**Trophic Levels**

Multiple Choice

1. Define the term trophic level.
2. An organism's feeding position in the food chain.
3. An organism's ability to adapt to its environment.
4. The way an ecosystem is able to adapt to change.
5. A particular hunting function only animals have.
6. State which organisms are found in the first trophic level.
7. Herbivores
8. Carnivores
9. Omnivores
10. Producers
11. State which organisms are found in the second trophic level.
12. Second Order Consumers
13. First Order Consumers
14. Third Order Consumers
15. Omnivores
16. State which organisms are found in the third trophic level.
17. Second Order Consumers
18. First Order Consumers
19. Third Order Consumers
20. Omnivores
21. Present roughly what percentage of energy is transferred from any trophic level to the one above it.
22. 25%
23. 90%
24. 50%
25. 10%
26. Only about 10% of energy is passed from one trophic level to the next. Recall what happens to the other 90%. Select ALL correct options
27. It is lost to the environment as heat.
28. It is lost in animal wastes.
29. It is permanently stored in glucose.
30. It is lost to other consumers once eaten.
31. Present reasons that organisms in the first trophic level may not have a lot of energy.

(Select all that apply.) Select ALL correct options

1. They don't have enough water to make sugars with photosynthesis.
2. There is too much light for photosynthesis to occur.
3. They don't have enough oxygen to make sugars with photosynthesis.
4. They can't get enough sunlight to make sugars with photosynthesis.
5. Lions eat young leopards. Leopards occupy the third trophic level of their ecosystem.

Identify the trophic level that lions occupy.

1. First trophic level
2. Second trophic level
3. Third trophic level
4. Fourth tropic level
5. Sharks eat octopuses. Octopuses occupy the third trophic level of their ecosystem. Identify the trophic level that sharks occupy.
6. First trophic level
7. Second trophic level
8. Third trophic level
9. Fourth tropic level
10. Cougars eat bobcats. Bobcats occupy the third trophic level of their ecosystem. Identify the trophic level that cougars occupy.
11. First trophic level
12. Second trophic level
13. Third trophic level
14. Fourth tropic level

11. Leopards eat young giraffes. Giraffes occupy the second trophic level of their ecosystem. Identify the trophic

level that leopards occupy.

1. First trophic level
2. Second trophic level
3. Third trophic level
4. Fourth tropic level

12. Bobcats eat rabbits. Rabbits occupy the second trophic level of their ecosystem. Identify the trophic level that bobcats occupy.

1. First trophic level
2. Second trophic level
3. Third trophic level
4. Fourth tropic level

13. Giraffes eat trees like the acacia. Trees occupy the first trophic level of their ecosystem. Identify the trophic level that giraffes occupy.

1. First trophic level
2. Second trophic level
3. Third trophic level
4. Fourth tropic level

14. Hares eat grass. Grass occupies the first trophic level of its ecosystem. Identify the trophic level that hares occupy.

1. First trophic level
2. Second trophic level
3. Third trophic level
4. Fourth tropic level

15. Algae use energy from the Sun to produce their own food. Identify the trophic level that algae occupy.

1. First trophic level
2. Second trophic level
3. Third trophic level
4. Fourth tropic level

16. Trees use energy from the Sun to produce their own food. Identify the trophic level that trees occupy.

1. First trophic level
2. Second trophic level
3. Third trophic level
4. Fourth tropic level

17. A field of grass contains 21000 kJ of energy. Calculate approximately how much of this energy can be passed on to herbivores that eat the grass.

1. 2100kJ
2. 210000kJ
3. 2100000kJ
4. 210 kJ

18. A population of titan triggerfish contains 8400 kJ of energy. Calculate approximately how much of this energy can be passed on to predators that eat the triggerfish.

* 1. 840000kJ
  2. 84kJ
  3. 84000kJ
  4. 840kJ

19. A population of seals contains 790 kJ of energy. Calculate approximately how much of this energy can be passed on to predators that eat the seals.

1. 79000kJ
2. 7.9kJ
3. 7900kJ
4. 79kJ

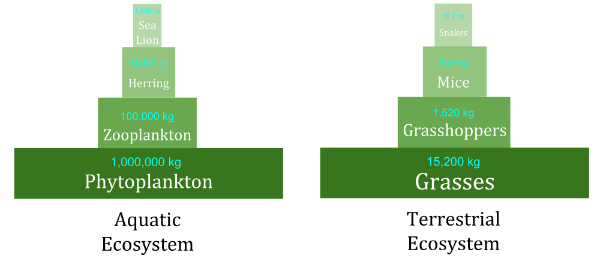
20. A field of grass (trophic level 1) contains 92000 kJ of energy. Calculate approximately how much of this energy can be passed on to second order consumers in trophic level 3.

1. 9200kJ
2. 92kJ
3. 920kJ
4. 9200000kJ

Short Answer

**1) As you go up the trophic levels, the consumers tend to increase in size (e.g. the lion is bigger than the gazelle). Explain this trend in your own words.**



**2) As you go up the trophic levels in an ecosystem, the total biomass of the organisms in each level tends to decrease. In your own words, explain the reasons for this pattern.**

**3) Caribou are one of the most iconic mammals in North America. Read the article about biodiversity monitoring, conservation decisions, and the survival of caribou. Investigate whether or not culling moose could save caribou populations. Be sure to explain your reasoning by referring to trophic levels.**

**How Killing Moose Can Save Caribou**

In the contiguous United States, the iconic caribou with its branching antlers has become so rare that it’s been dubbed the “gray ghost.”

Some of the larger herds of these moose-like ungulates make the longest land migrations of any mammal, trekking across frozen ice sheets in the north of Canada. Others lead comparatively sedentary lives in the Boreal Forest, the mountains of Canada and Alaska. A handful still roam across Idaho and Washington State. But no matter where they are, they’re considered endangered.

