Managing Prairie Dogs for Ferret Reintroduction: A Case Study

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Scenario

Black-footed ferrets are an endangered species in both Canada and the United States. Photo Credit: USFWS Mountain-Prairie

Hailey just finished up her junior year of college when she received a job offer to spend the summer working with endangered black-footed ferrets. So far, her favorite course in college has been Conservation Biology so this is a dream job: working to conserve an endangered species. In one class, Hailey's instructor talked about black-footed ferrets and described how they were once believed to be extinct, but were rediscovered in 1981 by a Wyoming ranch dog, Shep. Late one night Shep caught and killed a black-footed ferret and brought its prize back to its owners. Sheps' owners, having never seen a black-footed ferret, misidentified the animal as a mink. When they brought the carcass to a local taxidermist to get stuffed, the taxidermist revealed that they had an endangered black-footed ferret. This was an amazing discovery for local biologists: black-footed ferrets hadn't been seen in years but this new finding suggested that a ferret population still existed.

What Hailey wasn't aware of was that this was the second time that ferrets had "risen from the dead." During the first half of the 20th Century, black-footed ferret populations declined as their main prey item, prairie dogs (*Cynomys* spp.), declined. By this time, much of the native grasslands had been converted to cropland and the grasslands that remained were being used for cattle grazing. Unfortunately, many farmers believed that prairie dogs competed with cattle for forage, a claim put forth by Clinton Hart Merriam (1902) but never substantiated with scientific

data. In fact, there is evidence that mammalian grazers may actually benefit from prairie dogs because of their nature of tilling the soil, resulting in higher nitrogen content of the surrounding grasses (Krueger 1986). This may explain why native herbivores, such as bison and pronghorn, preferentially graze near prairie dog towns, suggesting that prairie dogs could benefit ranchers and their livestock. Nonetheless, because of anecdotal accounts of harm to cattle, massive prairie dog eradication programs were undertaken.

The concerted eradication of prairie dogs also posed serious problems for ferrets as they rely on prairie dogs for both food and lodging: as much as 90% of a black-footed ferrets diet is prairie dogs, and ferrets exclusively use prairie dog burrows for shelter. Ultimately, the decline of prairie dog colonies resulted in the decline of ferrets and by the late 1950's, there were no observations of wild living ferrets. A species that at one time had a population in the tens of thousands and was regularly listed in fur company trapping records, was now extinct.

However, in 1964, a small population of ferrets were rediscovered in South Dakota. This was the first reported sighting of a black-footed ferret since the species had been considered extinct. In 1971, biologists from the U.S. Fish and Wildlife Service captured six black-footed ferrets from this population in order to start a captive breeding program in an effort to prevent the complete loss of this species. Three other ferrets were added to the captive breeding program in 1972-73. As canine distemper was believed to have contributed to population declines of black-footed ferrets, biologists at Patuxent Wildlife Center administered a modified live vaccine for this deadly disease. Although the vaccine was tested and successful in Siberian ferrets (*Mustela putorius*), the results were devastating for black-footed ferrets; of the six original ferrets brought into captivity, four died leaving a population that was too small to sustain a captive-breeding program. The last individual from this population died in 1979.

This unique history of multiple extinctions for a single species is why the discovery of a single wild ferret in 1981 by Shep the farm dog was so amazing. The black-footed ferret is the ultimate "Lazarus" species – a species that has been rediscovered after being declared extinct – and for black-footed ferrets, it has been considered extinct twice in its' recent past.

Black-tailed prairie dogs at their burrows. Photo Credit: Unavailable. Available through Creative Commons CC0 attribution on Pixabay.

In recent years, a captive breeding program has been raising and reintroducing black-footed ferrets into the wild and this is the project that Hailey has been hired to help with. However, Hailey has been working on this project for over a month and has yet to see a ferret. On the other hand, she is intimately familiar with black-tailed prairie dogs. Up at dawn, Hailey climbs the orchard ladder to her post where she will spend the morning watching and recording prairie dog behaviour. Yesterday she spent the day conducting transect surveys to record the numbers of prairie dog burrows. She certainly did not anticipate that she would be spending her time studying a common rodent, she thought she would be studying endangered black-footed ferrets. With everything she has learned about the ecological relationship between ferrets and prairie dogs, she now realizes the importance of prairie dogs. Without healthy sustainable prairie dog populations, there would be

no ferrets.

