General principles of disease management and control in wildlife

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6th cycle Training of National Wildlife Focal Points
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Author Introduction

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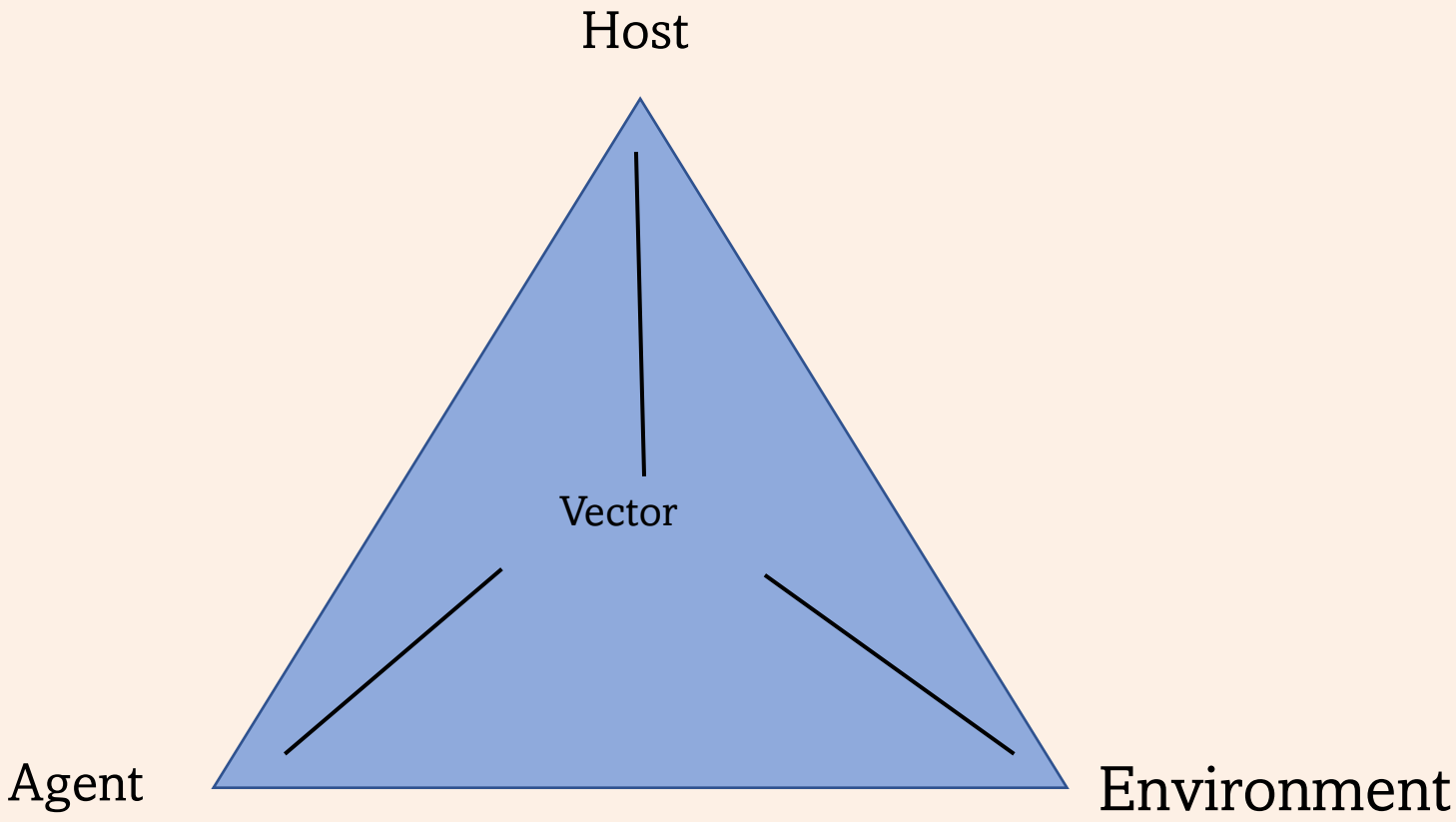
Disease Intervention Points



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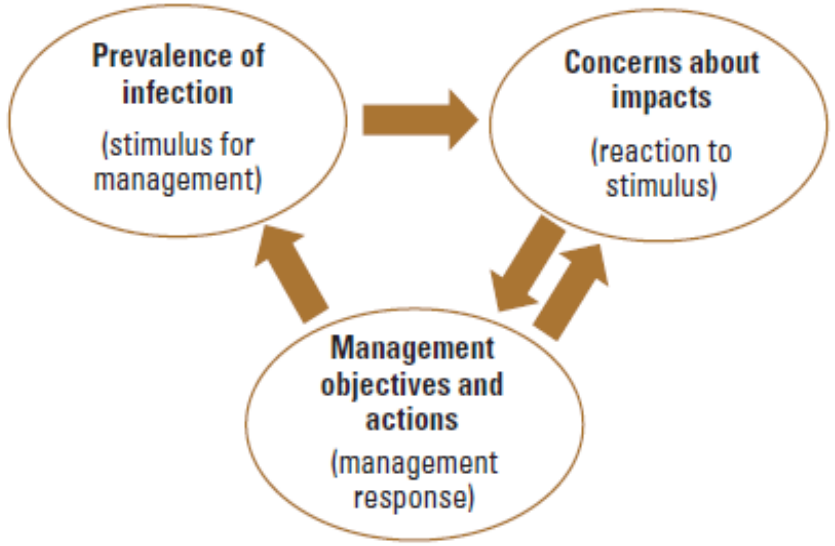
- Why is management being considered?
- What tools are available for management?
- What resources are available for management?
- Is there public and societal support for management?
- What would success look like?
- How will success be measured?
- How will the management actions and outcomes be communicated to stakeholders?

Initial considerations



https://www.fisheries.noaa.gov/science-blog/human-dimensions-wildlife-disease

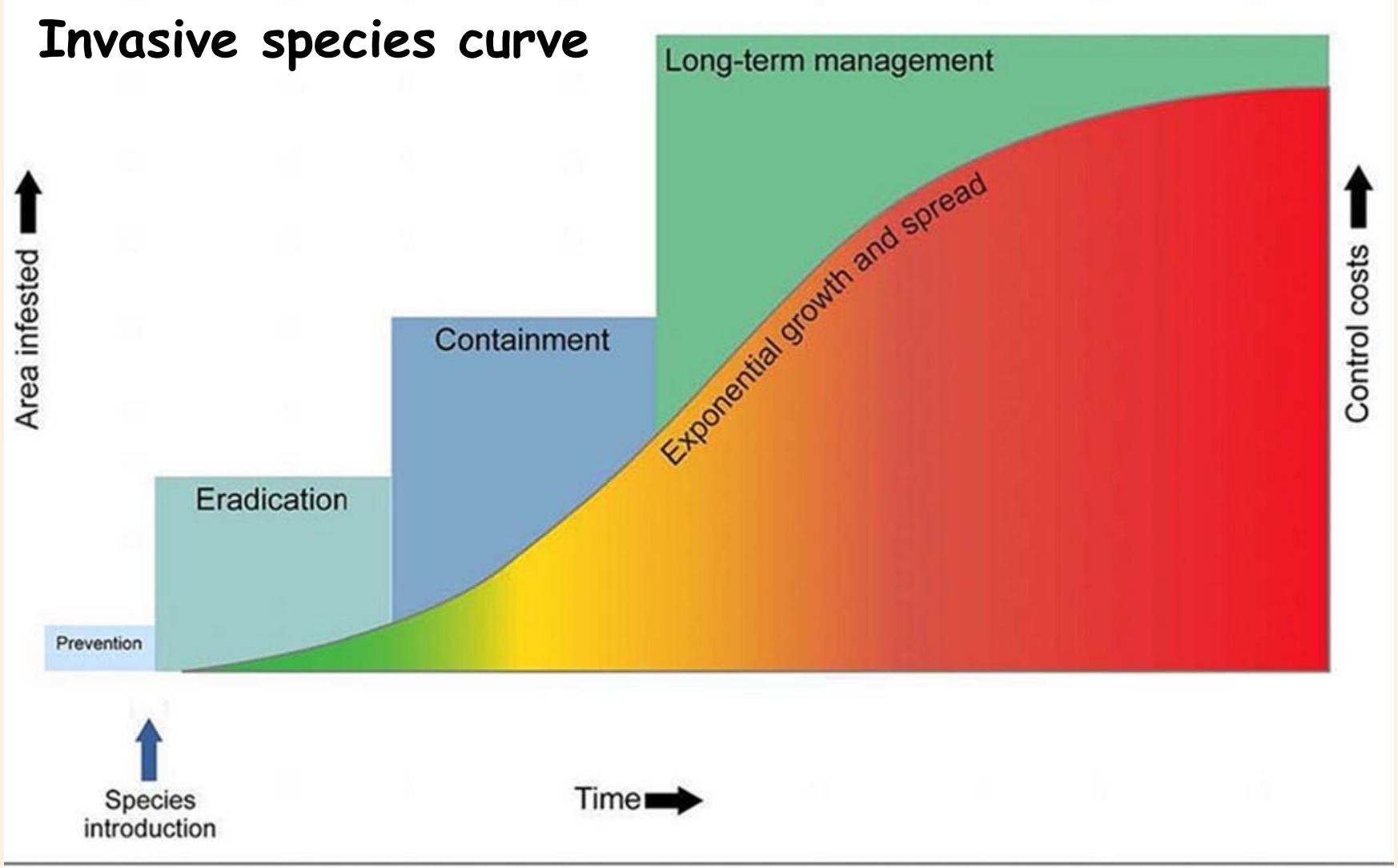
Disease management objectives

Prevention is defined as excluding or preventing the introduction of a disease into unaffected animals or a population

Control refers to activities designed to reduce the frequency of occurrence and contain the spread or effects of an existing disease within a population to a predetermined level.

