Relating Conservation Goals to Ecological Outcomes

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Introduction

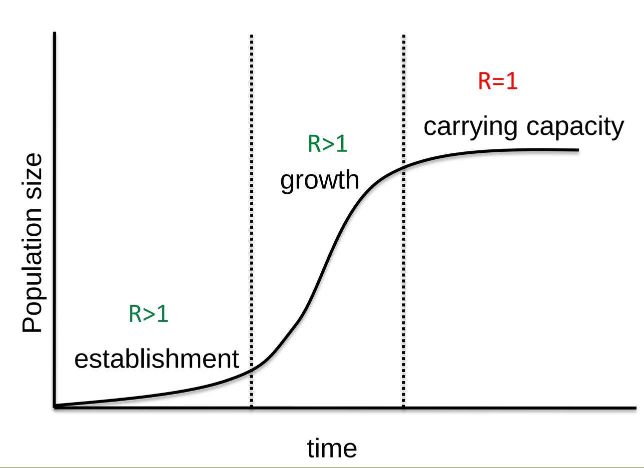
The Earth's biodiversity is declining. This is due to a variety of factors including habitat destruction, overexploitation of natural resources, and climate change. Conservation biologists use tools to help increase population sizes and to reach conservation goals. However, quantitative recovery goals are often set early in the conservation projects when there is a lack of information for many species, making setting appropriate goals difficult. Here we evaluated the appropriateness of stated goals for conserved species by examining available data on population growth after recovery began. We also used data on population growth to explore how extinction probability should impact goals for conserved populations.

Approximately 19,800 species are threatened to go extinct!

Figure 1: Endangered species including (left to right) the Palos Verdes blue butterfly, small whorled pogonia, and Apache trout are all valuable species in biodiversity as a whole.

Model for population growth

We assumed conserved populations would exhibit logistic growth. Under this deterministic model, an established population grows at a given proportional growth rate, R>1. As the population grows, limitations in natural resources causes the realized growth rate to decrease and eventually stabilize at R=1. When this occurs, the populations reaches a natural carrying capacity. This general model provides ecological milestones and an endpoint for population growth and allowed us to compare stated goals to potential population dynamics.



Data Collection

Methods: We examined 20 mammal species protected by the Endangered Species Act. We recorded population histories, recovery goals, and conservation tools used.

- Bighorn sheep (Peninsular)
- Black footed ferret
- Blue whale (Eastern North Pacific)
- Bowhead whale
- California bighorn sheep
- Columbian white tail deer
- Florida manatee
- Florida panther
- Guadalupe fur seal
- Gray bat
- Gray whale
- Gray wolf (Northern Rockies)
- Gray wolf (Western Great Lakes)
- Grizzly bear (Yellowstone)
- Red wolf
- Santa Catalina Island fox
- San Miguel Island fox
- Southern sea otter
- Stellar sea lion (Western)
- Utah prairie dog

Figure 2: Clockwise from top left; grizzly bear, Florida manatee, Florida panther, gray bat, blue whale, Utah prairie dog.

Growth Models

Goal: To examine current growth rates and look for signs of density-dependence. If significant signs of density dependence are found, estimate the populations carrying capacity and compare that with the conservation goal.

Methods: Use data to graph and analyze population growth

Results: 4 populations showed significant signs of density dependence (p<0.5). Out of these, we determined 3 of the goals fall within the 95% confidence interval range of carrying capacity, meaning goals are appropriate given current information.

Population	Goal	Estimated Carrying capacity	Carrying capacity 95% Confidence Interval	How goal relates to carrying capacity
Bighorn sheep	750	1012		
Black footed ferret	1500	1496		
Florida panther	720	506		
Gray whale	19500	20200	15930-77840	inside
Gray wolf	60	1602		
Grizzly bear	48	38	27-120	inside
Guadalupe fur seal	30000	5722		
Red wolf	550	264		
Stellar sea lion	45000	18617	n/a-23200	outside
Southern sea otter	3090	2452		
Utah prairie dog	6000	4906	3844-13486	inside

Table 1: For each species, we estimated carrying capacity by analyzing relationships between population size and growth rate and compared goals to predicted population dynamics.

Utah prairie dog population size over time

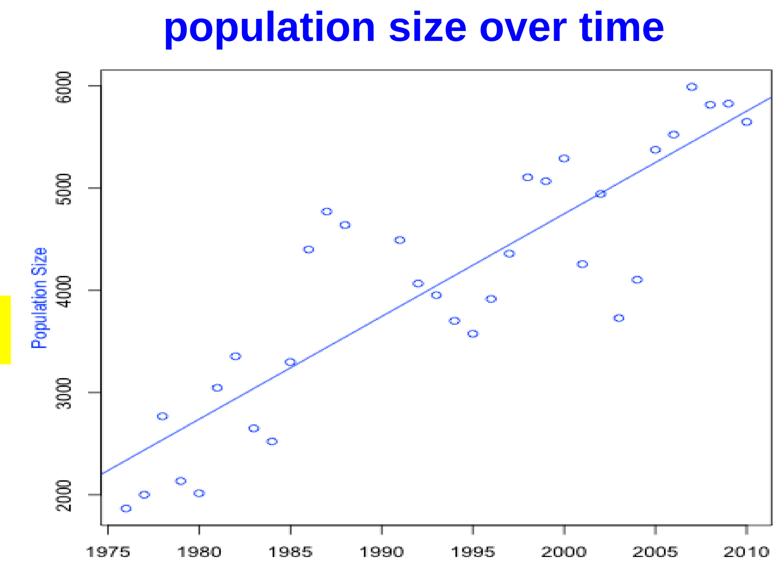


Figure 3: Population size is increasing over time.

