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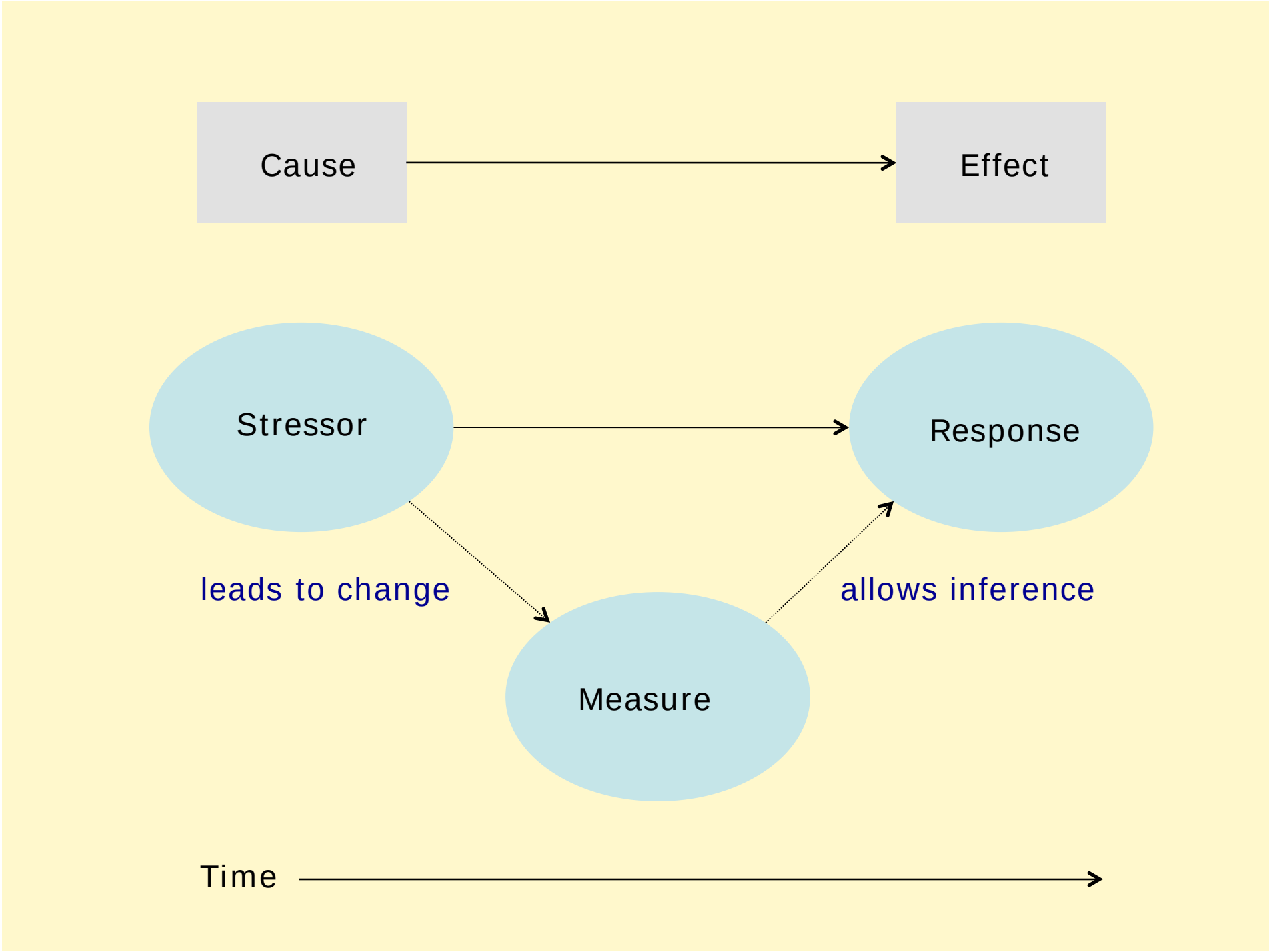
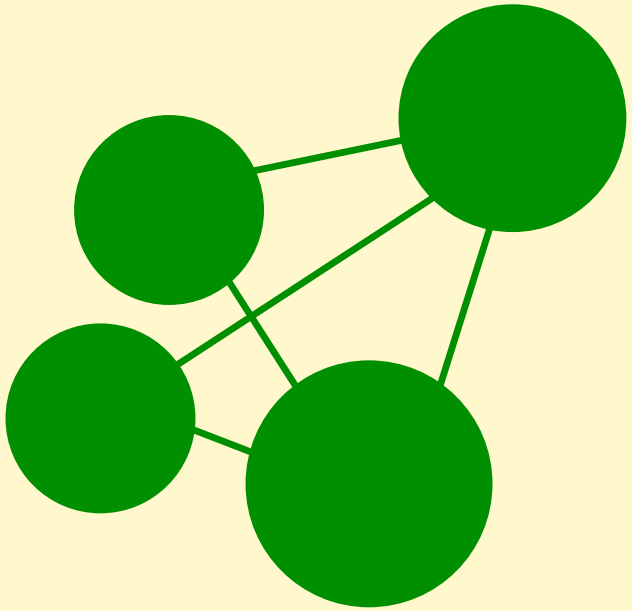
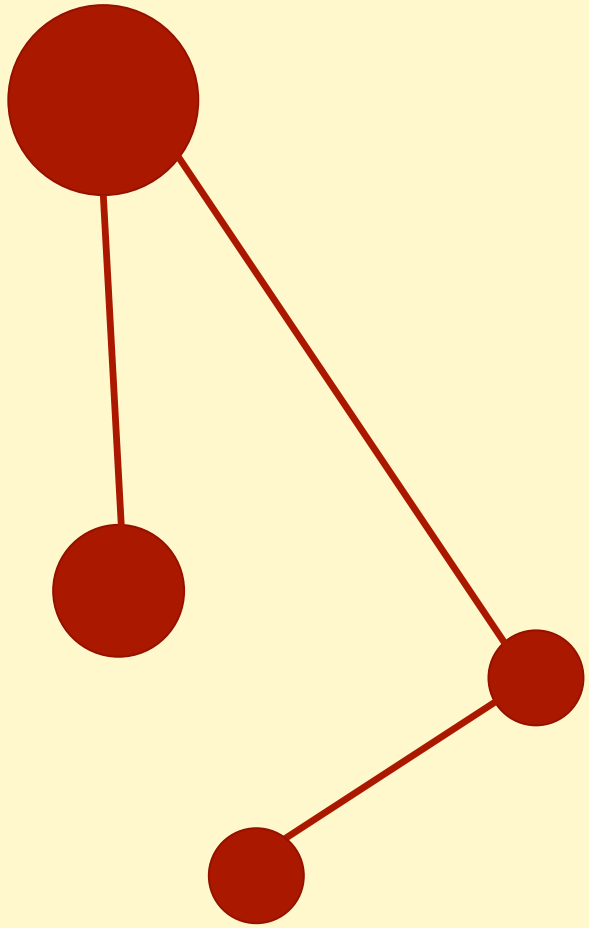

