through the following information and answer the questions that follow.

Brown (grizzly) bears (Ursus arctos) have populated a diverse array of ecosystems. Historically, they lived as far south as California and as far north as interior Alaska. Despite slight changes in species, this variation of habitat has shown that these large omnivores are capable of using whatever resources they encounter to survive. Highly adaptable, brown bears possess intelligence and survival skills.

Brown bears frequent both high and low elevations in their quest to find food. Not surprisingly, bears that rely on salmon streams tend to have a smaller home range compared to those who forage far and wide for vegetation and small mammals throughout the year (Schwartz et al. 2003). The primary food sources in spring tend to result in gains in the bear's lean body mass, with around 70% of that gain coming from protein and water. In contrast, summer and fall weight gains tend to be more directed towards fats or lipids – during these seasons, nearly 80% of the diet is high in lipid concentration (Hilderbrand et al. 1999).

Bears are one of the few large mammals that will enter a sort of hibernation, which can last 3-5 months out of the year. They need to gain enough weight in their active months to supply them with the energy – fat reserves - that they will need during the dormant season.

Bears are omnivores, meaning they will eat plants and animals. A bear's diet may consist of lush grasses, succulent herbs, tender shoots, flowers, leaves, roots, bulbs, tubers, mosses, horsetails, willows, berries, insects, larvae, grubs, fungi, birds, eggs, acorns, cones, nuts, small mammals (squirrels, voles, and mice), big game (sheep, moose, and caribou), and salmonids (all family of Oncorhynchus).

Keep in mind, not all these foods are available at all brown bear habitats. Bears in some areas struggle for food. It is not uncommon that some habitats do not provide a substantial amount of meat for the bears to consume. In these locations it is common to see vegetarian bears, feeding off only vegetation or remains of carrion (Hilderbrand et al. 1999).

Surprisingly, some studies have shown that bears are acutely aware of the nutrients they need and will forgo eating protein in favor of berries and roots in order to keep a well-balanced diet (Erlenbach et al. 2014). This fact is surprising because of the duration of time required for plant foraging compared to salmon fishing. Scientific studies show that bears with access to both berries and salmon will split their time consuming each resource. Berries provide a high

concentration of carbohydrates the salmon do not. This is lends evidence to the theory that bears are aware of the nutrients they need and will attempt to maintain a balanced diet.

The size difference between bears in different locations is almost always evident in their weight. A 20 year old male bear in the interior of Alaska usually weighs around 600 pounds at the most, while a costal bear can weigh anywhere from 800 to more than 1,000 pounds.

Weight is not the only factor that is affected by the ease of catching salmon. Studies have shown that bears that have access to salmon streams tend to have larger litters (Hilderbrand et al. 1999). Scientists studying bear densities tell us that there are 27 bears per 1000 square kilometers in Denali National Park, a location far from salmon spawning grounds in Interior Alaska. Meanwhile, population densities of 147 bears per 1000 square kilometers are usual in Lake Clark National Park, one of the largest wild salmon spawning grounds in the world.

Another aspect of population density concerns the amount of competition for resources. Bears in both Lake Clark and Denali National Parks have competition for resources - particularly other predators, like bears and wolves. However, food is not equally abundant in both places. Lake Clark National Park provides a feast for the bears that call it home. In the early spring there is an abundance of sedge in the saltwater marsh in Chinitna Bay. Transitioning to summer, bears will start to feed on the bivalves hidden beneath the surface of the beach. Finally, in late summer early fall, bears will start to eat the salmon that are migrating upstream to spawn.

Bears are an important part of their ecosystem. It is useful to think of them as conduits for nutrients. They transport the nutrients found their food (e.g., salmon, berries, carrion) to the plants of their habitat through their scat and the carcasses they leave behind (Olson 2007). Many ecosystems in Alaska are nutrient-poor, because of a variety of natural factors. Thus, the nutrients scattered around by defecating bears allow more plants to thrive than could without bears (and their poop!).

In particular, coastal areas benefit from defecating bears who have eaten salmon. Marine-derived nitrogen is among the many nutrients that bears pass from the salmon to the land. This marine derived nitrogen has been found in plants and soil up to 5 miles away from any salmon spawning grounds.

Another nutrient that is commonly transported by the bears who have eaten salmon is $H^{13}C$, which is necessary for carbon fixation (Kline et al. 2011). The nutrients being spread by the bears have been shown to increase plant growth up to 3 times that of plants with no salmon influence.

Bears are an integral part of the ecosystem in Alaska. Without them, nutrient flow in the ecosystem would lessen and prey species might become unhealthily large. The health of Alaska's wild spaces depends on the health of brown bear populations.