As Hailey finishes off her work for the day, her supervisor approaches and tells her that tomorrow she is going to visit one of the captive breeding locations and transport black-footed ferrets back to her field site for reintroduction into the wild. She has heard her colleagues talk about the "ferret boot camp" and this is going to be her opportunity to see ferrets and learn more about the captive breeding program.

When Hailey arrives at the facility she is amazed at the level of work and training that must take place to successfully raise and reintroduce ferrets back into the wild. Besides the team of biologists that are actually at the breeding facility, the Black-footed Ferret Recovery Implementation Team (BFF RIT) is a multi-agency conservation effort led by the U.S. Fish and Wildlife Service and includes federal, state and tribal governments, zoos, private landowners and nonprofit organizations from both Canada and the U.S. In fact, there are representatives from 40

A. Captive Breeding of Black-footed Ferrets

When Shep the farm dog discovered a population of wild black-footed ferrets near Meeteetse, WY, the responsibility for monitoring and protection of the population fell to the Wyoming Game and Fish Department. The population grew to a high of 129 individuals in 1984, but by the following year, only 38 individuals were observed and there were no young that had been produced from the previous year. It was believed that the population was dying out from sylvatic plague. This dramatic population decline alarmed the Game and Fish biologists who began trapping all remaining individuals to try and save the species. Over the course of two years, only 18 animals were rescued and brought into captivity. Of these 18 individuals, only seven successfully reproduced. These individuals were the start of the captive breeding program that still exists today. In fact, all existing black-footed ferrets are descendants of these seven individuals.

Instructions: Answer the following questions.

1. Identify some problems or concerns about a captive breeding program for black-footed ferrets. Think about the possible threats to maintaining a sustainable, reproductively healthy population of black-footed ferrets.
2. For each threat identified in the previous question, what are some strategies that could be used to mitigate their negative effects?
3. In the wild, ferrets are not restricted in their movements and will move across both state and national boundaries creating a number of transboundary issues. What are some of the issues that the Black-footed ferret recovery implementation team (RIT) will need to address considering the fact that ferrets cross state lines and also into Canada.
4. Watch the video showing the ferret boot camp (ABC News, 2012; link below) and explain the importance of preconditioning ferrets before release into the wild. https://www.youtube.com/watch?v=1tJycGXJVNg&oref=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D1tJycGXJVNg&has_verified=1

B. Where to Reintroduce Ferrets?

One of the main problems with captive breeding program is identifying appropriate release locations. It is important to consider all aspects of the ecology of the organism and to ensure that reintroductions are not negatively influencing naturally occurring species that may have filled the ecological niche once restricted to black-footed ferrets. Ferrets are solitary and territorial; it is unlikely to find more than one reproductive female per 62 acres. Recovery plans for Black-footed Ferrets suggest a minimum of 3500 wild ferrets are needed for a sustainable population (Parks Canada). Ferrets have been released at 28 locations, including the Fort Belknap Reservation in Montana (USFWS, 2017).

Instructions

Using the Interactive Map available at https://tinyurl.com/ESRI-ferrets, explore the spatial relationships between historical and present ranges of black-footed ferrets and black-tailed prairie dogs. Answer the following questions below.

1. Using Map 1, how does the historical range of black-footed ferrets compare to the historical range of black-tailed prairie dogs?

2. Given the ferrets' dependence on prairie dogs, how do you explain the presence of black-footed ferrets outside of the historical range of black-tailed prairie dogs?

3. The interactive prairie dog colony map (Map 4) provides information that can be used to select release sites for captive-bred ferrets. Based only on size of prairie dog colonies, where are the best sites on the Fort Belknap Reservation to release ferrets? What other factors should be considered when identifying possible release sites?

4. Given the territorial nature of ferrets, how many reproductive females could be supported at each of these sites? (Use the median colony size)

5. How might adjacent land use influence which sites are selected for ferret release?

C. Ferret Energetics

One of the challenges in black-footed ferret recovery plans is reintroducing them in areas where the prairie dog populations can support the ferrets. While the exact energy needs of each ferret varies, we use population averages to determine which prairie dog colonies can support ferret reintroduction. Conservation biologists use mathematical models to calculate the average energetic needs of an individual of a species. However, these models can be simplified into more basic calculations to approximate black-footed ferret's energetic needs.