Eradication is the total elimination (i.e., zero incidence) of an existing disease worldwide.

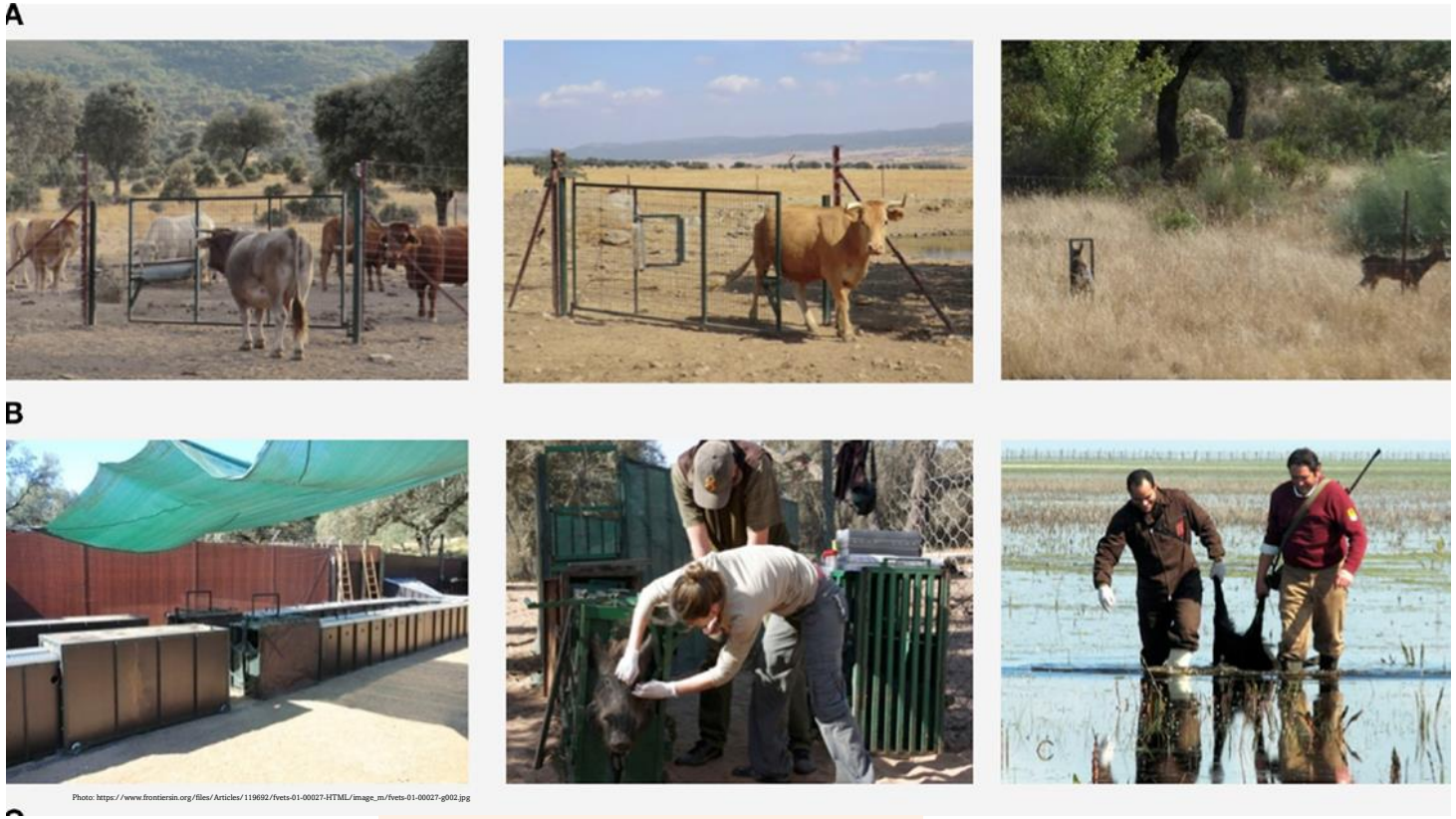
Invasive species curve

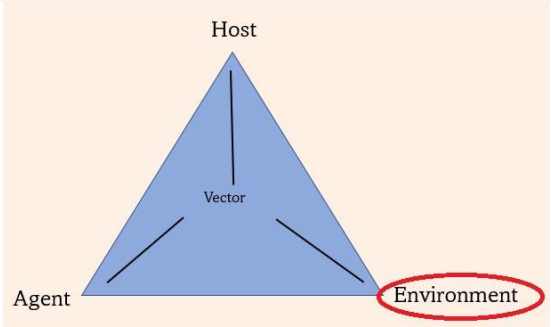


Sources: National Invasive Species Council; U.S. Department of Agriculture; National Park Service; U.S. Fish and Wildlife Service; Rodgers, L, South Florida Water Management District; Department of Primary Industries, State of Victoria, Australia; and GAO. | GAO-16-49

Control- Environmental manipulation

- Contaminants
- Infectious agents
- Vector borne disease
- Translocations





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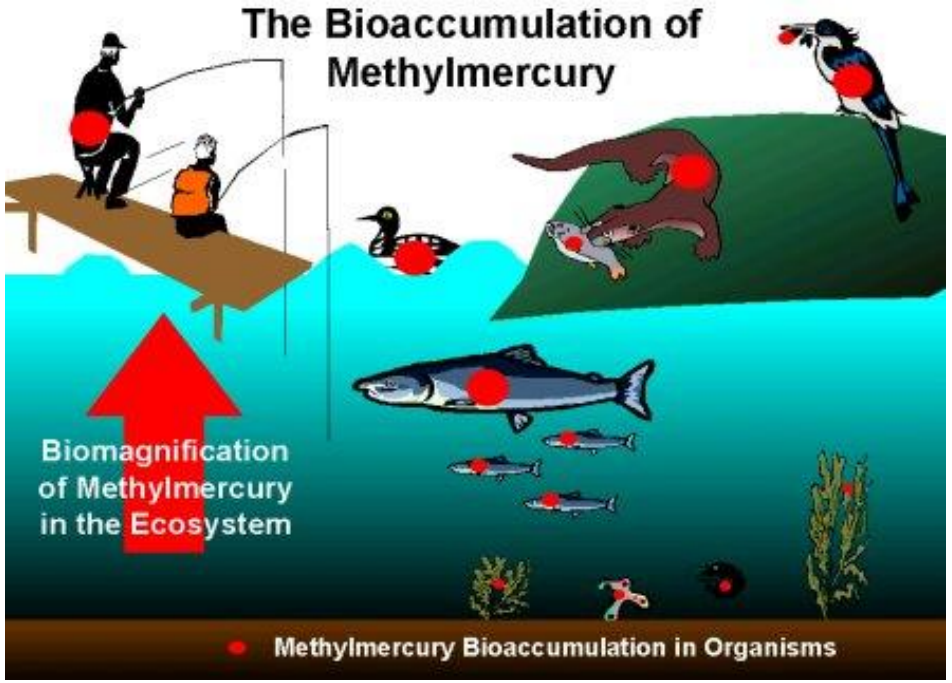
Prevention and control- Toxicants

- For some diseases, the most appropriate intervention is to eliminate its cause
  - Typically aimed at elimination of the agent from a defined area rather than its total eradication
- More support for non-infectious substances that have direct, acute effects and have the potential to affect human health