Carrying Capacity and Bears in Alaska: Student Response Sheet

Thoroughly answer following questions. Note that many of the following questions are multi-part, and require extensive answers.

1. Define carrying capacity in terms of brown bears in Lake Clark vs. brown bears in Denali.

2. Bears were once present as far south as California. Over time they have disappeared most of the lower 48 states. How might the influx of humans have influenced bear populations?

3. How might the increased appeal of tourism and wild bear viewing affect the populations of bears over time?

4. How might a bear compensate when facing increased competition for resources?

5. How might bear hibernation stress the environment where bears live? Provide justification.

6. Using the separate brown bear density estimates handout, create a graph that shows a comparison of bears in different locations around the park.

7. Write down several concluding thoughts in regards to the reasons for the variation of populations.

8. There is always a competition for resources amongst a species, community, and ecosystem. Provide a list of species that might compete with brown bears for resources. Be sure to think outside the scope of obvious competition. Provide reasons for why each other species might be a competitor with brown bears.

9. Propose a conclusion about what might happen to those plants that rely on marine dissolved nitrogen and $\delta^{13}C$ if the bears were no longer around. How might that affect the ecosystem?

10. Use the following information to create a graph by location and date. Explain why, within the same ecosystem and park, bears would choose one location over the other. What trends do you see amongst bear populations by location?

	Chinitna Bay	North Tuxedni Bay	Shelter Creek	Silver Salmon Creek	South Tuxedni Bay
07/12/04	33.77%	15.58%	24.68%	3.90%	22.08%
07/13/05	34.92%	7.94%	12.70%	6.35%	31.75%
07/20/05	31.03%	31.03%	13.79%	10.34%	0.00%
07/10/08	32.58%	20.08%	6.06%	5.30%	20.08%
07/15/09	69.35%	6.53%	5.53%	8.54%	7.54%
07/13/11	36.94%	14.18%	4.85%	8.21%	25.75%
07/20/12	50.61%	11.59%	6.10%	3.05%	22.56%
07/09/13	51.78%	14.72%	5.08%	9.14%	15.74%
07/26/13	65.08%	3.17%	3.17%	14.29%	7.94%
07/08/14	44.19%	20.35%	4.07%	9.88%	18.02%
Grand Total	45.59%	14.37%	6.68%	7.49%	18.58%

While counting bears, scientists will often record other data about the place and time. Below is the tide and temperature taken during bear counting session. Graph the results and look for a correlation between the amount of bears viewed and the temperature or tide. Justify your correlations.

	Tide (Seldovia 22:00)	Temperature (Kenai, ^{o}F)	Total Bears
21-Jun-04	7.03	57.2	147
12-Jul-04	12.90	59.0	77
15-Jun-05	14.26	55.0	220
23-Jun-05	2.01	53.1	193
13-Jul-05	13.09	63.0	63
20-Jul-05	5.53	60.1	29
18-Jun-07	6.28	48.9	169
27-Jun-08	16.52	48.0	208
10-Jul-08	14.57	51.8	264
24-Jun-09	1.34	50.0	247
15-Jul-09	13.88	57.9	199
23-Jun-10	10.32	54.0	195
23-Jun-11	13.79	53.1	176
13-Jul-11	6.59	54.0	267
6/21/2012*	3.06	55.9	139
7/20/2012*	1.27	60.1	164
12-Jun-13	6.02	48.0	88
25-Jun-13	1.17	57.0	202
9-Jul-13	2.62	55.9	197
26-Jul-13	5.85	55.0	63
24-Jun-14	9.11	54.0	208
8-Jul-14	14.28	55.0	164

Carrying Capacity and Bears in Alaska: Student Assessment Sheet

Read through the following instructions on your assessment of carrying capacity and bears in Alaska.

You will be responsible for:

- Researching and gathering information on habitat similarities and differences between Denali National Park and Lake Clark National Park
    - Identify food sources
    - Competition for resources
    - Limiting factors for carrying capacity
    - Habitat range
    - Density of bear populations
- Creating a Venn Diagram, or other method of comparison, showing the similarities and differences between Denali bears and Lake Clark bears
    - Be sure to highlight similarities in food availability, prey, availability of resources, territory ranges, and all things you found in your research.
- Create a diagram or drawing of how bears fit into the ecosystem
    - You can create a food web or any other images that shows how far the reach of bears is in this environment
- Write a one-page analysis of carrying capacity and Alaska bears, including the following information:
    - An analysis of bears on the interior vs. bears on the coast
    - The impact of any differences between populations
    - An analysis of factors that might limit an increased bear population
    - Future expectations on bear population sustainability

Carrying Capacity and Bears in Alaska: Sources and References Sheet

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