FIGURE SET 4

FIGURE SET HEADER for Set #4

Figure Set 4: How **do** wolves impact elk and elk browsing, if not by direct population control?

Purpose: To introduce the idea of *indirect* effects of predator on prey by changing prey behavior, and of trophic cascades effects of predators on primary producers; to construct a flow diagram of effect of prey behavioral response to predation on vegetation; to use concept mapping to construct a complex food web for the Greater Yellowstone Ecosystem.
Teaching Approach: informal group work
Cognitive Skills: knowledge, comprehension, interpretation, application, synthesis
Student Assessment: flow diagram and (optional) concept map

BACKGROUND for Set #4 (back4.html)

Background

*How **do** wolves impact elk and elk browsing, if not by direct population control?*

This final segment of the issue introduces the notion of indirect effects of predators on prey, and of predators on other components of the food web and ecosystem via trophic cascades. Ripple and Beschta (2004a,b) proposed that wolf restoration may not have a very strong effect on elk population *sizes*, but it does have a very strong effect on elk *behavior*, in that it is no longer safe for the elk to hang out and browse in the riparian areas where food is abundant, because cover for their predators is also abundant. Enclosed areas, stream banks, and short sight-distance make the riparian areas more risky than open upland sites. Increased vigilance on the part of the elk, saving grace for woody riparian vegetation, and for a suite of other organisms that rely on the health of that vegetation.

FIGURE for Set #4 (figure4.html)

Figure
Figure 4-1 Riparian Willows Before & After Wolves

Legend
Figure 4-1. Repeat photo pair showing riparian willow habitat on Blacktail Creek in the Yellowstone Northern Range: from 1996 (left), after 70 years of wolf extirpation; and in 2002 (right) after 7 years of wolf recovery. Notice the larger size and abundance of willows in 2002. From Ripple and Beschta (2004b).

Figure
Figure 4-2 Upland Willows Before & After Wolves

Legend

Figure 4-2. Repeat photo pair of upland willow habitat and browsing exclosure in the Gallatin River Basin, Yellowstone Northern Range: from 1995 ((a), top), after 70 years of wolf extirpation; and in 2003 ((b), bottom) after 8 years of wolf recovery. In this habitat, the difference in willow height inside and outside of the exclosure is the same in both photos; arrows indicate location of willows in and out of the exclosure. From Ripple and Beschta (2004a).

Figure

Figure 4-3 Upland vs .Riparian Aspen

Legend

Figure 4-3. Photo pair of aspen in riparian (A top) vs. upland (B-bottom) habitat along the Lamar River in 2006. In riparian habitat there has been abundant recent recruitment of young aspen (3-4 m tall), while in an adjacent, more open upland there has been little recruitment (aspen <1 m tall). The dark, furrowed bark comprising approximately the lower 2.5m of aspen boles in (B) represents long-term damage due to bark stripping by elk. From Ripple & Beschta 2007.

STUDENT INSTRUCTIONS for Set #4 (students4.html)

Student Instructions

What are other ways that wolves could be affecting elk browsing, other than via direct population control? After brainstorming ideas with the rest of the class (in the previous section), you and your partner should join another pair to make an informal group of four. Study the three photo pairs in Figure 4 together, looking for differences and similarities in each pair.

- What patterns can you see in the woody vegetation (willows and aspen) in these photos?
- Where is there evidence of release from browsing pressure by elk, and where is browsing pressure still evident?
- What other differences might there be between sites that are still heavily browsed and sites that are not?
- Wolves are now present in all of these areas, and yet their impact on elk seems to be variable. How might elk behavior vary in the different kinds of sites shown in the photos?

After you have had a chance to discuss these questions and the trends shown in the photo pairs with your group, work together to create a flow chart of predator-prey encounters. Show how prey (elk) behavior and choice of foraging site might vary under conditions without predators (wolves) (i.e. Yellowstone National Park from 1926-1995), vs. with predators (i.e. Yellowstone after wolf restoration, 1995-present). Your instructor may show you examples of flow charts to give you an idea of how to get started.