Prevention and control- environmental contamination

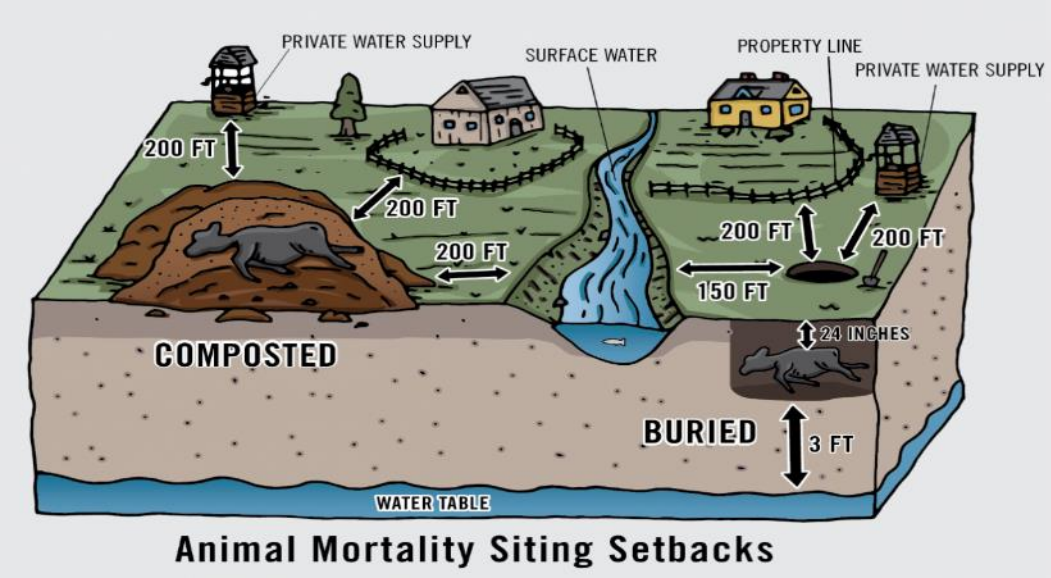


Image: https://agriculture.vermont.gov/composting-livestock-mortalities

- If pathogens are able to persist in environment may need to minimize contamination of the surrounding area during mortality events
  - Examples: anthrax, botulinum toxin
- Common disposal methods for wildlife carcasses include:
  - Incineration
  - Deep burial
  - Landfill
  - Composting

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Prevention and control-vectors

- Insecticides
- Benefits: can be very effective
- Challenges: serious environmental side effects
- Selective pressure for resistant organisms

https://www.npr.org/2013/12/01/228523650/saving-the-native-prairie-one-black-footed-ferret-at-a-time

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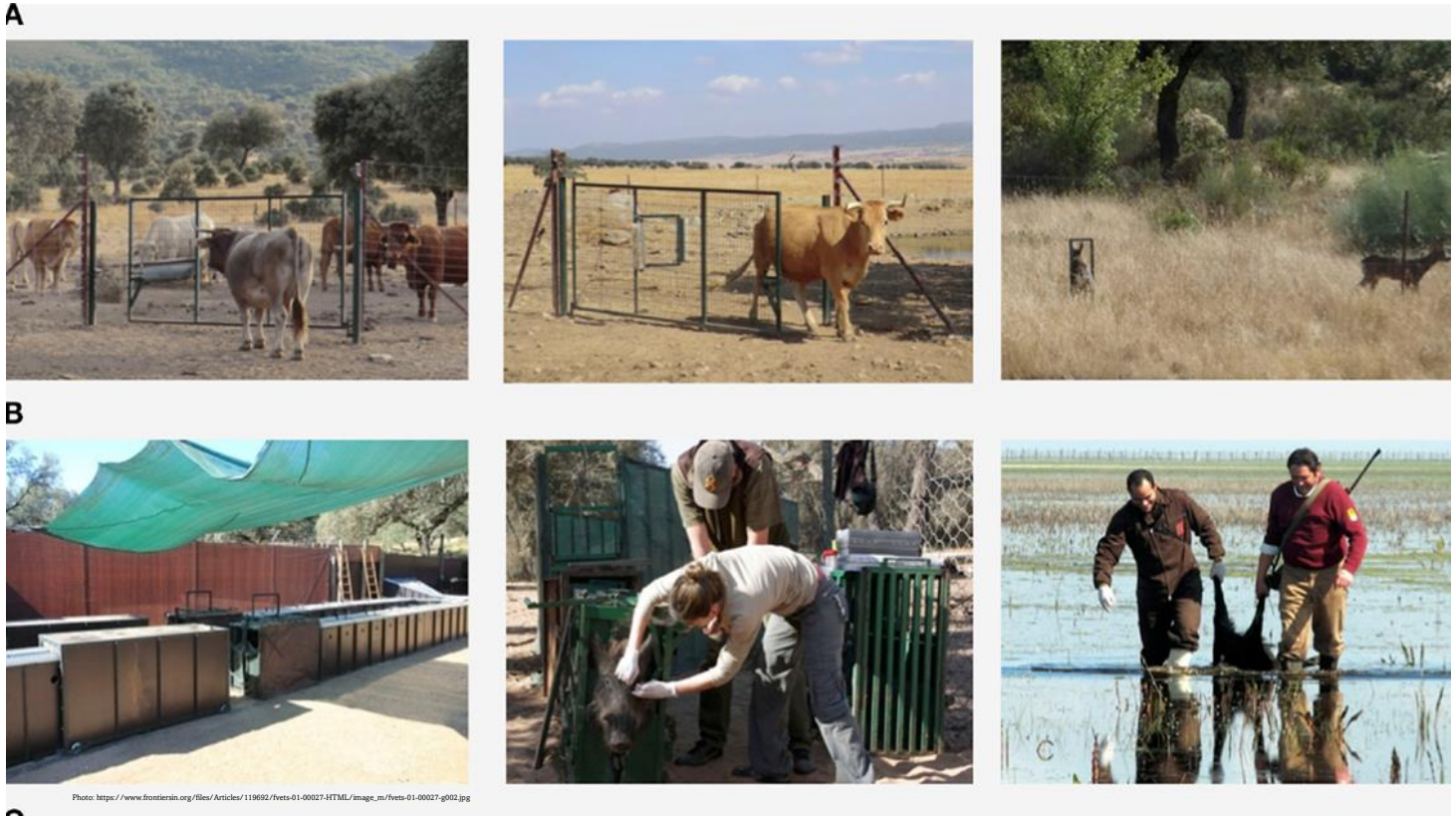
Prevention and control-translocations

- Evaluation of health status of source population including tests for specific diseases-
  - May include restrictions on movement of animals from areas where specific diseases are known to occur
- Quarantine of animals to be moved for time period equal to maximum incubation period for diseases of concern
- Diagnostic testing and prophylactic treatment of animals to be moved for diseases of concern

Control-Host manipulation

- One of the most common techniques for diseases with no intermediate hosts
- Host manipulation approaches:
  - Distribution
  - Selective removal
  - Density reduction



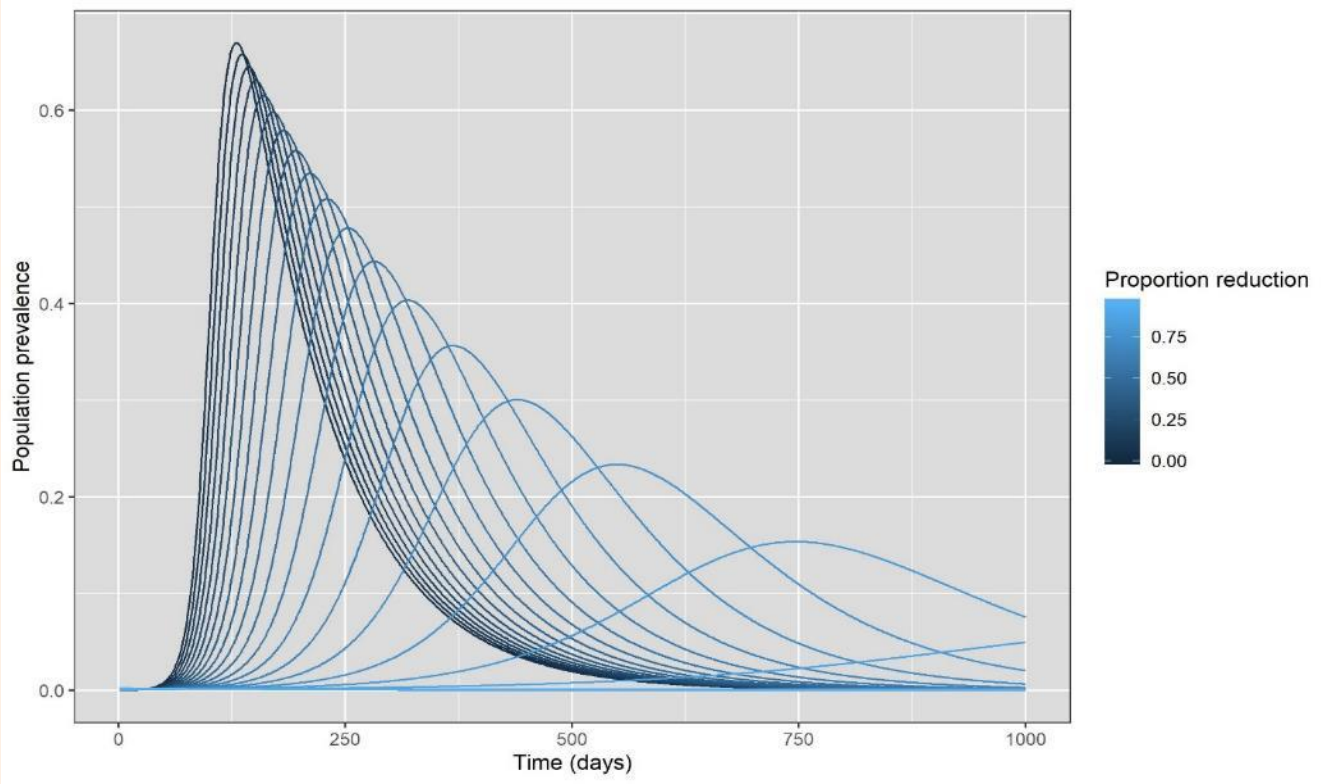
Theory behind host manipulation for disease control