Instructions:
Use the worksheet below to calculate the minimum black-tailed prairie dog colony size to support both an adult male or non-reproductive female, and a reproducing adult female ferret and her litter until they leave the nest. For the purposes of these calculations:

- Use 800g for the average weight of an adult ferret, male or female
- The median weight for an adult black-tailed prairie dog is 712g. Each killed prairie dog is about 75% water, the other 25% contains approximately 5 kcal/g dry weight.

1. Calculate the average number of black-tailed prairie dogs needed per year to support a male or non-reproducing female black-footed ferret:

a). What are the total kcal (Calories) in a 712g black-tailed prairie dog?	kcal =
b). The basic *daily* metabolizable energy requirements for an adult male or non-reproductive female ferret is represented by M_m in equations. For black-footed ferrets, M_m = 0.226 * Ferret Mass (g) + 14.0, in kcal/day. In non-reproductive females or males, M_m also equals the total daily metabolizable energy requirements, written as *M*.	M_m =
c). Calculate the *yearly* metabolizable energy requirements for an adult male or non-reproductive female.	kcal/year =
d). Not all the energy in a killed prairie dog is converted into ferret maintenance, reproduction, and growth (*M*). Total kill (*K*, measured in kcal) must be higher than *M* to compensate for energy lost via waste (*W)* and feces (*F*). Waste and feces are calculated as a percent of the total kill (*K*), with waste (*W*) approximately 20% of *K* and feces (*F*) approximately 10% of *K*, leaving 70% of *K* for *M*. $K = M + F + W$. Using *M*, which you calculated in part (c), Calculate *K*, the total number of kcal a ferret needs for one year.	*K* = Total *K* for one year:
e). How many prairie dogs are needed by ferrets to provide the necessary kcals for one year? Use your numbers from parts (a) and (d) for your calculation.	

2. Calculate an estimate of the average number of prairie dogs needed per year to support a reproducing female ferret.

In the above question (1a), the total metabolizable energy requirements (*M*) for males and non-reproducing females are the same as the basic metabolizable energy requirements (M_m). However, in reproducing females, the value of M varies over the reproductive period:

- Days 1-90 and 240-365 the female is not pregnant nor caring for pups: $M = M_m$
- Days 91-135, the female is pregnant: $M_{pregnant} = M_m + M_g$
- Days 136-175, the female is nursing pups: $M_{nursing} = M_m + M_l$
- Days 176-239, the female is feeding weaned litter: $M_{feeding} = M_m + N_{pups}(M_{pup})$, where N_{pups} = number of pups

You will use some of your numbers from Question 1 in this next question. Write your answers here for reference: Total kcal (Calories) in a 712g black-tailed prairie dog: _____ (from 1a) Basic *daily* metabolizable energy requirements for a ferret (M_m) _____ (from 1b)	
a). When the female is pregnant her total metabolizable energy requirements ($M_{pregnant}$) increase by M_g, which is approximately 20% of M_m. Calculate M_g and then *M* for a pregnant female, using the formula $M_{pregnant} = M + M_g$	M_g = $M_{pregnant}$ =
b). When the female is nursing her total metaboliziable energy requirements ($M_{nursing}$) increases by M_l, which is approximately 200% of M_m. Calculate M_m and then $M_{nursing}$, using the formula $M_{nursing} = M_m + M_l$	M_l = $M_{nursing}$ =
c). When a female is feeding her weaned litter, the energetic needs of the pups are continually changing. To simplify complex calculations, use 51.4 kcal/day as an average estimate of the energetic needs of a pup (M_{pup}), and assume that the female has a litter of four pups. Calculate $M_{feeding}$ using $M_{feeding} = M_m + N_{pups}(M_{pup})$	$M_{feeding}$ =
d). Calculate the total kcal needed by a reproducing female for an entire year. Multiply the total energetic needs for each life stage by the number of days in that stage (given at the beginning of question 2). Remember, days 1-90 is 90 days, not 89. You will have a value for *M* for days 1-90, $M_{pregnant}$ for days 91-135, $M_{nursing}$ for days 136-175, $M_{feeding}$ for days 176-239, and *M* for days 240-365.	*M* for days 1-90: $M_{pregnant}$ for days 91-135: $M_{nursing}$ for days 136-175: $M_{feeding}$ for days 176-239: *M* for days 240-365:

e). Calculate the total kill (*K*) in kcal the reproducing female will need throughout the year. Unlike in part A, you will need to calculate values of *K* for each reproductive stage during the year. Remember, waste and feces are calculated as a percent of the total kill (*K*), with waste (*W*) approximately 20% of *K* and feces (*F*) approximately 10% of *K*, leaving 70% of *K* for *M*. *K=M+F+W*. Calculate *K* for each of the five *M* parts of question (d), and then determine the annual *K* for a female ferret producing a litter.	*K* for days 1-90: *K* for days 91-135: *K* for days 136-175: *K* for days 176-239: *K* for days 240-365: Total *K* for a year:
f). Similar to question 1(e), calculate how many prairie dogs are needed to provide the necessary kcals for one year for a reproducing female ferret? Use your numbers from above.	Total kcal per year/kcal in a prairie dog

3. In question 1 and 2 above, you calculated the number of prairie dogs needed to support individual ferrets. However, prairie dog populations need to be large enough to support the loss of those numbers of prairie dogs through predation while still maintaining a sustainable population. In this section, you will calculate the minimum size of a prairie dog colony that is required to support black-footed ferrets using the energetic needs from questions 1 and 2.

You will use some answers from above in this section. Write them here for reference: Average number of prairie dogs per year that are needed to feed an 800 g male or non-reproducing female black-footed ferret: _____ (from 1e) Average number of prairie dogs needed per year to feed a reproducing female black-footed ferret: _____ (from 2f)	
Prairie dog colonies grow at an average rate of 1.5. For example, a colony with 60 individuals in year one will likely have 90 individuals in year two (60 individuals * 1.5 growth rate = 90). The maximum sustainable number of prairie dogs lost to ferret predation is estimated to be half of the new recruits. In our example colony with 60 individuals, 30 more individuals were added from year one to year two, so 15 individuals could be lost to predation. With a growth rate of 1.5, the sustainable rate of predation is 0.25 (e.g., 15/60 = 0.25). Calculate the prairie dog colony size required to support ● one male or non-reproductive female ● one reproductive female	If the sustainable rate of predation is 0.25, then the colony size required = number of prairie dogs the ferret needs/0.25 **For a male/non-reproductive female:** **For a reproductive female:**

4. Researchers estimate prairie dog colony size for many reasons. Colony size is usually estimated in acres, not individual colonies. Because our ferret energy calculations are in prairie dogs, we need to estimate the number of prairie dogs per acre. Prairie dog densities are variable and can be difficult to estimate. Biggins et al. (2006) estimated that colonies can range from 7-17 prairie dogs per acre. Black-footed ferret females are territorial, so regardless of prairie dog density it is unlikely to find more than one female ferret per 62 acres. For the purposes of this activity, use 10 prairie dogs per acre for your calculations.

a) Minimum colony size per adult male or non-reproductive female: _____

b) Minimum colony size per reproductive female: _____

D. Prairie Dog Demographics

Managing prairie dog populations is essential to the recovery of black-footed ferrets. Life tables are a standard method of monitoring population demographics and predicting trends in population growth. John Hoogland from the University of Maryland intensely studied black-tailed prairie dogs at Wind Cave National Park in South Dakota for more than a decade and part of this project involved tagging each individual. He conducted his study before sylvatic plague reached South Dakota in 2007 so his data are an invaluable record of prairie dog population demographics in the absence of plague (Hoogland, 1995).

1. Complete the following life table by calculating:

a.) Number of prairie dogs dying during the interval, *dx*, which is the difference between number alive at beginning of interval and number alive at beginning of next interval
b.) Survivorship of prairie dogs, *lx*, which is the proportion that survive to from 0 to a given age interval
c.) Probability of dying during age interval qx_t, which can be calculated using dx_t/lx_t and
d.) Male and female realized fecundity for each age interval which is a measure of *lx*mx*

Life Table for a Cohort of Black-tailed Prairie Dogs (*Cynomys ludovicianus*) born in 1981 in Wind Cave National Park, South Dakota. Data from Hoogland (1995; pg. 395)

	Age in Years	*nx* (# at start of interval)	*dx* (# dying during interval)	*lx* (survivor-ship)	*qx* (probability of dying during interval)	*mx* (age-specific fecundity)	*lx*mx* (realized fecundity)
Males	0	67		1.000		0.000	
	1	26				0.000	
	2	21				1.857	
	3	9				2.000	
	4	2				7.500	
	5	2				11.500	
	≥6	0		0.000	-	-	-
							Σ
Females	0	52		1.000		0.000	
	1	21				0.143	
	2	19				1.632	
	3	14				1.143	
	4	7				1.429	
	5	4				3.250	
	6	2				2.500	
	7	1				0.000	
	8	1				0.000	
	≥9	0	-	0.000	-	-	-
							Σ

2. Sketch both survivorship curves using the *lx* values you calculated. Do male and female prairie dogs have similar survivorship curves?