Cause
Effect
Stressor
Response
leads to change
allows inference
Measure
Time

Drivers of metapopulation dynamics





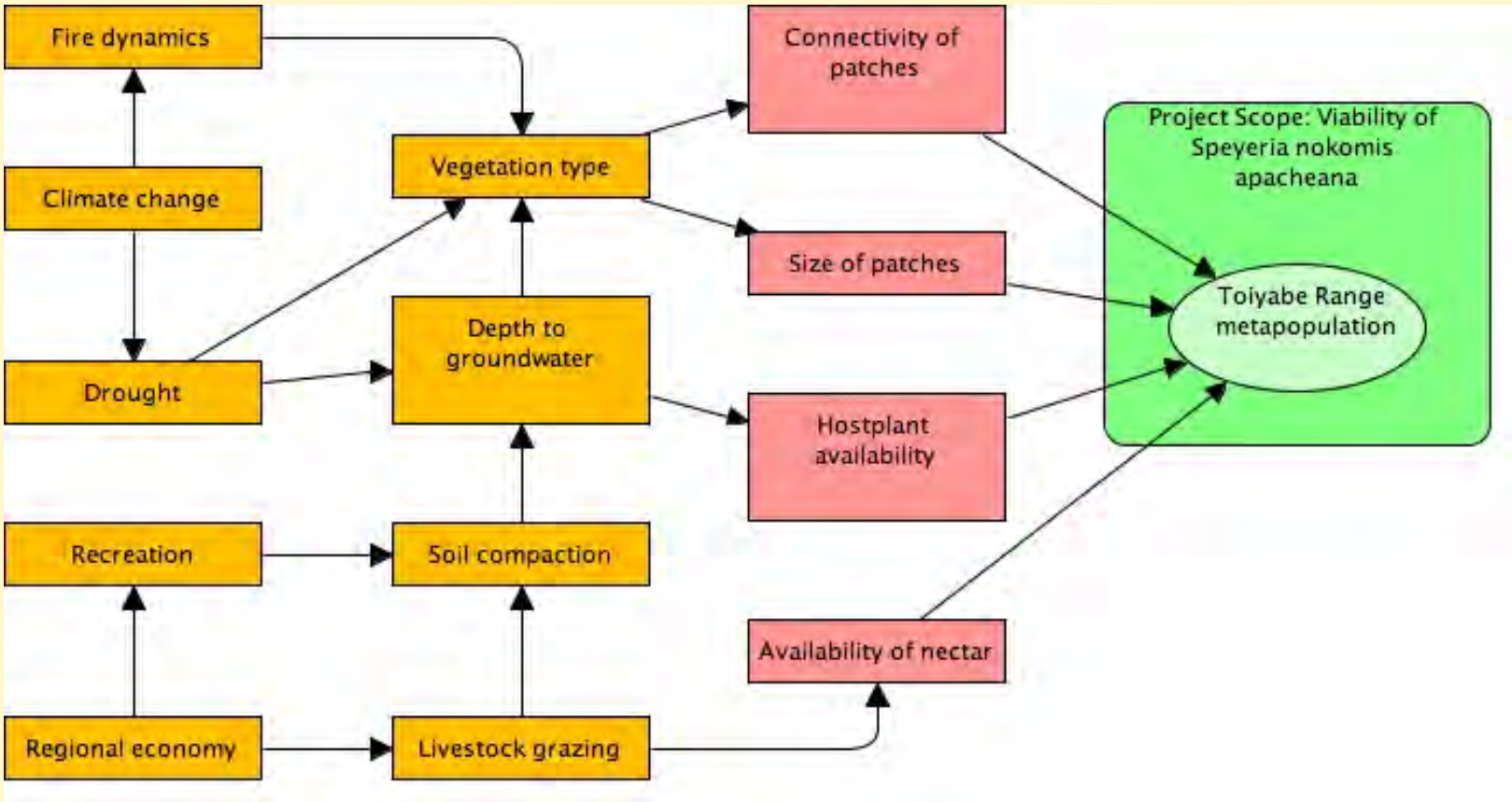
Area, isolation assumed to serve as surrogates for habitat quality

Speyeria nokomis apacheana

Arid, montane landscape

Isolated patches of habitat

Mark-recapture data


Fire dynamics
Climate change
Drought
Recreation
Regional economy
Vegetation type
Depth to groundwater
Soil compaction
Livestock grazing
Connectivity of patches
Size of patches
Hostplant availability
Availability of nectar
Project Scope: Viability of Speyeria nokomis apacheana
Toiyabe Range metapopulation

Patch geometry, vegetation

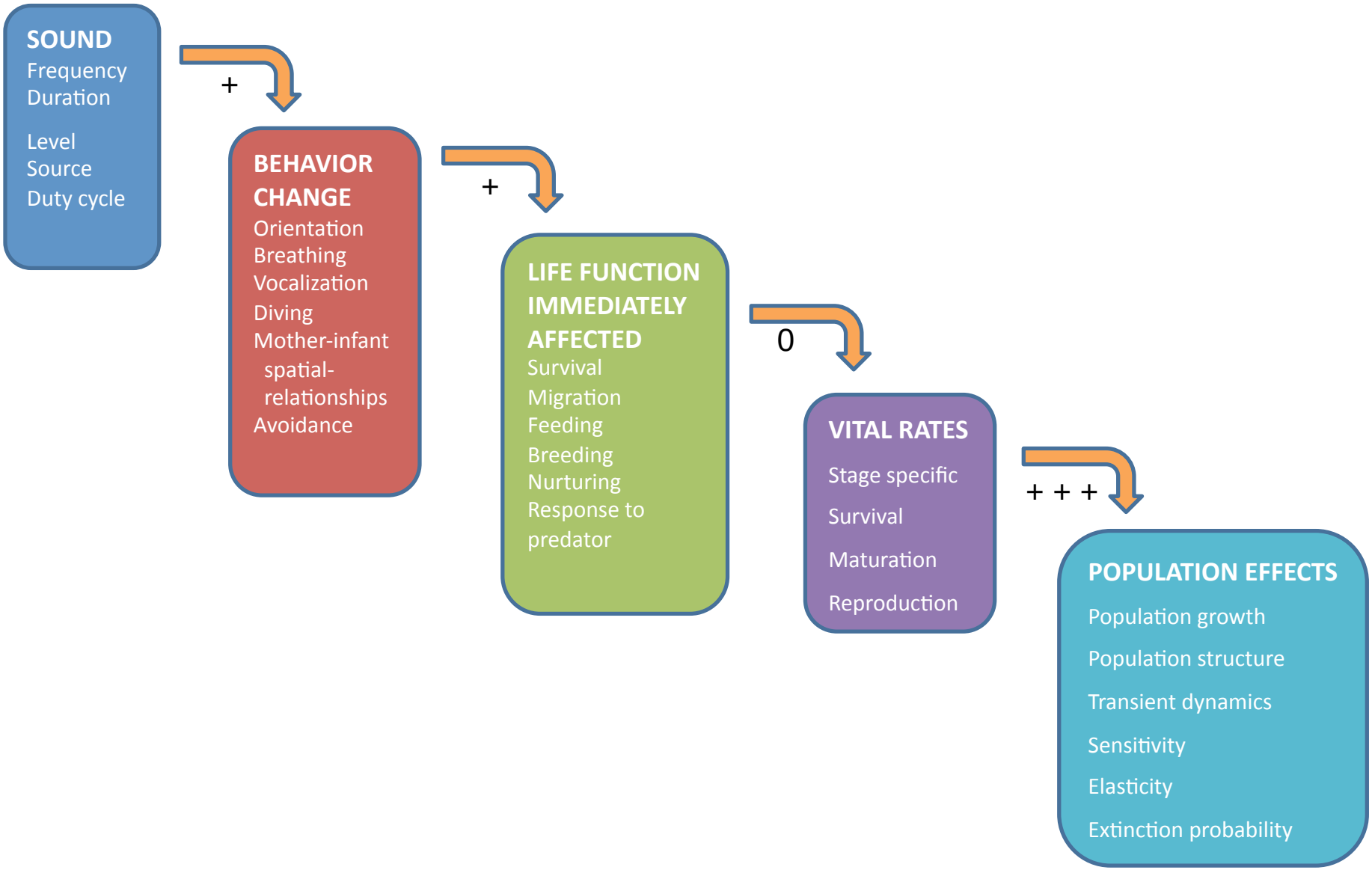
Direct drivers

Management interventions

- Delay grazing in wet meadows
- Minimize summer camping
- Restrict herbicide use in riparian areas