Before disease established:

- Reduce $R_0 < 1$ by reducing infectious contacts or direct exposure to the infecting agent

After a disease is established:

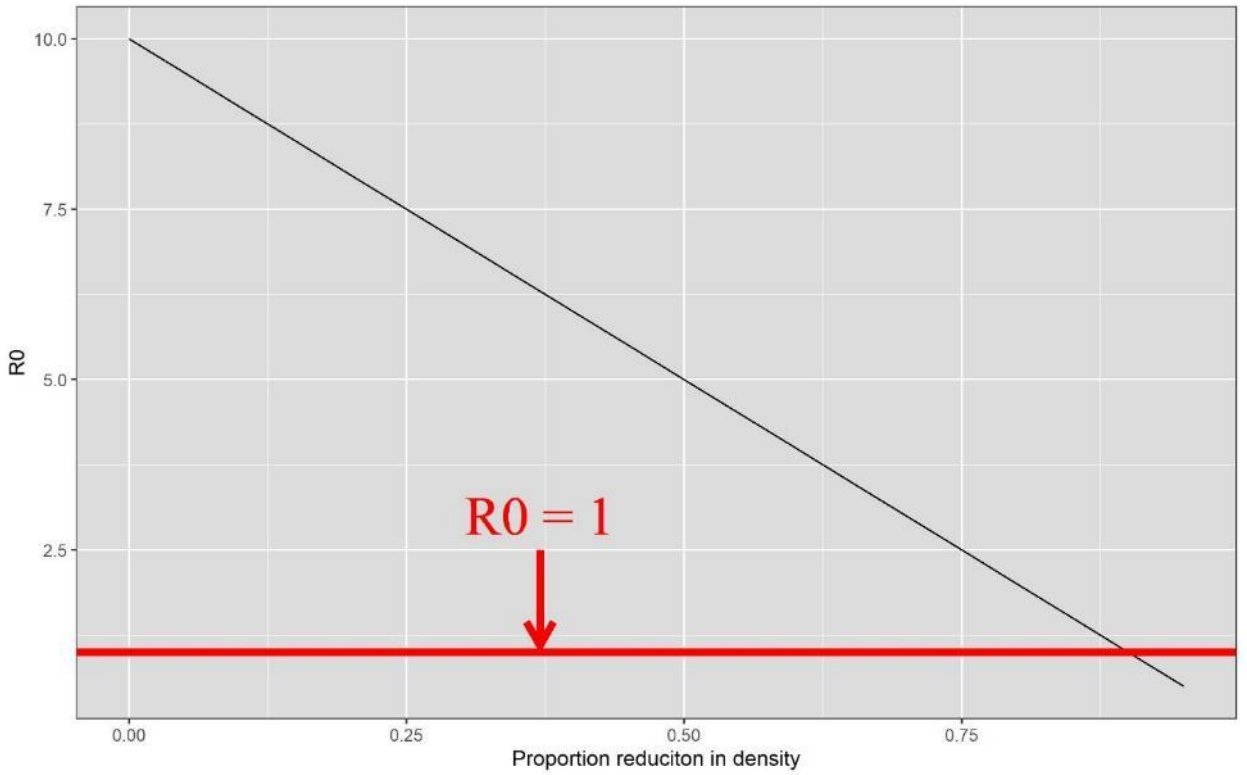
- Manipulations of host populations may still be advantageous to reduce the intensity of disease through time



Demonstration of prevalence curves as the density of the population is reduced.

Theory behind host manipulation for disease control

- Understanding the theory of host manipulations is important for
  - Choosing and designing appropriate management actions
  - Communicating expectations with politicians and the public



Demonstration of the impacts of density reduction on R_0 when assume starting density of 10 animals/km^2