“Woodland caribou are probably North America’s biggest terrestrial conservation challenge,” says Robert Serrouya, a researcher at the Alberta Biodiversity Monitoring Institute and the lead author of a study published today in PeerJ. “They’re naturally rare, they cover a huge area, and their habitat needs conflict with industry, with forestry, oil and gas.”

While they aren’t necessarily a keystone species, protecting caribou means protecting old growth forests that provide habitat for countless other species, Serrouya says. Unlike moose, which prefer glades, the caribou Serrouya studies live in snow-covered old-growth forests in southern British Columbia. Over the last few decades, their populations have been decimated by the cascading effects of ecosystem change, including habitat loss, climate change and an increase in wolves.

Many of these problems, it turns out, can be traced back to the caribou’s larger and more invasive cousin: the moose. Both species overlap in Canada and Alaska, where they struggle and compete to survive over vast swathes of frozen wasteland. Now, scientists are suggesting that we kill one to save the other.

The problem starts with logging. In swaths of mountainous forest in southern British Columbia, loggers have long destroyed old growth trees that harbor the tree lichen woodland caribou subsist on. Logging has also opened up new habitat for moose, which historically have only lived in the area in small numbers. Once the invading moose move in, they feed on shrubs and young saplings that pop up in the clear cut areas.

Hot on the heels of the moose are the wolves and cougars that prey on them. These plentiful wolves mostly feed on the larger numbers of moose in the area, but they also end up killing more caribou as the occasional bycatch. As a result, some caribou—known as reindeer in Europe and during Christmas—are on a fast track to extinction.

“You could protect the habitat and stop all logging and [caribou] would still go extinct,” Serrouya says. He adds that increased forest fires due to climate change and other factors are also opening up more moose-friendly habitat.

In the past, neighbouring Alberta has killed off wolves by poisoning or shooting them by helicopter in order to stabilize its Little Smoky caribou herd. It seems that effort has paid off: After officials killed off 841 wolves over seven years (as well as many moose), the Little Smoky herd appears to be on the road to recovery. However, this solution is naturally controversial, and other research says it provides only a short-term solution in an area heavily impacted by habitat loss.

In 2003, the British Columbia provincial government introduced a potentially more long-term solution when it increased its quotas for how many moose hunters could harvest, particularly females. The idea was that if hunters shot more moose, fewer wolves would hang around the area, and the caribou would suffer less from predation.

Serrouya and his colleagues jumped on the opportunity to track the effort. They placed radio collars placed on more than 50 wolves, 60 moose and about 300 caribou from the Columbia North herd from 1992 to 2014 in a 2,500 square mile area in the Cariboo and Columbia mountain ranges of B.C.

For years, they tracked data on where the animals were and how long they survived. They found moose were hunted down from about 1,650 animals to 300, and wolves were two to three times more likely to disperse more than 100 miles out of the experimental area. “They were more likely to get the hell out of there,” Serrouya says. “In other words they were short on food.”

What about the caribou? Before 2003, the researchers found, caribou in the herd were dropping by about 5 percent per year. But after the increased moose harvest was opened, the population of caribou showed an increase of 2 percent per year. Meanwhile, neighbouring caribou herds not subjected to moose control continued to decline.

Serrouya calls it a “glimmer of hope” but is careful to get too excited over the small yearly increase, which doesn’t represent a real recovery in his eyes. “They just stabilized,” he says.

John Fryxell, a biology professor at the University of Guelph in Canada who was not involved in Serrouya’s study, points out that even decade-long conservation studies sometimes aren’t long enough to fully understand what’s going on in populations of long-lived animals like caribou. Females can live up to 17 years, and their populations are subject to other long-term natural ebbs and flows in numbers. “Those things could be going on quite independently of the treatment that you’ve executed,” he says.

Yet he doesn’t believe that to be the case in Serrouya’s research. “You can quibble about some of those issues in the study but by and large the cut and thrust of what they describe in their abstract holds water,” he says, adding that the work done by Serrouya’s research institute is some of the best on caribou conservation. “I think they’ve done a terrific job.”

Fryxell says there is some chance that this technique could be used in Ontario, despite the fact that the region is vastly larger than the area where the moose hunt quotas were increased. But the findings can’t necessarily be extrapolated to all other ecosystems, says Vince Crichton, a retired wildlife manager who worked with moose and caribou for many years for the Manitoba provincial government. Mountainous areas are very different from flat boreal ecosystems, he says, and populations of moose and caribou coexist quite well in parts of Manitoba.

“[Manitoba] for decades has had about 3,500 woodland caribou and despite the presence of wolves, bears and moose on the landscape, they have survived to about the same number today,” he says. “One solution doesn’t fit all.” He adds that caribou find a way to keep their calves away from bears and wolves by raising them on islands in lakes in the region.

Serrouya believes that, if there is any hope for woodland caribou, more government funding for these kinds of programs is necessary. But he also believes that conservation efforts need to be multi-pronged. For instance, he says there needs to be a reduction in logging as well as more wolf and other predator killing. Aside from moose, climate change and logging is also ushering in the expansion of white-tailed deer, which Serrouya says should also be subjected to increased hunting.

“A single approach isn't going to work,” he says. “You’ve got to hit this complicated problem at all levels. From the habitat, from the alternative prey, the moose and deer, and from the predator perspective, you’ve got to hit all three trophic levels simultaneously.”

Fryxell says that increased focus on research and action is definitely necessary not only for caribou, but for ecosystems in general.

“Nature would be way better in our country if we pursued most problems with the kind of rigor that these guys demonstrated,” he says.