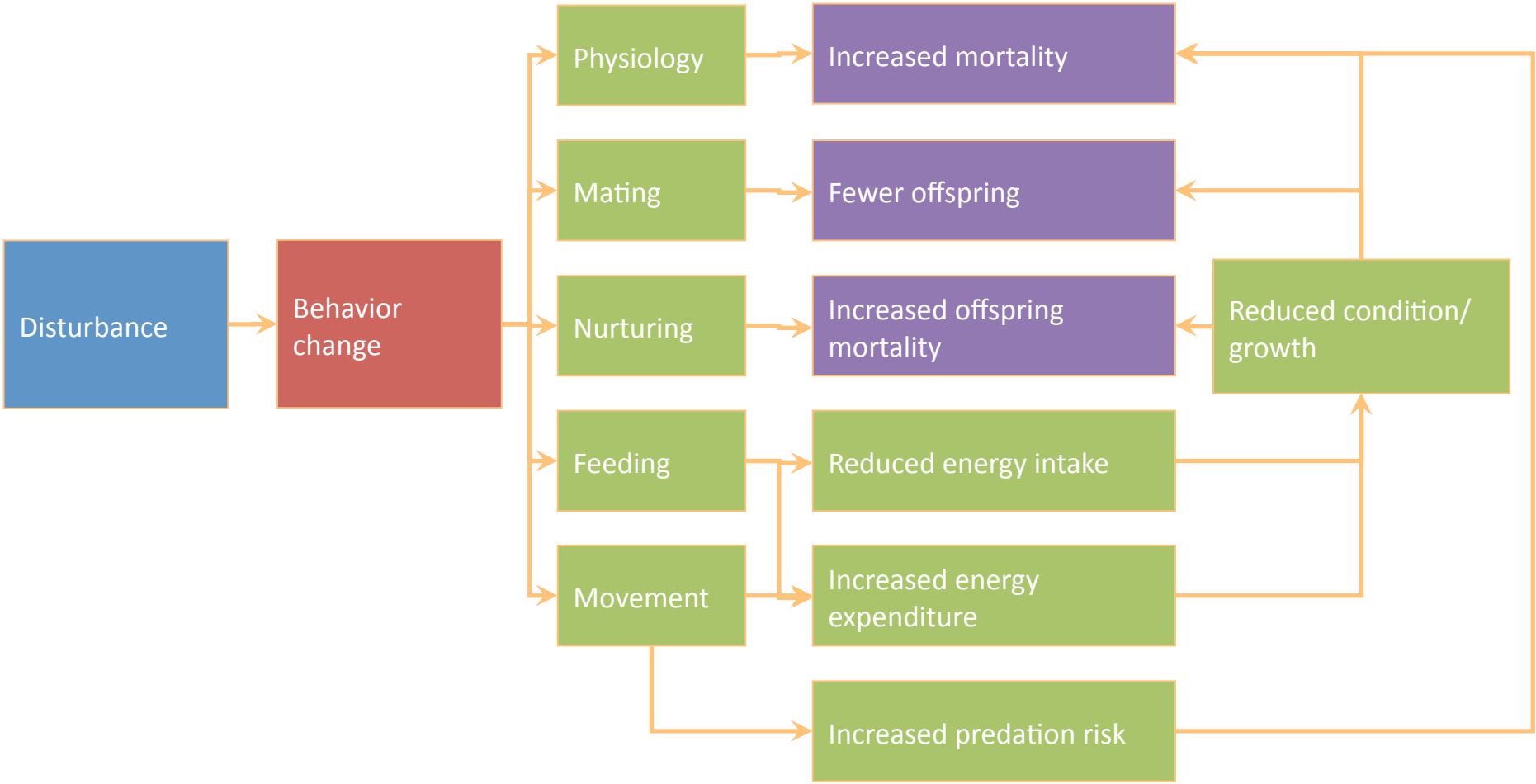
Population-level effects of disturbance on marine mammals

- No universally applicable algorithm for estimating population-level effects
- Types and strength of inference given different organisms, data types, quantitative methods


SOUND
Frequency
Duration
Level
Source
Duty cycle
+
BEHAVIOR CHANGE
Orientation
Breathing
Vocalization
Diving
Mother-infant spatial-relationships
Avoidance
+
LIFE FUNCTION IMMEDIATELY AFFECTED
Survival
Migration
Feeding
Breeding
Nurturing
Response to predator
0
VITAL RATES
Stage specific
Survival
Maturation
Reproduction
+ + +
POPULATION EFFECTS
Population growth
Population structure
Transient dynamics
Sensitivity
Elasticity
Extinction probability

Objective

Guidance for identifying, quantitatively estimating mechanisms by which population dynamics may respond to changes in baseline behavior of individuals

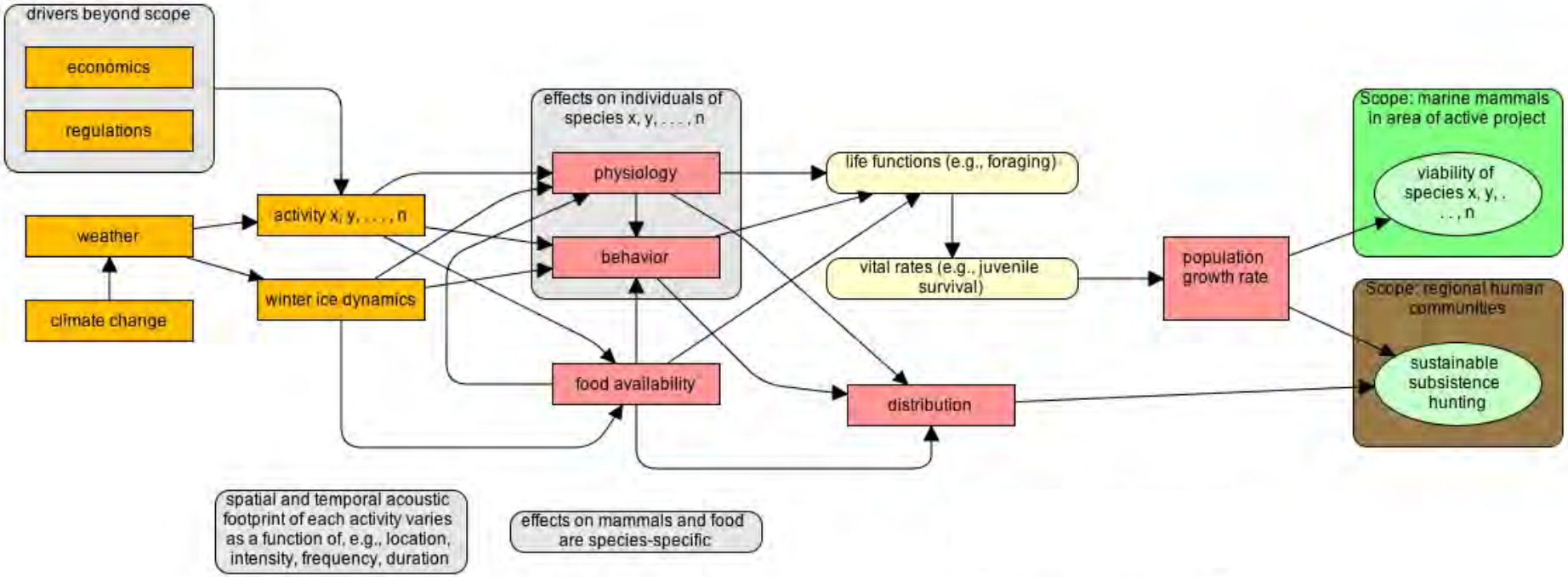

Disturbance
Behavior change
Physiology
Mating
Nurturing
Feeding
Movement
Increased mortality
Fewer offspring
Increased offspring mortality
Reduced energy intake
Increased energy expenditure
Increased predation risk
Reduced condition/ growth