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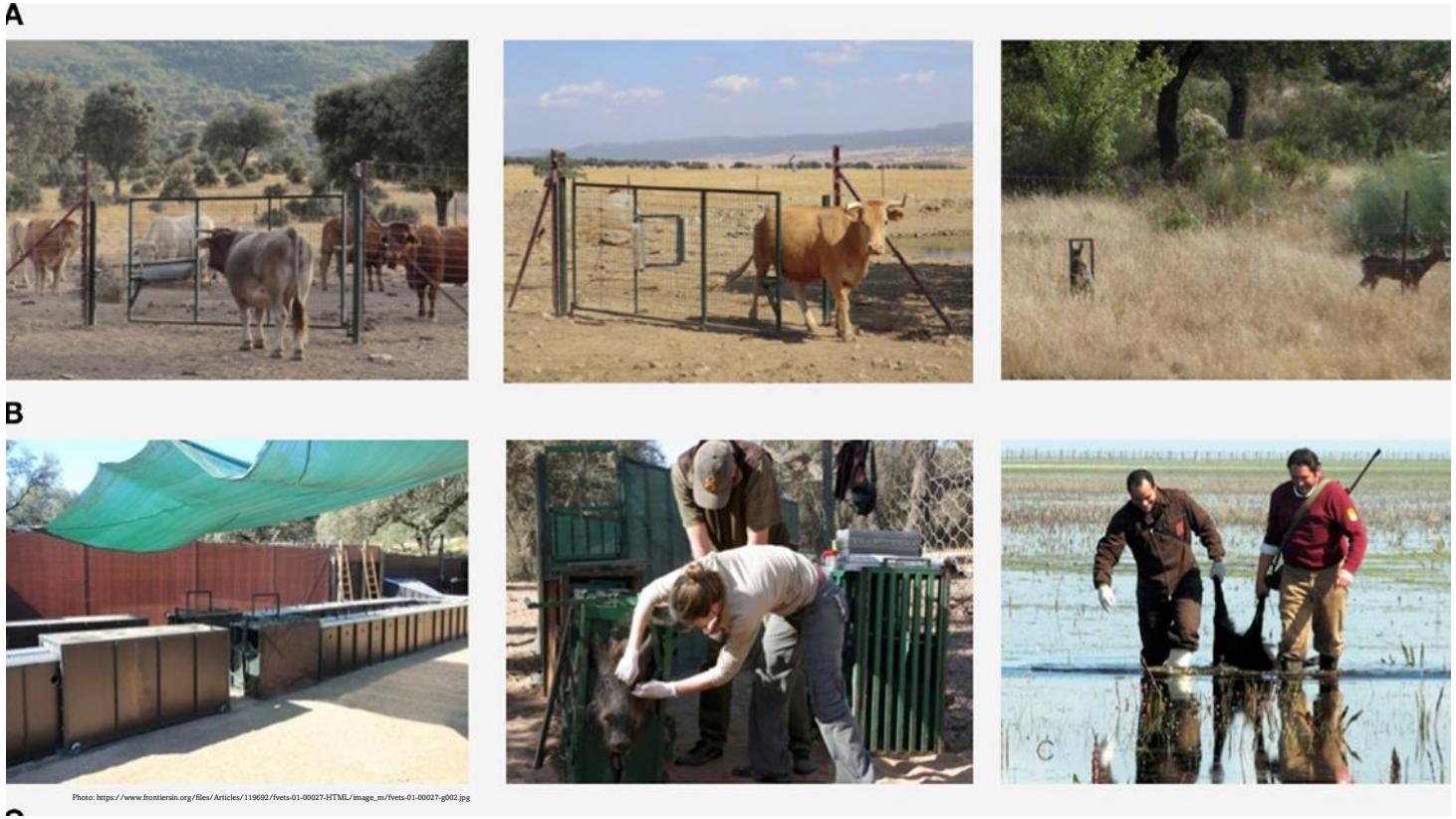
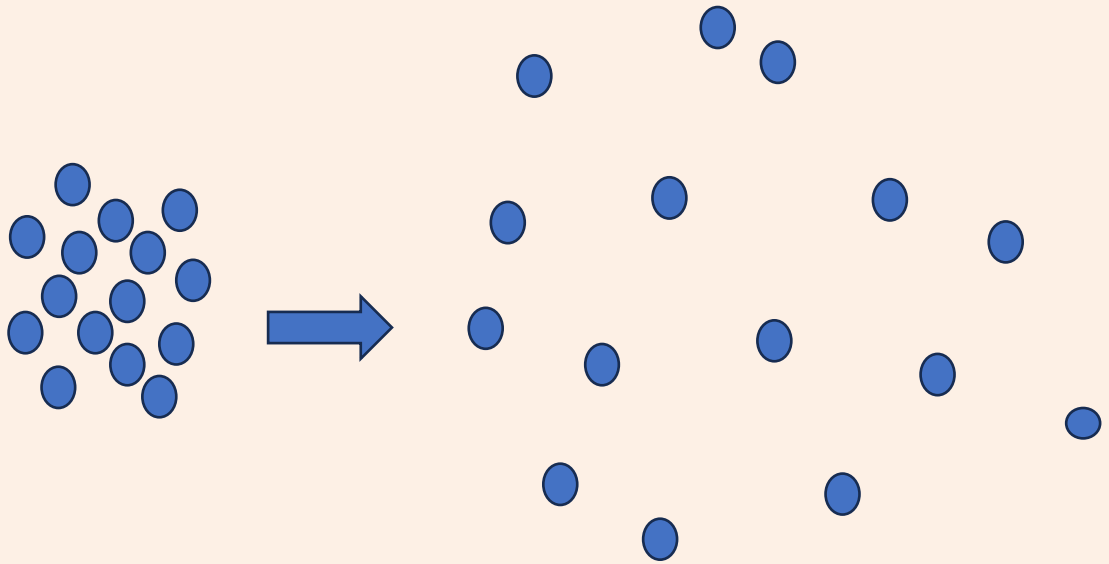
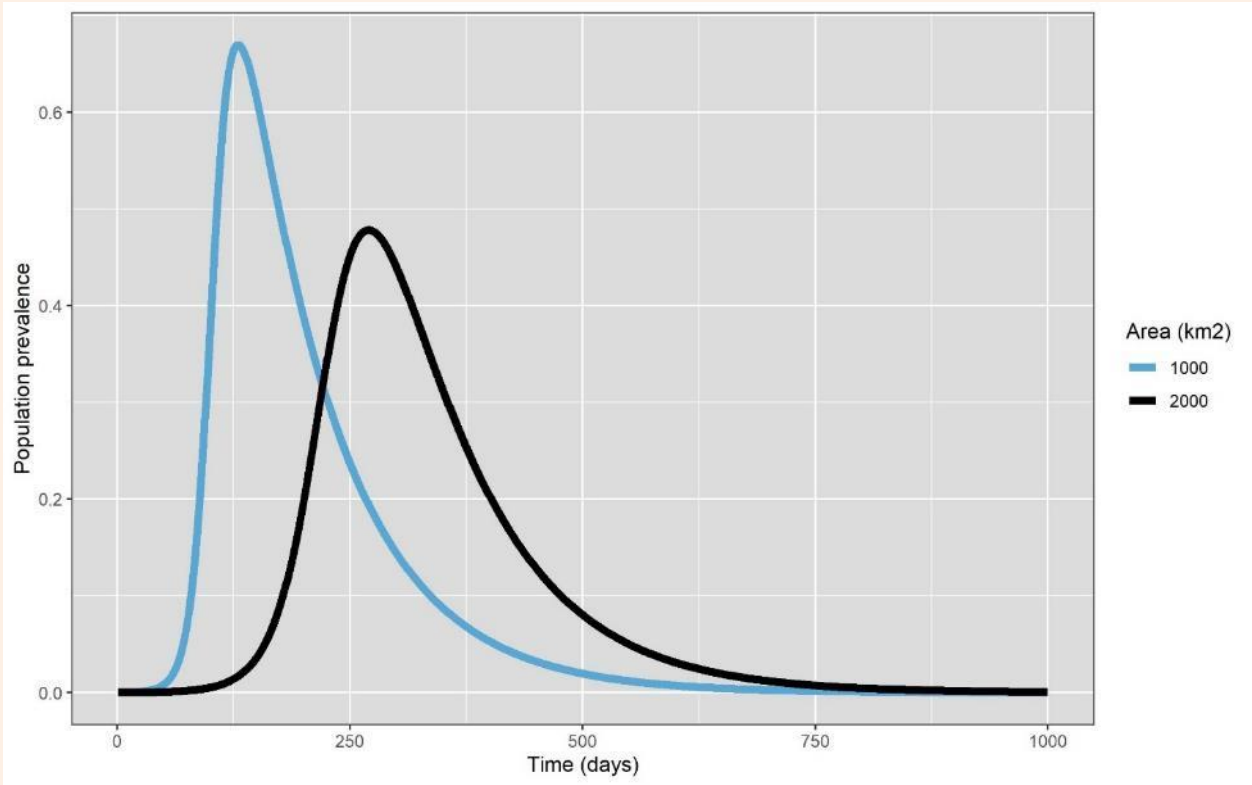


Modifying distributions of wildlife

Theory

- Does not change overall number but rather the area inhabited by hosts
- Reduce contacts of susceptible individuals or reduce exposure to noninfectious agent

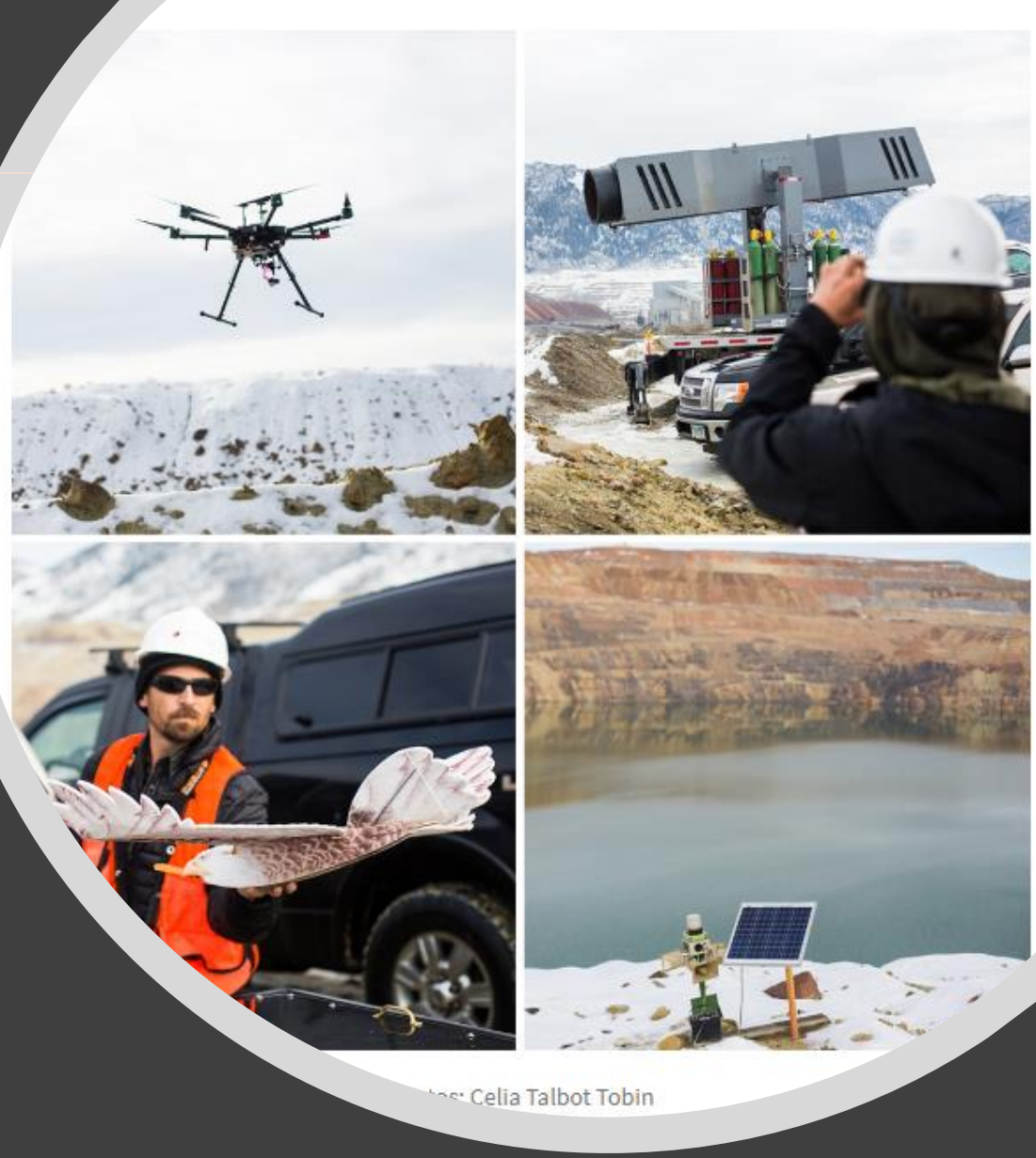




Impacts of increasing the area used by a population on prevalence

Dispersal of wildlife

- Most useful for
  - Localized outbreaks
  - Other suitable habitat is available
- Methods:
  - Anything that cause wildlife to flee area (lasers, noise, heavy machinery, UAVs, boats)
- Examples
  - Contaminated area
  - Botulism