As population size increases, proportional growth rate decreases. This allows us to predict a carrying capacity (★) for the species and compare it to stated goals (★)

Impact of population size on proportional growth rate

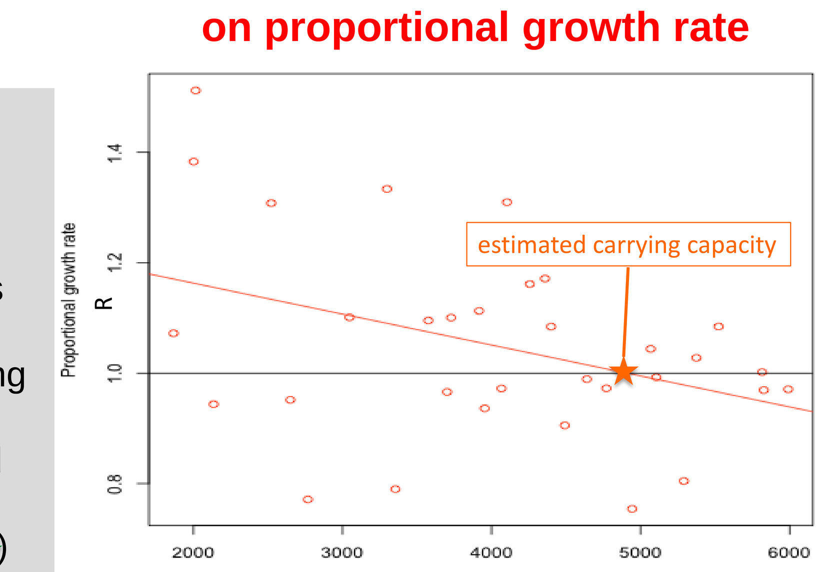


Figure 4: As population size increases, proportional growth rate decreases, approaching 1.

Utah prairie dog goal falls within 95% confidence interval

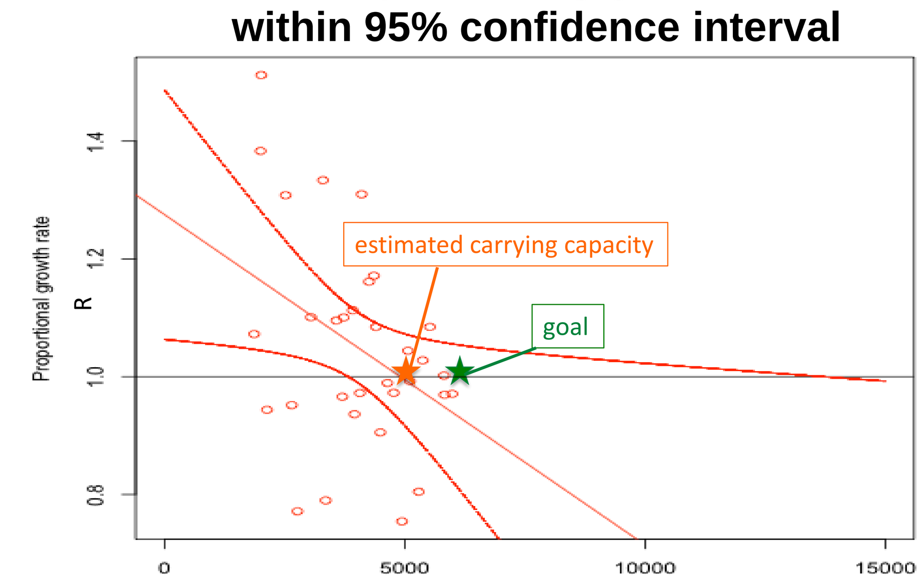


Figure 5: Goal is within 95% confidence interval range.

Population Viability Analysis

Goal: Determine probability of extinction 50 years after goal is reached, and 50 years from now (if goal is not reached).

Methods: Run 1000 hypothetical population growth simulations using mean growth rate and variance recorded for each species.

Results: Most goals are set high enough that populations face little chance of extinction. In many species, population growth is high enough that extinction probabilities are nearly the same for the existing population.

Population	Probability of extinction 50 years after goal	Probability of extinction 50 years from now
Bighorn sheep	0%	0%
Black footed ferret	0%	0%
Florida panther	0%	0%
Gray whale	0%	0%
Gray wolf	0%	0%
Grizzly bear	5.8%	6.4%
Guadalupe fur seal	0%	0%
Red wolf	0%	0%
Stellar sea lion	0%	0%
Southern sea otter	0%	0%
Utah prairie dog	0%	0%

Table 2: Populations and their extinction probabilities, given population sizes matching goal and most recent data.

Discussion

Results show that most goals are set high enough that, if reached, the populations will have very low probabilities of extinction. However, it should be noted that dynamics are based on populations under current conservation practices. Since only 4 populations showed significant signs of density-dependence, the other populations may not have enough data available for conservationists to make appropriate quantitative goals. At this point in time, growth rates are high enough that even if the goal is not reached, species have very low extinction probabilities. Together, this implies that adaptive management may be useful for setting more appropriate goals as more species specific data becomes available.

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References: All pictures are from esasuccess.org