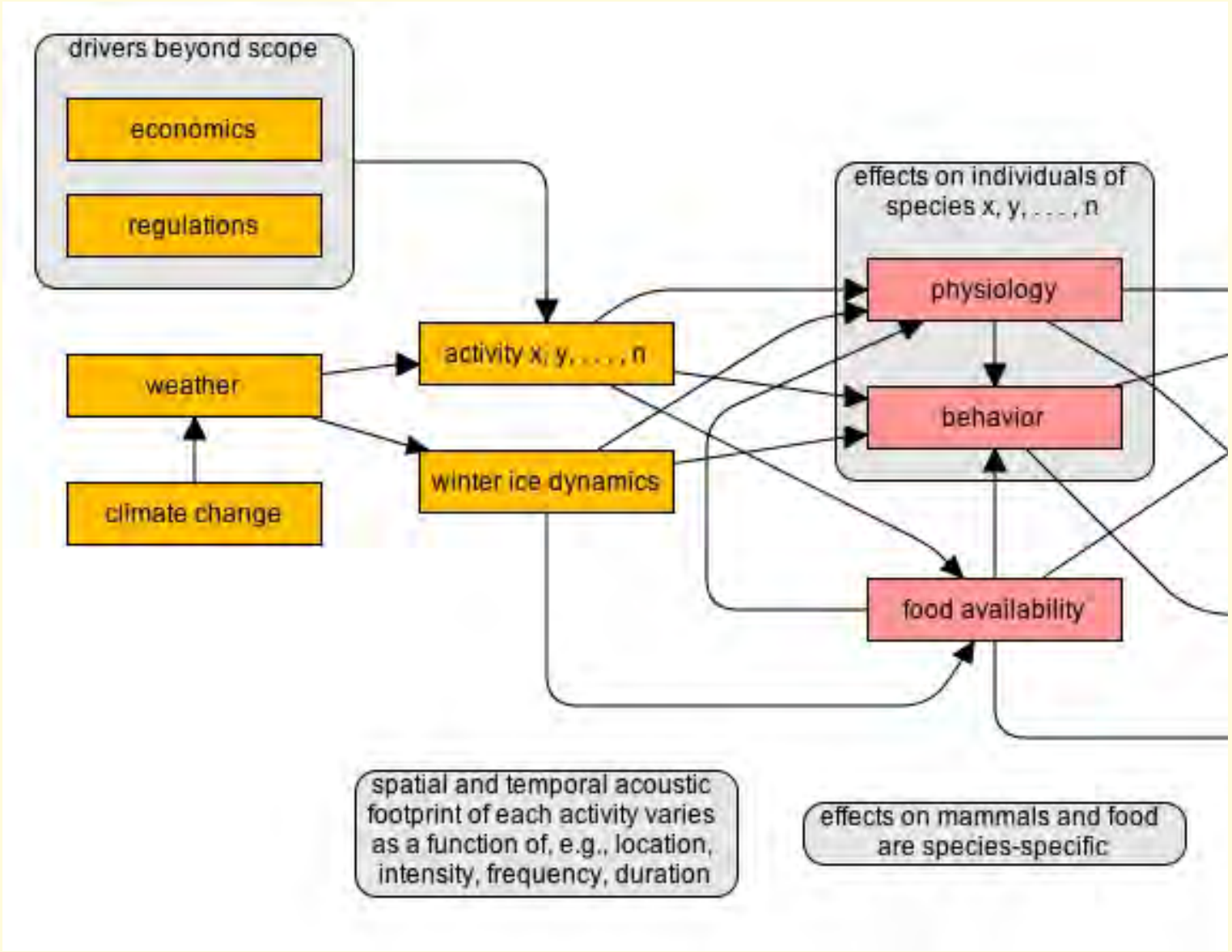
Illustrative steps

- Identify high-priority functional groups
- For each group, identify life functions known or assumed to have greatest effects on vital rates
- Identify measures of those life functions and methods of measurement
- Hypothesize how life functions respond to changes in behavior, highlight uncertainties
- Identify methods to test those hypotheses

Outcomes

- Classify taxonomic groups along gradient of feasibility of estimating individual and population-level effects of disturbance
- Identify needs for empirical data, quantitative or qualitative methods, technological advances
- Prioritize data collection, technology development, modeling in an objective, repeatable manner