3. Calculate the net reproductive rate, R_o, for male and female prairie dogs by summing the realized fecundity at each age interval, $\sum lx*mx$. Use the average R_o for males and females to estimate the population net reproductive rate. Based on this value, is the prairie dog population stable, declining, or increasing?

E. Social-Environmental Issues with Prairie Dogs and Ferrets

As with any issue, the black-footed ferrets and black-tailed prairie dogs exist within a larger social-environmental context. The perceived conflict between ranching/farming and prairie dogs was discussed earlier in this case, but there are many other conflicts that exist as well. Local newspapers can be a useful source of information about perspectives held by different groups of people. Conflict can stem from many sources including desired land use, private property rights, disease exposure, and cost of conservation and re-introduction. An important part of ecology and managing natural resources is being able to integrate data across social and environmental fields. Use the information you have gathered so far in this case to complete the exercise below:

1. Working in a group of 4-5 people, read through several newspaper articles (see suggestions) or find more recent articles on the internet. You can divide up the work to cover more articles. Good sources of information include *High Country News*, *North Forty News*, *The Coloradoan*, and *The Denver Post*. Articles about other prairie dog species may provide information that is useful in the case of black-tailed prairie dogs. Remember that in this type of research, opinion pieces can be useful, as they portray an individual's or group's perspective on an issue.
2. With your group members, identify the stakeholders from each article. Write down their opinions and concerns as raised in these articles, and one piece of evidence that supports their point of view. Assign each group member as a different stakeholder.
3. Mass vaccination of prairie dogs may be necessary to sustain black-footed ferret populations. Assume the role of your assigned stakeholder to discuss the pros and cons of vaccinating prairie dogs. Should all prairie dog towns be vaccinated or only those that are ferret release sites? What are the unintended consequences of a mass vaccination program? Could a successful vaccination program increase tensions amongst stakeholders regarding the management of prairie dog populations?

Some articles to get you started:

Clagett, R. (2016, September 5). The slaughter of innocents: After prairie dogs invade a corner of her lot, a writer weighs the cost of eliminating them. High Country News. Available: http://www.hcn.org/issues/48.15/the-slaughter-of-innocents

Duggan, K. (2016, March 20). Property owner starts exterminating prairie dog colony. The Coloradoan. Available: http://www.coloradoan.com/story/news/2016/03/21/prairie-dog-colony-culled/81934710/

Finley, B. (2017, February 20). Prairie dog towns in Colorado cover twice the acreage researchers once thought. The Denver Post. Available: http://www.denverpost.com/2017/02/20/colorado-prairie-dog-population/

Marmaduke, J. (2015, November 4). Plague-infected animal found at Bobcat Ridge Natural Area. The Coloradoan. Available: http://www.coloradoan.com/story/news/2015/11/04/plague-infected-animal-found-bobcat-ridge-natural-area/75171118/

Mast, K. (2013, December 16). States test a new prairie dog plague vaccine. High Country

News. Available: http://www.hcn.org/blogs/goat/states-test-prairie-dog-plague-vaccine

Raham, G. (2011, September 15). The black-footed ferret: Flagship species for the prairie ecosystem. North Forty News. Available: http://www.northfortynews.com/the-black-footed-ferret-flagship-species-for-the-prairie-ecosystem/

Raham, G. (2016, August 19). Fewer than a dozen black-footed ferrets survive on Soapstone prairie, pushing new thinking about species conservation. North Forty News. Available: http://www.northfortynews.com/fewer-than-a-dozen-black-footed-ferrets-survive-on-soapstone-prairie-pushing-new-thinking-about-species-conservation/

4. Imagine that you and the other members of your group are Hailey's peers and you need to informally present information from your summer work to others at your college or university. Pick a specific social-environmental issue you've read about and outline key points you think are important to present to your peers. This informal presentation should be about 5 minutes long.

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