Dispersal of wildlife

Considerations:

- Can be resource intensive and effects can be transient
- If disease is emerging and restricted in extent, dispersing can be counter-productive
- Impacts to dispersal areas: crop depredations or wildlife-livestock interactions

https://www.outdoorlife.com/conservation/wyoming-elk-population-problem/

Fencing

- Fencing aka forced separation of wildlife
  - Reduce spread infected hosts to new regions
  - Reduce transmission within already affected areas
- Most successful examples: separation wildlife and livestock

Fencing-considerations

- Effectiveness decreases over time
- Surveillance may be needed for placement of fence
- Behavioral characteristics of hosts-leaping, digging, swimming
- Not effective for vector-borne pathogens
- Continued maintenance costs of fencing
- Unintended consequences for wild populations: gene flow, social networks, population sinks, direct mortality

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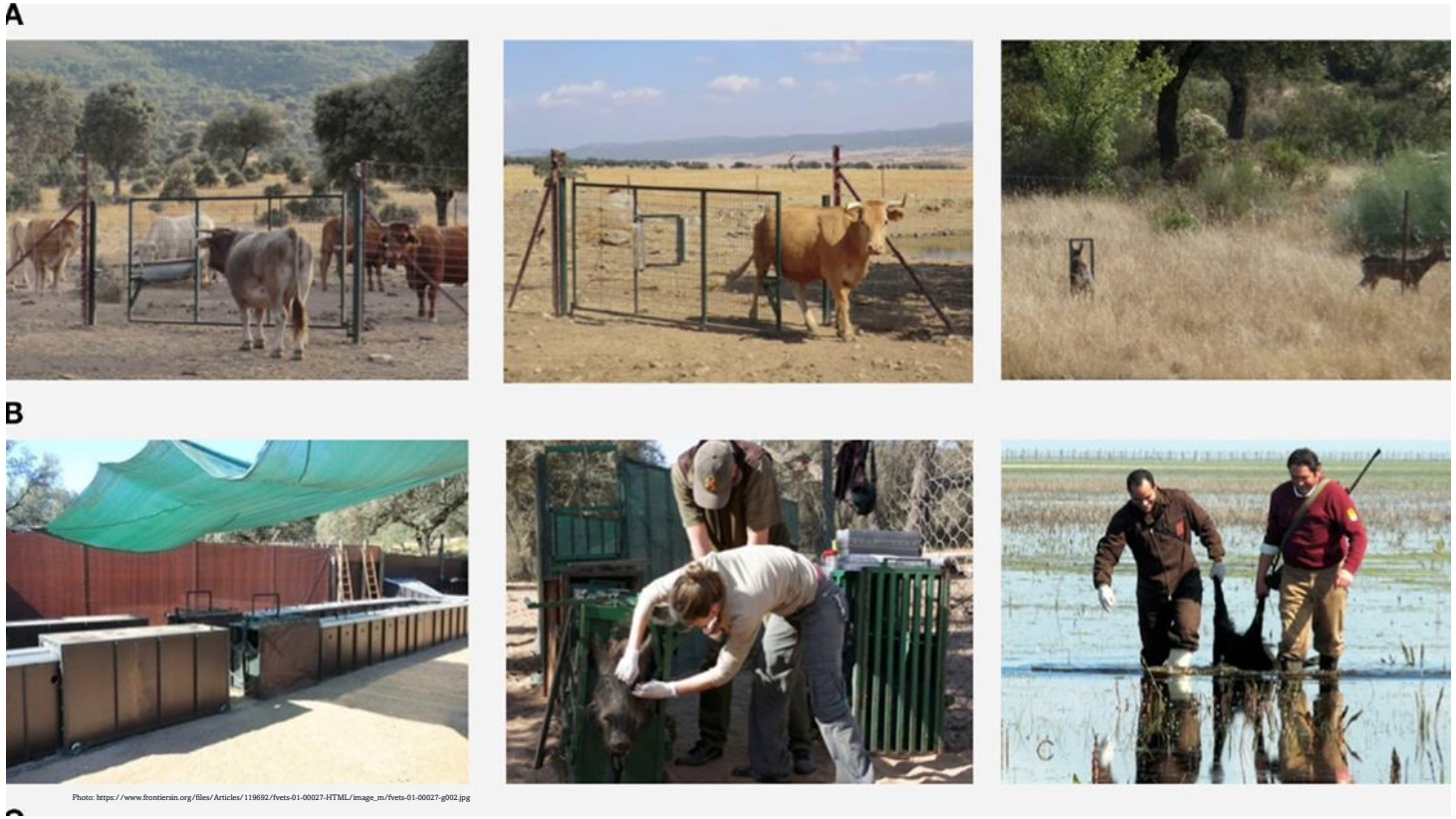
  - Selective removal
  - Density reduction



Selective removal

- Culling infected individuals from population
- Reduce contact between healthy and sick individuals
- Must be able to identify sick individuals

Approaches:

- Remove infected individuals
- Remove individuals disproportionately driving incidence (super spreaders)
- Removal of groups most at risk of being infected or transmitting pathogen

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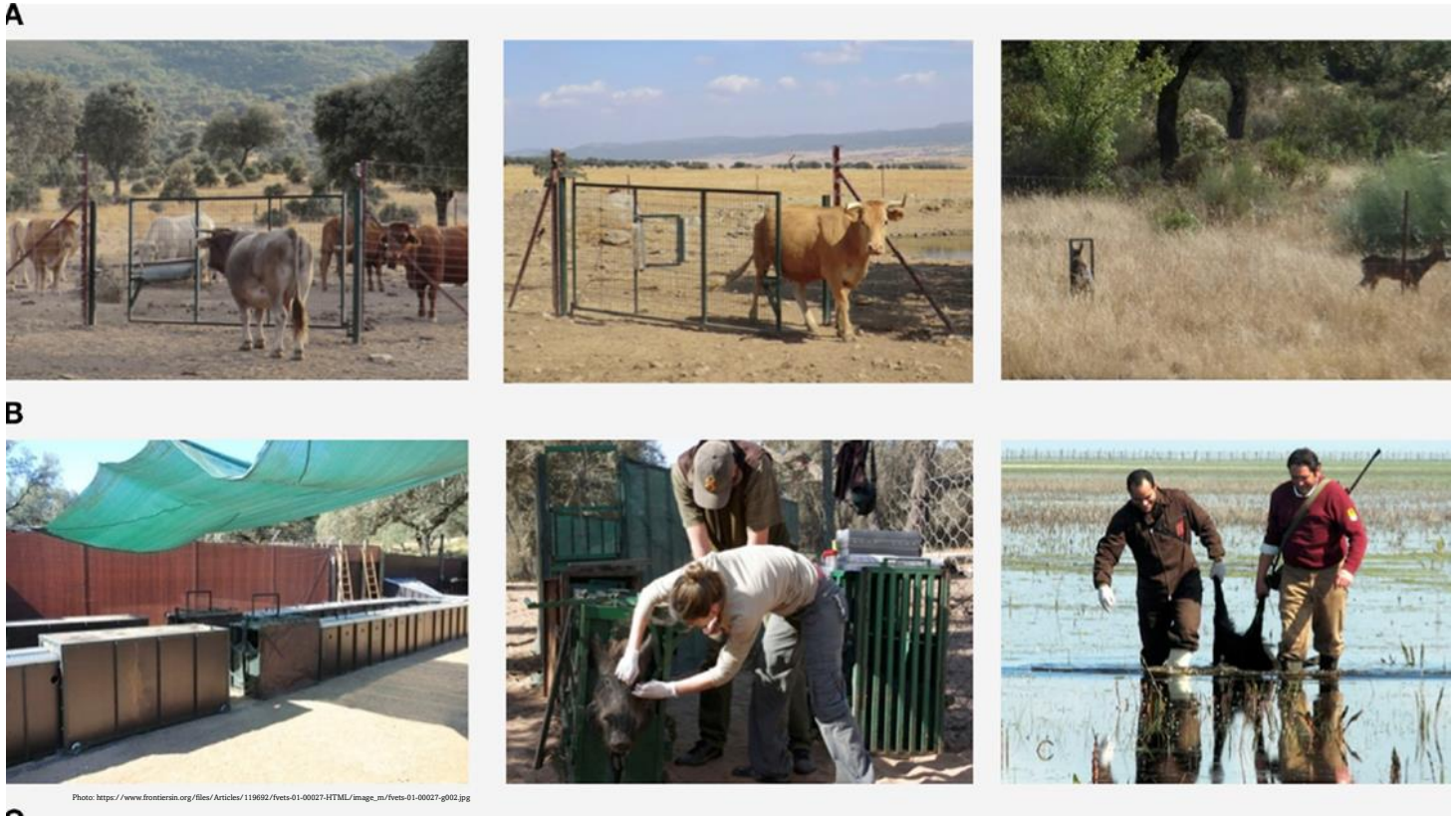