drivers beyond scope
economics
regulations
weather
climate change
activity x, y, . . . , n
winter ice dynamics
effects on individuals of species x, y, . . . , n
physiology
behavior
food availability
life functions (e.g., foraging)
vital rates (e.g., juvenile survival)
population growth rate
distribution
Scope: marine mammals in area of active project
viability of species x, y, . . . , n
Scope: regional human communities
sustainable subsistence hunting
spatial and temporal acoustic footprint of each activity varies as a function of, e.g., location, intensity, frequency, duration
effects on mammals and food are species-specific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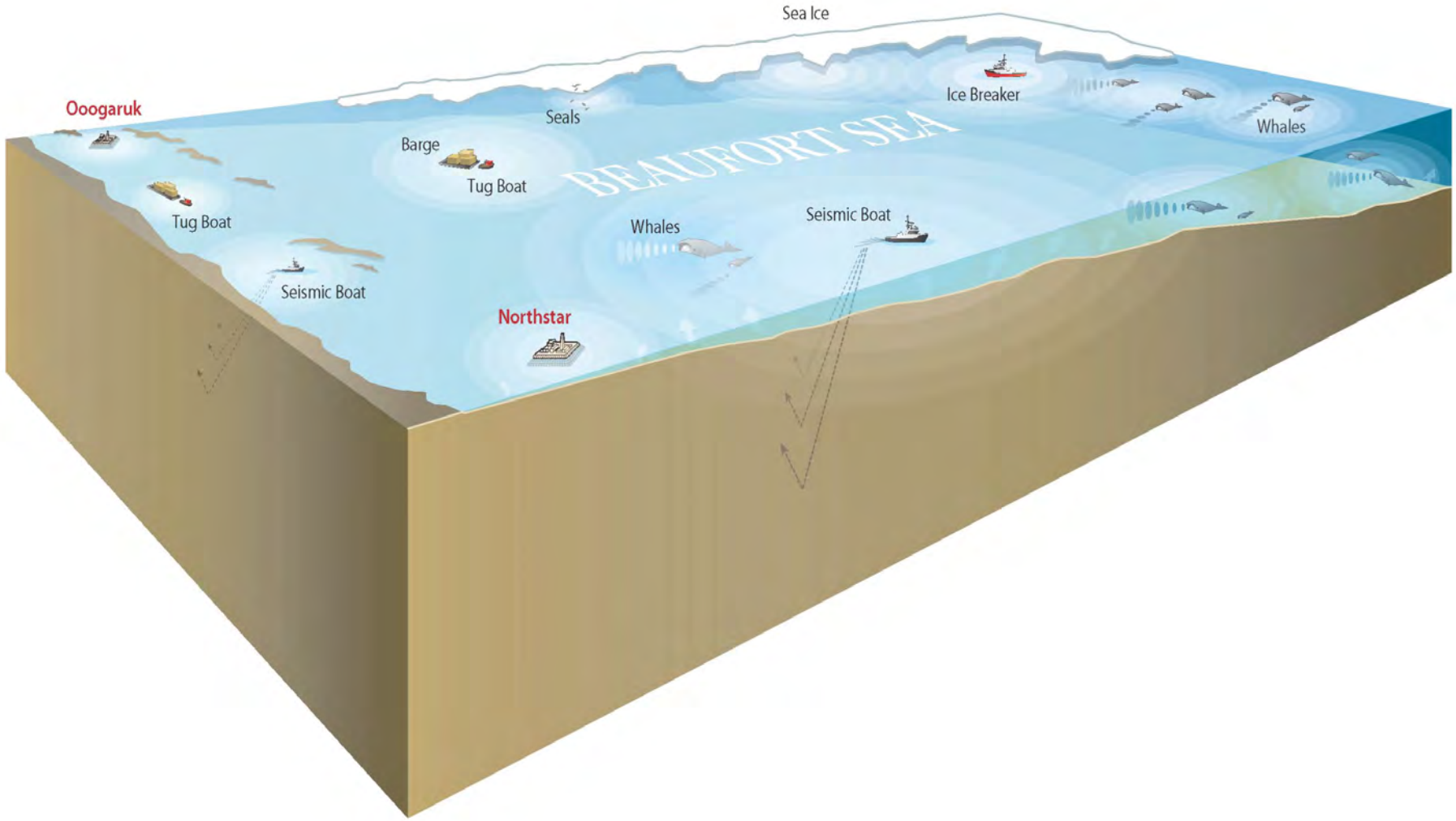
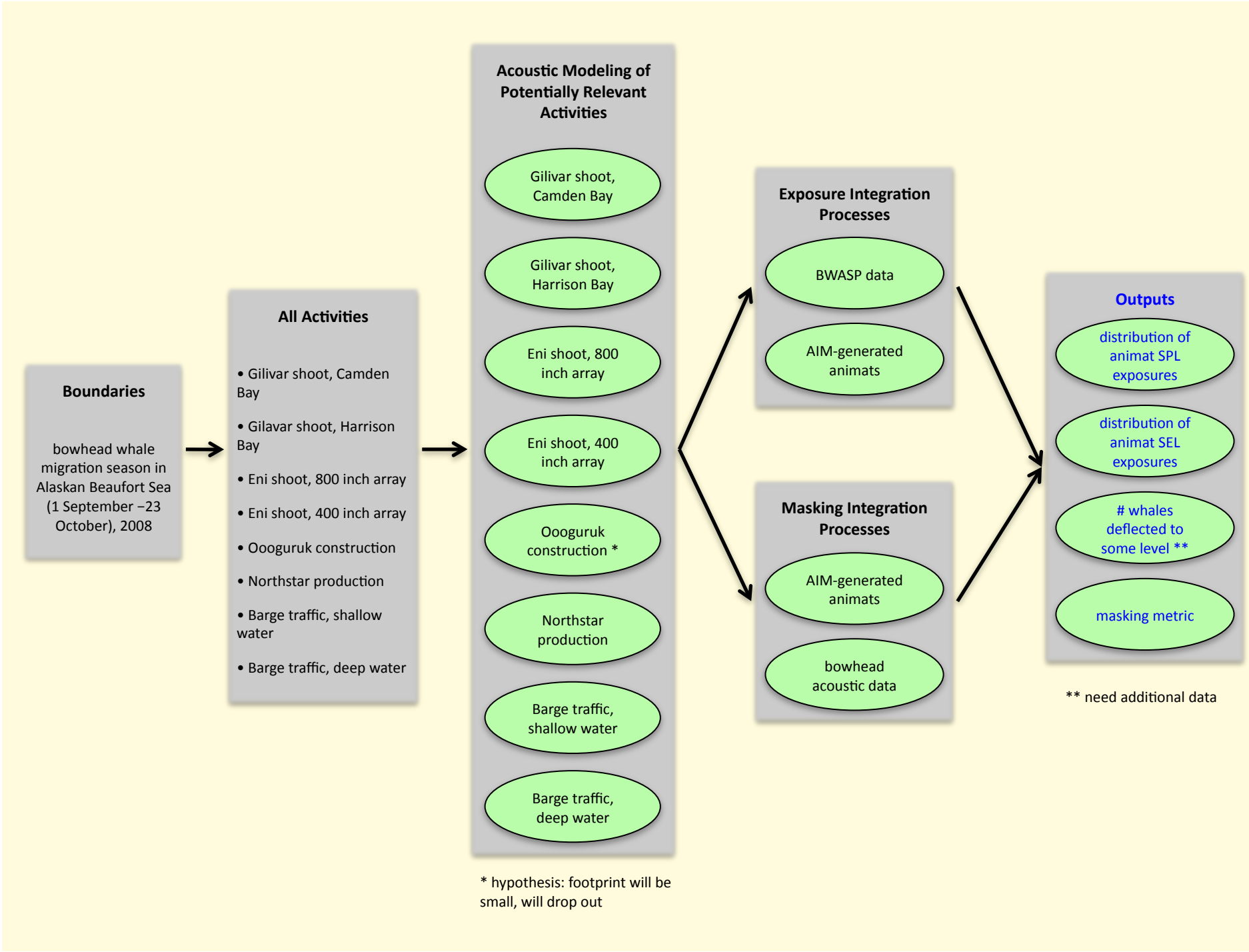
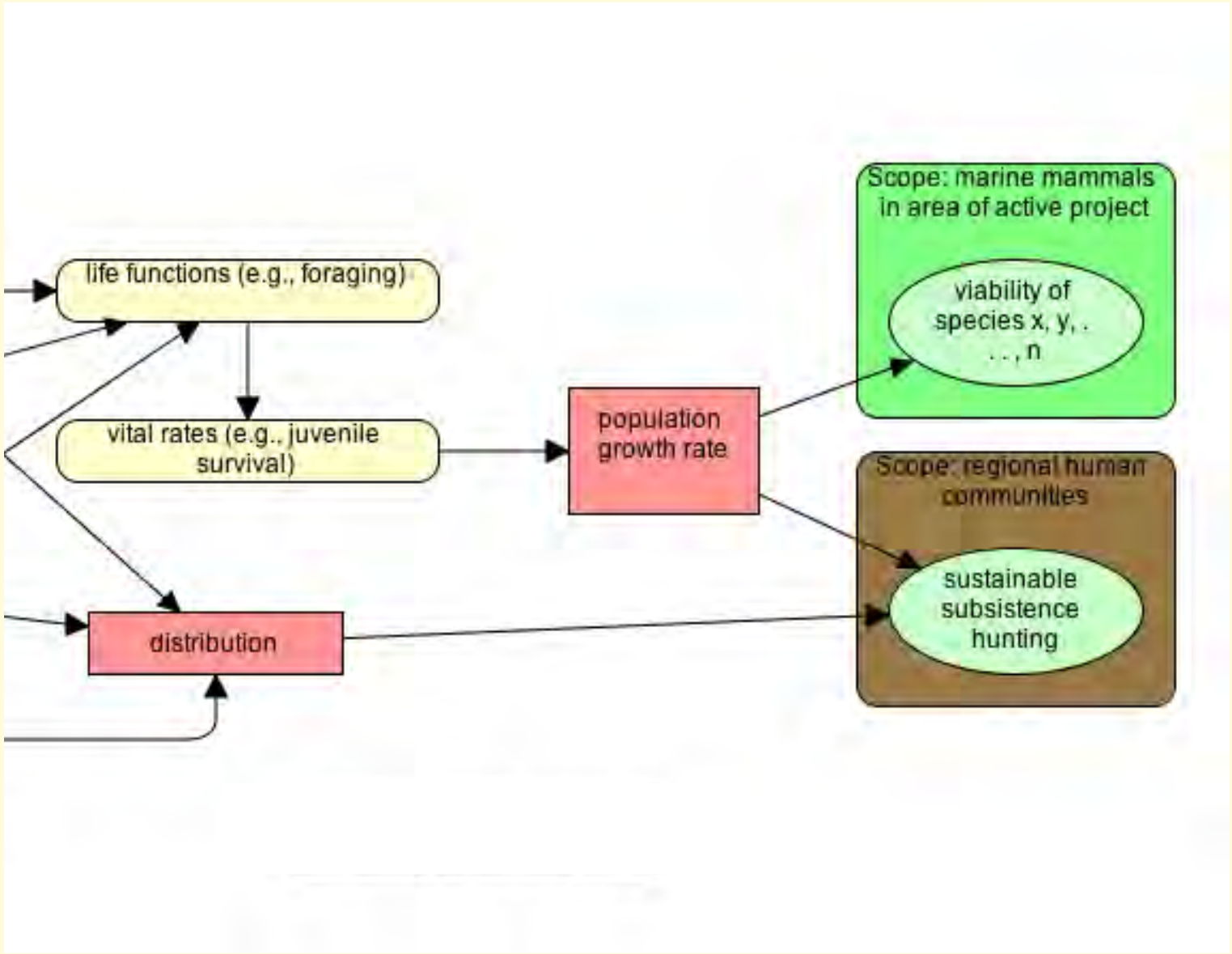
Cumulative effects of underwater sound