As a companion to the flow chart, work with your group to construct two simple food chains showing the relationships among wolves, elk, and riparian plants in a system with and without

wolves. Groups will be called upon to present their diagrams to the class for discussion, and your instructor will probably ask each group to turn in a copy of the three diagrams.

After more discussion of *trophic cascades* and indirect effects in food webs, your final (individual) assignment (probably as homework) will be to construct a concept map of the Yellowstone food web that shows the impacts of wolf removal on elk behavior, woody riparian plants, beaver (who rely on cottonwoods and willows as their main food source), migratory birds (who use the riparian forest as an important stop-over point and source of food), and stream channel functional health (stream banks are held in place by riparian vegetation, for example). If you have not already used concept maps to model the interactions in biological systems, your instructor will walk you through an example to give you an idea of how best to construct one.

NOTES TO FACULTY for Set #4 (faculty4.html)

Faculty Notes

Have students work in informal groups of about four, and study the photo pairs in figure set 4. They should discuss among themselves what the photographs are showing that, in fact, it is elk *behavior* that is most strongly impacted by the presence of wolves, because of their fear of predation, which is greater in some habitats than in others. The photos themselves are fairly straightforward, but less advanced students may need help in recognizing the significance of what is being shown here: the potential power of indirect effects in food webs.

Introduce the idea of flow charts to the class, so that groups can use the information gleaned from the previous figure sets and this last set of photos to construct their own chart showing how prey foraging behavior is likely to change in the presence of predation risk. Ripple and Beschta (2004b) include such a diagram in their paper instructors may want to refer to it as a model, keeping in mind that students will come up with many variations, most of them equally valid.

Call on a few groups to draw their simple food chains and flow charts on the board for discussion purposes. -

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Follow this activity with a mini-lecture on indirect effects, predator-prey non-lethal vs. lethal effects, and trophic cascades. This is also a good opportunity to introduce the idea of top-down vs. bottom-up trophic cascades. Ask the class which type of cascade is shown in this ecosystem

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For the final assessment of this issue, assign as homework a concept mapping exercise (see electronic references in Resources section). Each student should construct their own concept map of the Yellowstone food web, showing the impact of wolf removal on elk behavior, woody riparian plants, beaver (which rely on cottonwoods and willows as their main food source), migratory birds (which use the riparian forest as an important stop-over point and source of food), and stream channel functional health (stream banks are held in place by riparian vegetation, for example). There are other components of the ecosystem that you could add (or remove) from this exercise; see Ripple and Beschta (2004b) for additional ideas.

If concept maps have not been used in the class previously, students will need to be taught how to make them by working through an example from a different natural system (perhaps from a General guidelines for grading a concept map are listed below in this loose rubric:

- **Accuracy and Thoroughness**. Are the concepts and relationships correct? Are important concepts missing? Are any misconceptions apparent?
- **Organization**. Was the concept map laid out in a way that higher order relationships are apparent and easy to follow? Does it have a title?
- **Appearance**. Was the assignment done with care showing attention to details such as spelling and penmanship? Is it neat and orderly or is it chaotic and messy?
- **Creativity**. Are there unusual elements that aid communication or stimulate interest without being distracting?

(Adapted from http://www.udel.edu/chem/white/teaching/ConceptMap.html)

For advanced students, several good exam or quiz essay questions could come out of this exercise:

- Ask students to describe a (hypothetical) situation where the trophic cascade works from -
- Ask students how the Yellowstone trophic cascade might be different if the strongest effect of wolves on elk was lethal instead of non-lethal.
- Ask students to construct a concept map showing the impacts of beaver removal on the Yellowstone ecosystem. (This would require additional background information about the role of beavers in riparian systems - and beaver ecology in general look for primary literature on the WWWeb, using (*e.g.*)