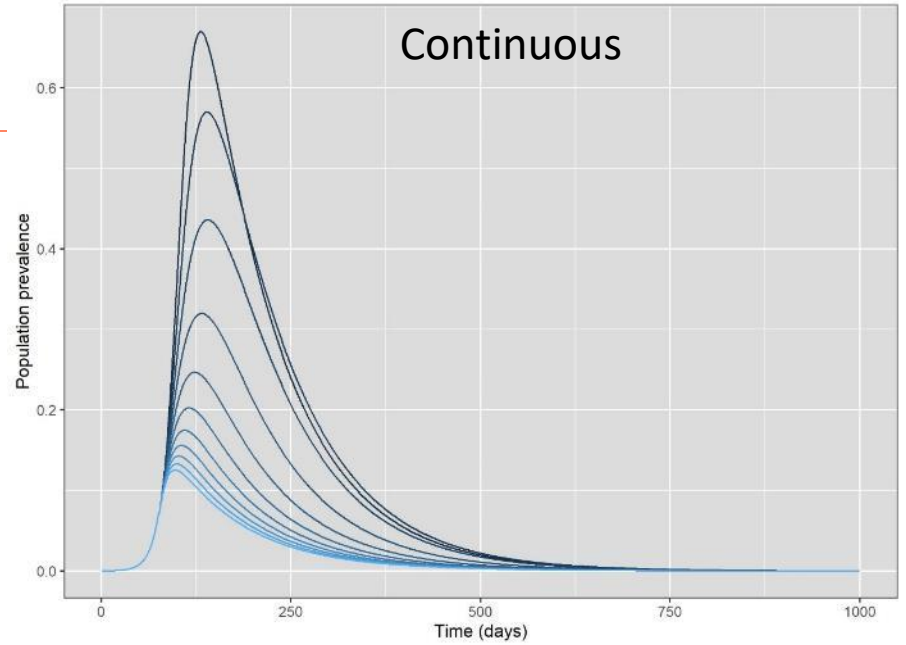
Density reduction

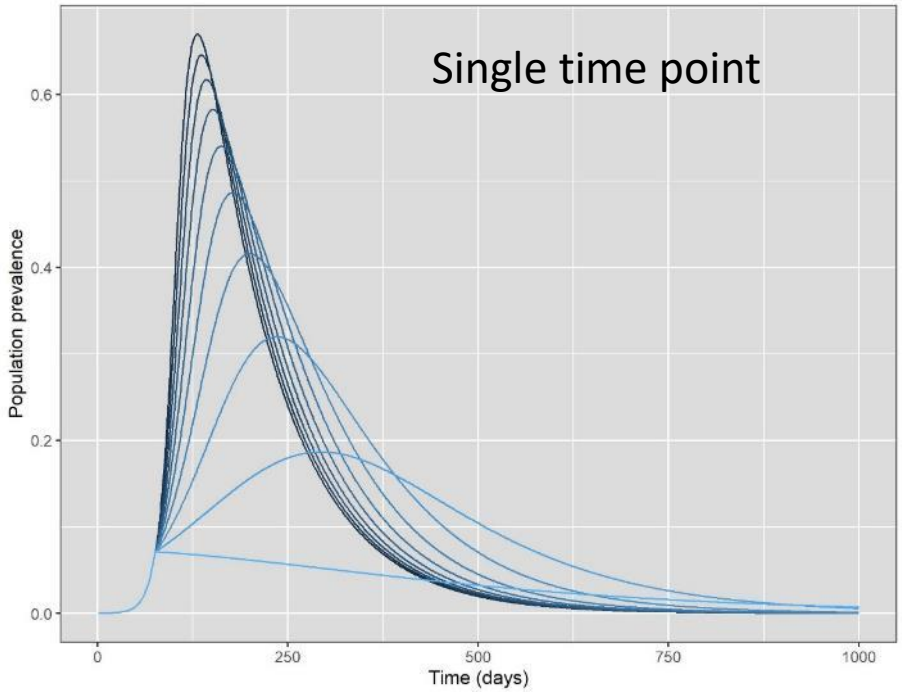
Continuous removal

- Can alter course of disease
- Random selection = recovered removed at same rate as susceptible
- Constant rate of removal logistically challenging

One time removal

- More logistically feasible
- Large proportion removed
- Less impact on prevalence





Density reduction-methods

- Lethal
  - Human mediated lethal methods most common
- Non-lethal methods:
  - Translocations
  - Protecting predator populations
  - Habitat manipulations
  - Discontinuation of supplemental feeding

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Density reduction- general considerations

- What scale? Local? Larger areas with a buffer?
- More effective for newly introduced diseases
- More effective for directly transmitted diseases
- Population demographics should also be considered (migration, immigration)

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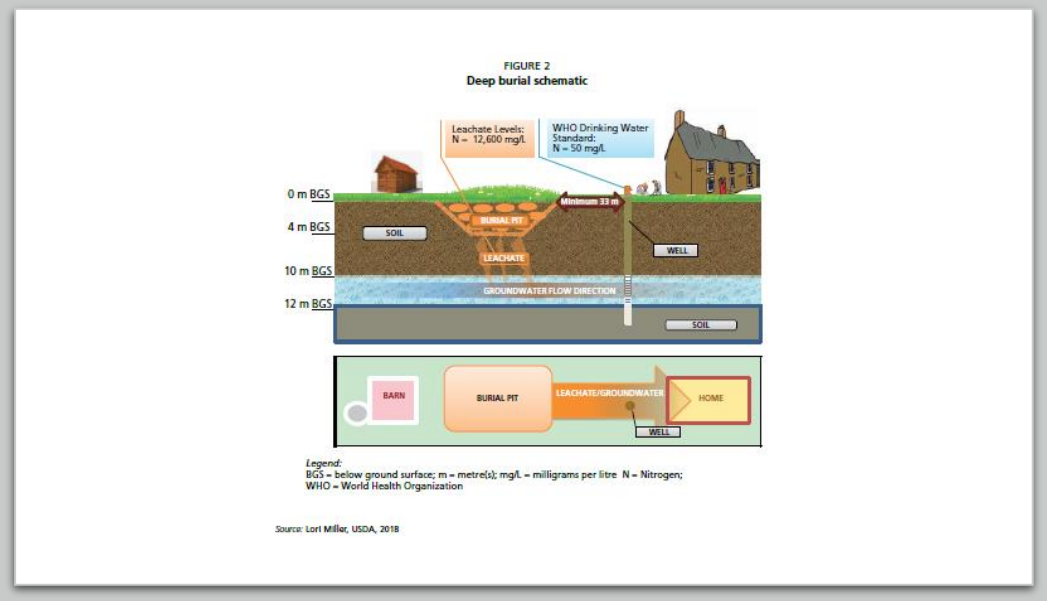
Density reduction- logistical considerations

- Carcass disposal: particularly for large species
- For game species may consider using hunters
  - Still may need to supplement efforts
- Need to know ecology of species – reduction may increase movements (e.g., badgers)
- May be able to use mathematical models to inform length of time efforts will be needed



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Density reduction - social considerations

- Can be highly controversial
- Magnified when removal not limited to those most at risk or the infected
- Measuring impacts important for maintaining public support and guiding refinements

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Assessing use of host manipulation

Complete table on page 74 of 6th Cycle Manual

			Distribution Alteration	
Compartment	**Characteristics**	**Result**	**Dispersal**	**Fencing**
Agent	Endemic	Yes	👎	👍
		No	👍	👎
	Novel to the system	Yes	👍	👎
		No	👎	👎👍
	Localized	Yes	👍	
		No	👎	👎👍
	Emergence mediated by environm	Yes	👍	
		No	👎	👎
	Vector-transmitted	Yes	👎	👎👍
		No	👍	
	Directly transmitted	Yes	👎	👎
		No	👍	👍
	Indirectly transmitted	Yes	👍	
		No	👎	👎
	Human-assisted transmission/spre	Yes	👎	👎
		No	👍	👍
	Affects multiple hosts	Yes	👎	👎
		No	👍	👍
	Rate of transmission	High	👎	👎
		Low	👍	👍
	Seasonal effects	Yes	👍	👎
		No	👎	👎

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Treatment of hosts

Circumstances where treatment may be considered:

- Treatment can be efficiently done for a large proportion of the population, or an individual(s) is of particular significance
- Treatment is conducted prior to the capture and translocation of animals
- Treatment is used to train personnel or harness public concern and gain support for disease management