Boundaries
bowhead whale migration season in Alaskan Beaufort Sea (1 September –23 October), 2008
All Activities
• Gilivar shoot, Camden Bay
• Gilavar shoot, Harrison Bay
• Eni shoot, 800 inch array
• Eni shoot, 400 inch array
• Oooguruk construction
• Northstar production
• Barge traffic, shallow water
• Barge traffic, deep water
Acoustic Modeling of Potentially Relevant Activities
Gilivar shoot, Camden Bay
Gilivar shoot, Harrison Bay
Eni shoot, 800 inch array
Eni shoot, 400 inch array
Oooguruk construction *
Northstar production
Barge traffic, shallow water
Barge traffic, deep water
* hypothesis: footprint will be small, will drop out
Exposure Integration Processes
BWASP data
AIM-generated animats
Masking Integration Processes
AIM-generated animats
bowhead acoustic data
Outputs
distribution of animat SPL exposures
distribution of animat SEL exposures
whales deflected to some level **
masking metric
** need additional data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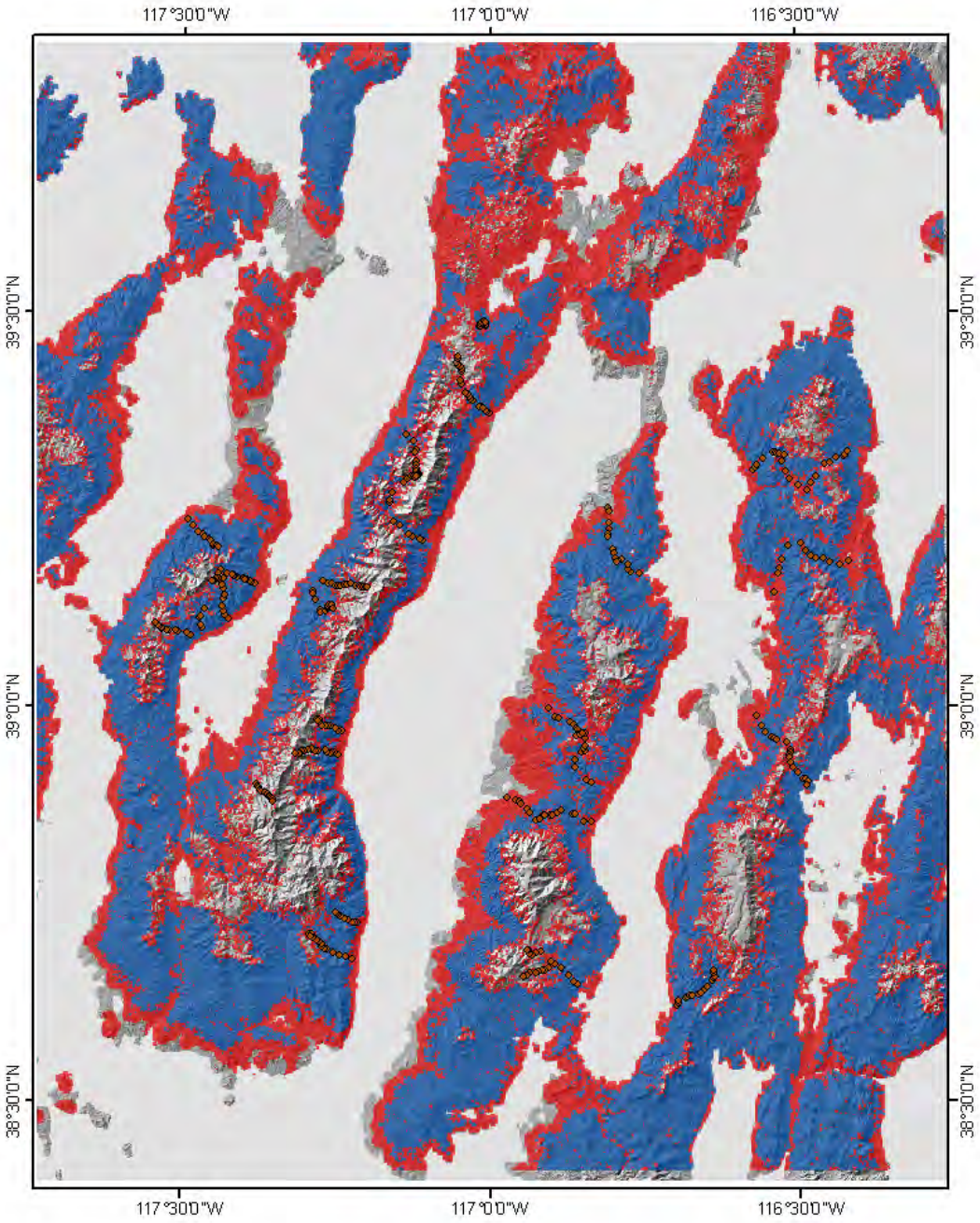
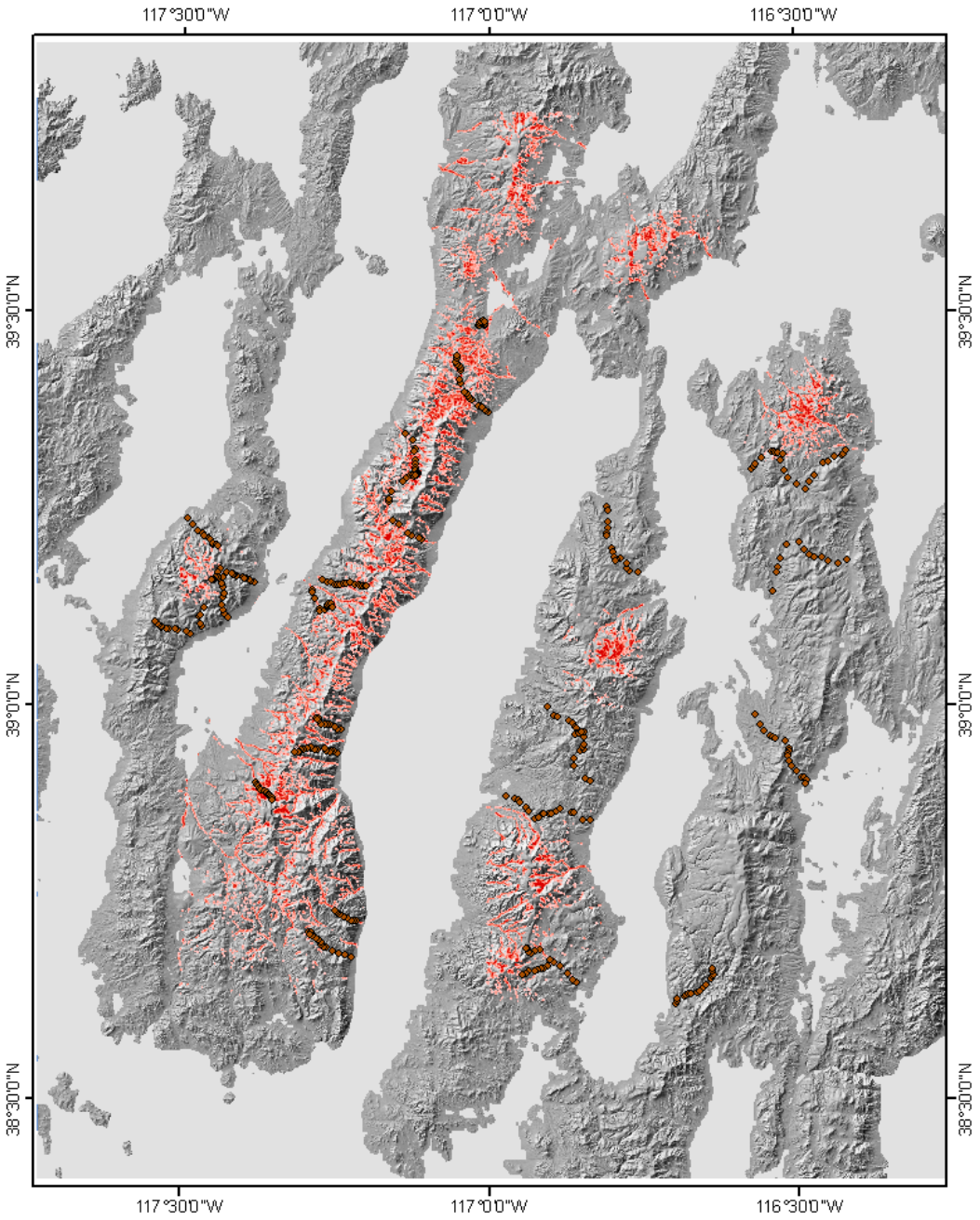
sustainable subsistence hunting