Treatment of hosts- considerations

- Difficulty delivering treatments limits usefulness for managing disease in wildlife
- Ongoing treatment may be necessary
- Widespread use of chemical can exert selective pressure for resistant pathogens
- Handling and treating wildlife is stressful for them
- Few drugs are labeled for use in wildlife

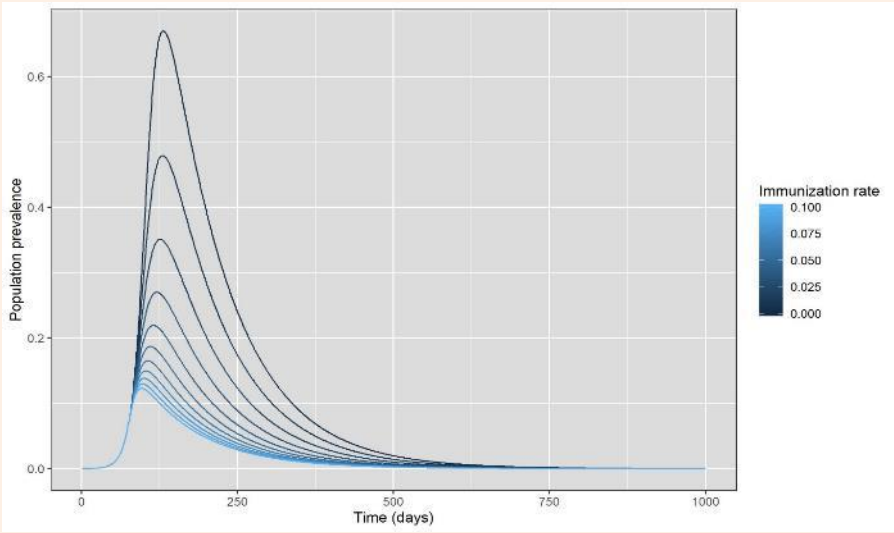
Black Bear #17-1298

Photo: Black bear being treated for sarcoptic mange

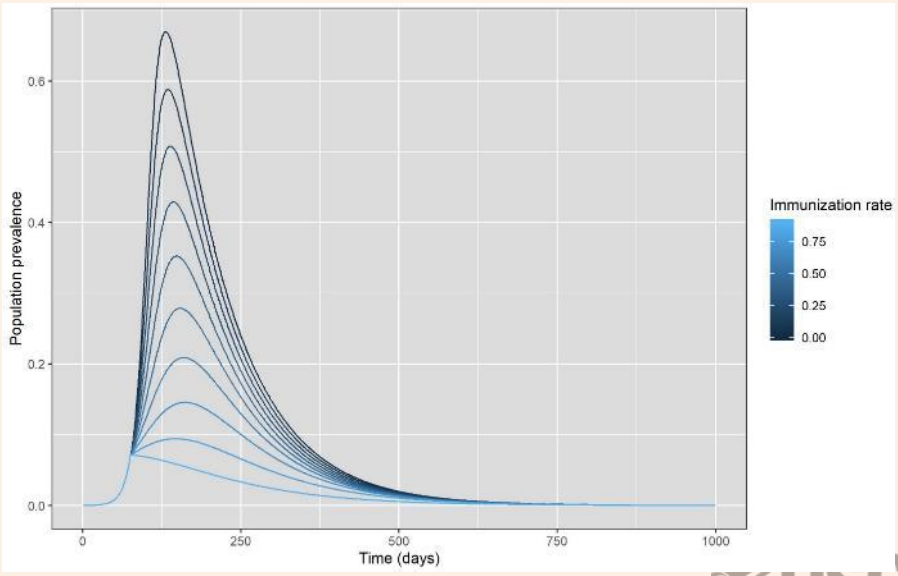
Immunization of hosts

- Used to prevent infection or development of a disease
- If population vaccinated only once, a large portion of population needs to be vaccinated
- May also consider vaccinating prior to arrival of disease or continuous vaccination

Effects of continuous immunization



Effects of one-time immunization



Immunization-considerations

- Vaccines that protect from infection (and not just disease) most beneficial to populations
- Safe for target and non-target species
- Field conditions and administration to wild animals
- Number of doses required
- Time to development can be long and require sustained commitment logistically and financially

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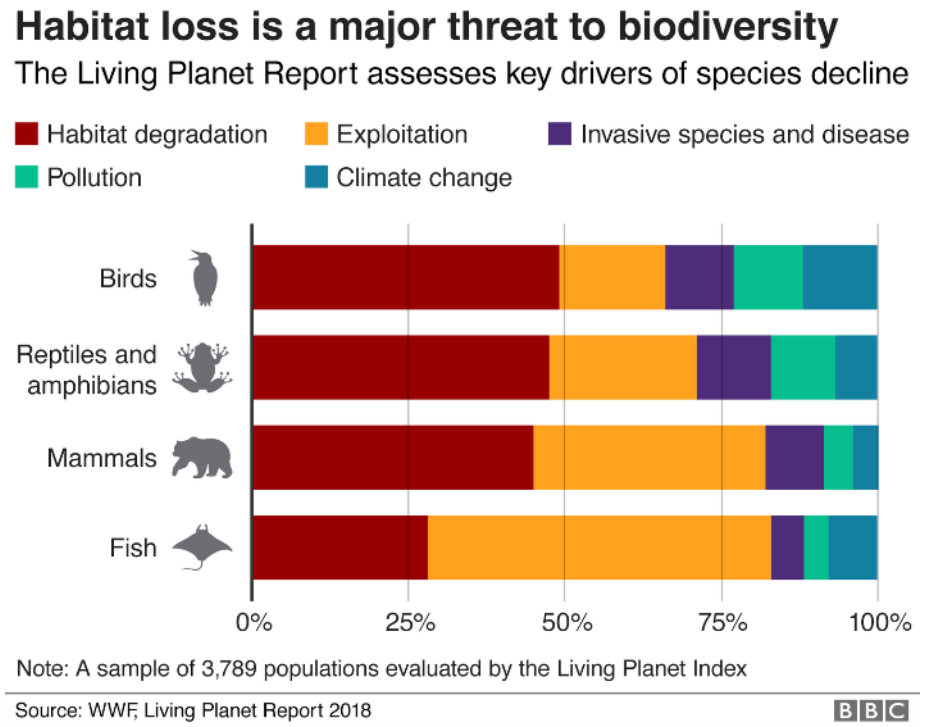
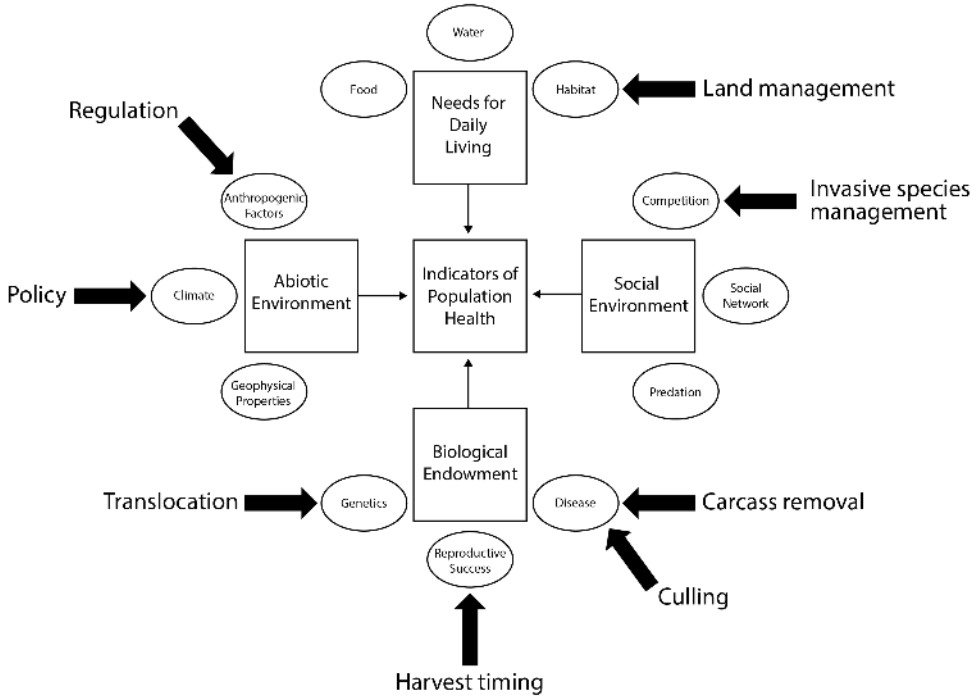
Disease in context

- Disease is one of many components affecting the health of wildlife
- Can we influence disease outcomes through other types of management?





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New approaches for wildlife disease management?

- Effective for mitigating the impacts of disease
- Assist with decision making in the face of complexity and uncertainty
- Find effective interventions that are acceptable to stakeholders
- Ultimately, disease management in wildlife involves managing humans and their behaviors!