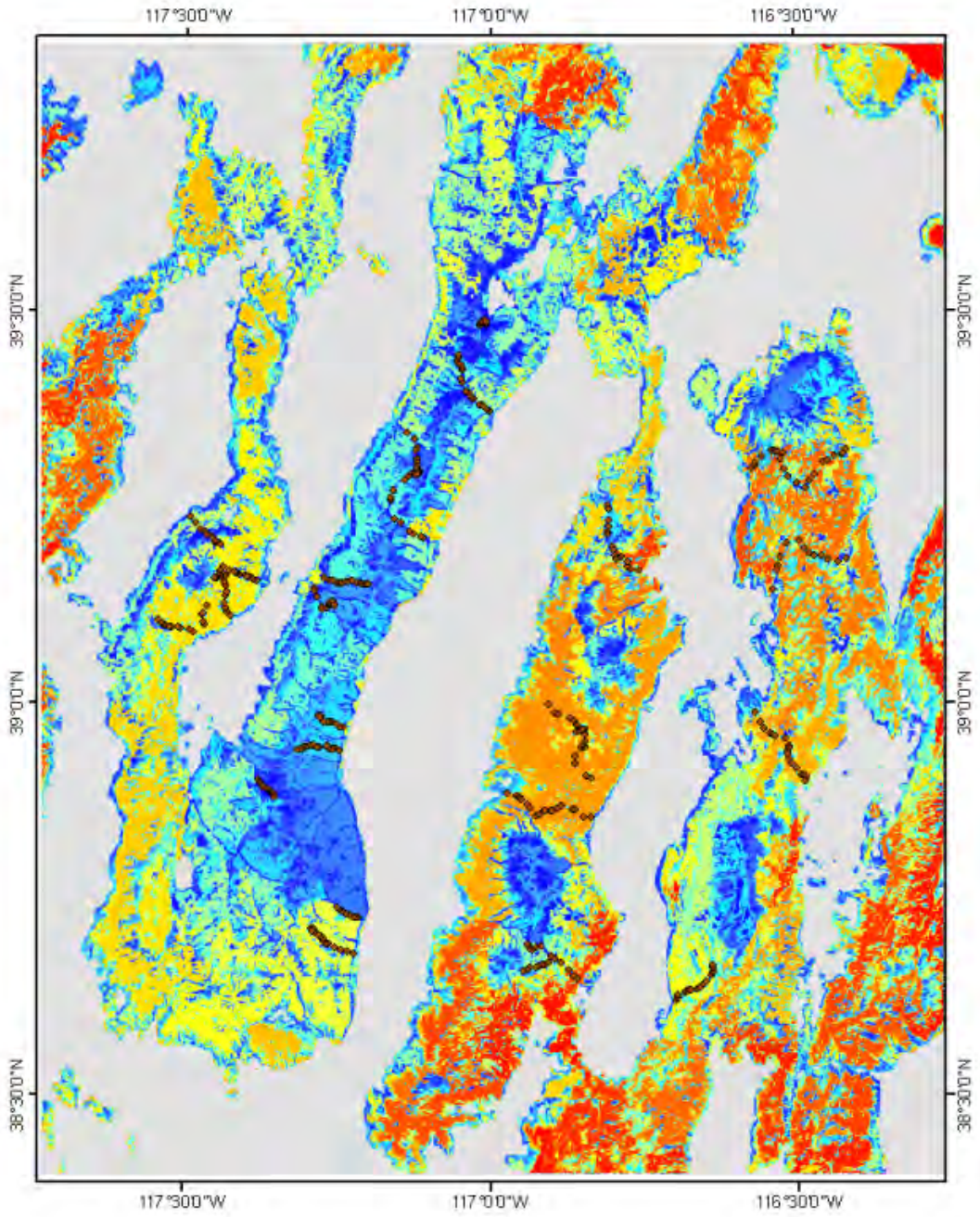


Scenario 1: expansion of pinyon-juniper woodlands by 2100

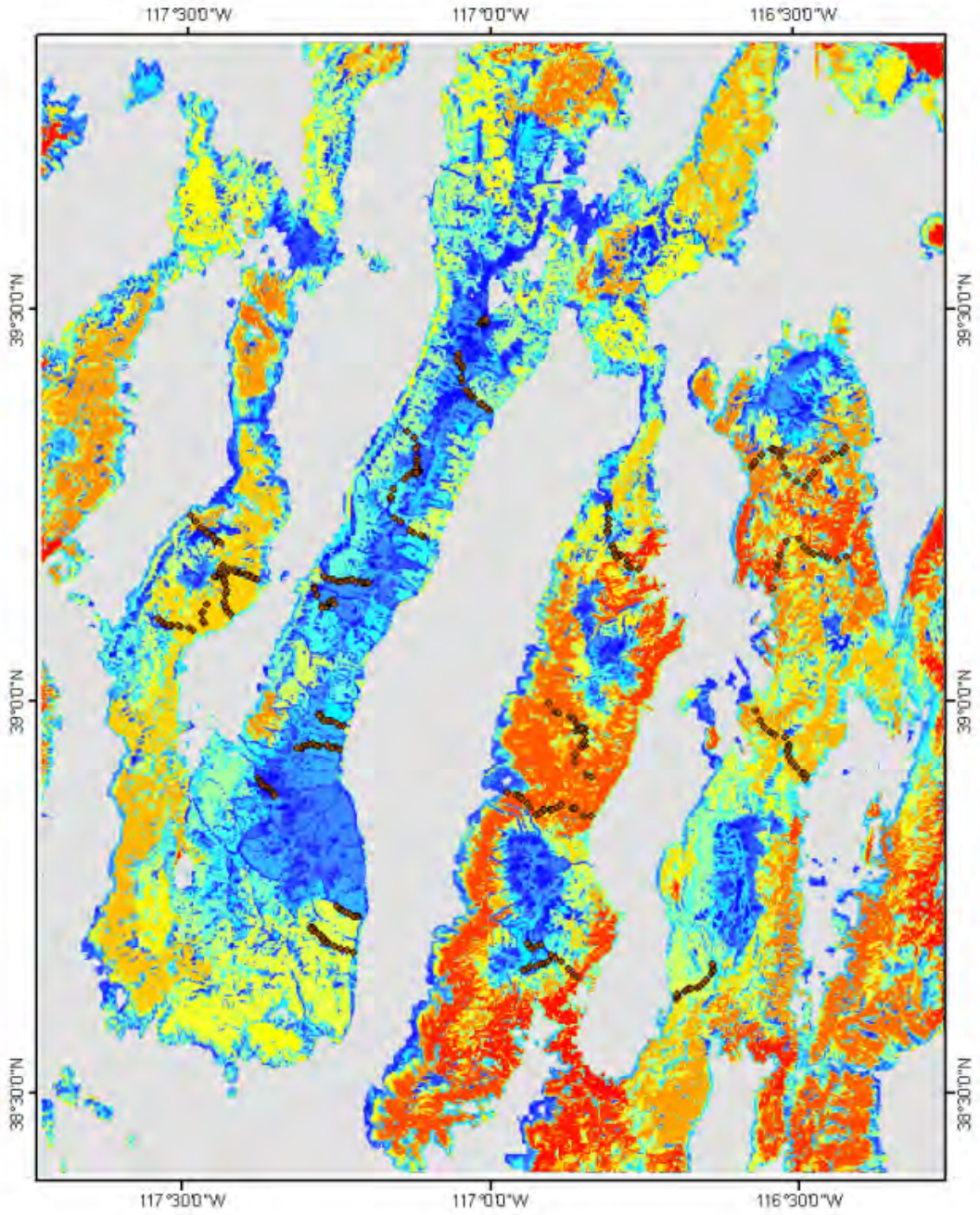


Scenario 2: contract extent of riparian cover by 10%

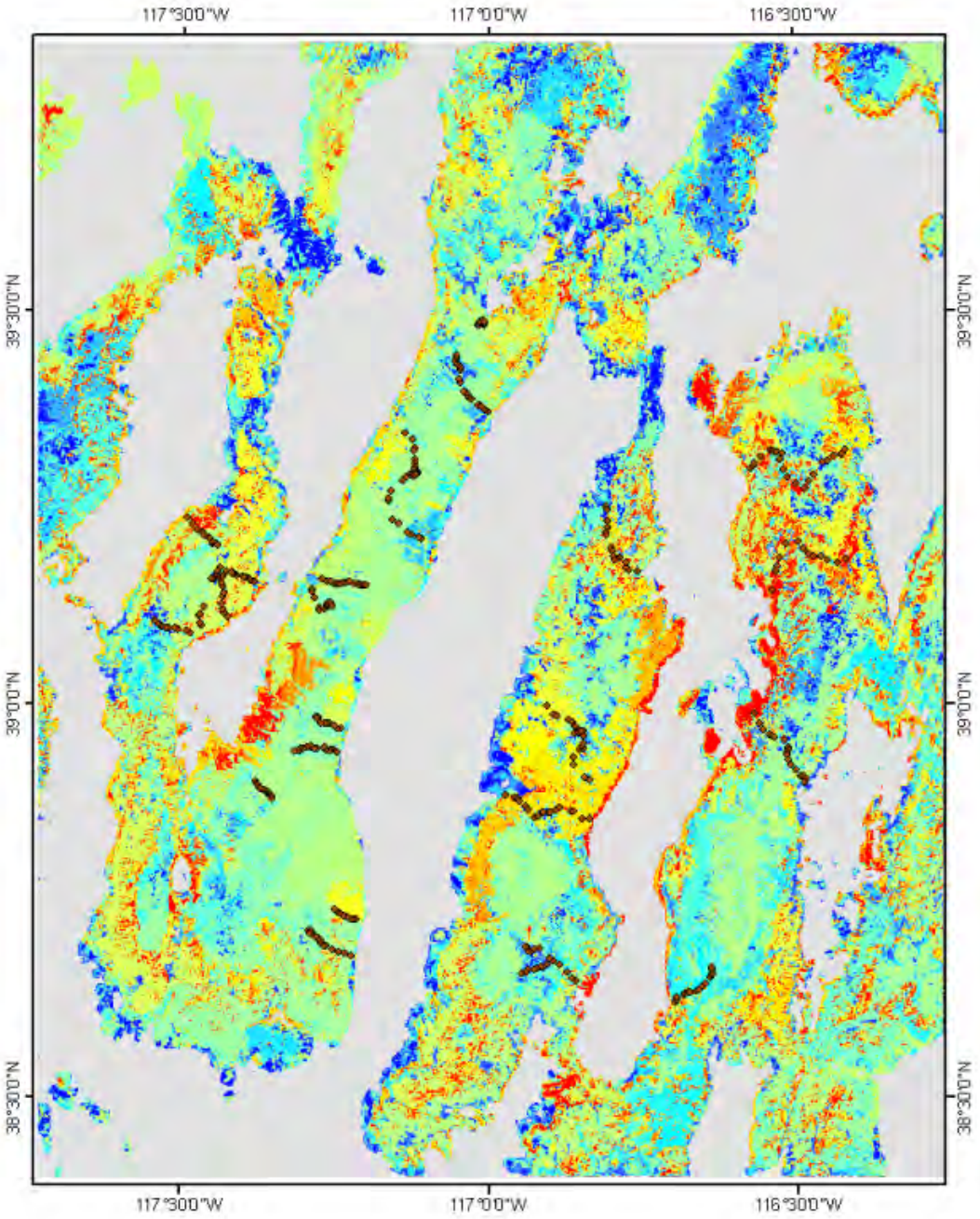
Color intensity proportional to percent cover lost



Structural connectivity: static features of habitat that are associated with occupancy



Future probabilities of occurrence if pinyon-juniper woodlands expand as projected



Changes in probabilities of occurrence (blue = increase, red = decrease)

Can intervention influence the outcome?