Idaho EPSCoR Annual Meeting 2020

GEM3 Research Accomplishments

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GEM3
Genes by Environment
Modeling · Mechanisms · Mapping

Research Accomplishments:

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Genes by Environment
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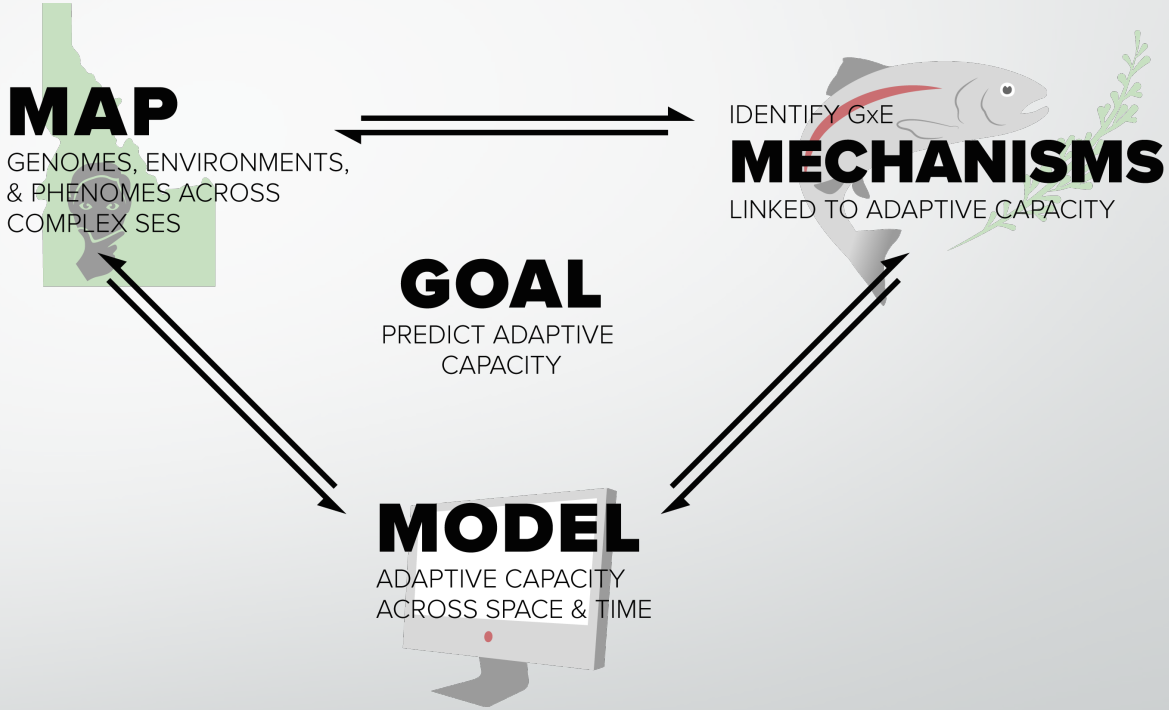
Research Accomplishments:

GEM3 Goal

Enable the research community to understand the factors for, and forecast the outcomes of, how genetic diversity and phenotypic plasticity affect response to environmental change, shaping both population response and adaptive capacity.



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GEM3 Genes by Environment Modeling · Mechanisms · Mapping

Research Accomplishments: Year 2 Reverse Site Visit

RSV Panel Recommendation:

Integration was identified as critical to the project's success. The project would benefit from clear planning and the identification of key areas:

- 1a - **Sagebrush Physiology/Genomics Integration**
- 1b - **Trout and Sagebrush Integration**
- 1c - **Genomics of Trout and Sagebrush**
- 1d - **Omics data and Modeling**

Integration Frameworks

30,000 ft

What is the adaptive capacity of landscapes and organisms as environmental conditions change in scope and intensity?

We can address:
To What?
For Whom?
At what Scale?
For what Purpose?

Coordinate with agency research partners and stakeholders

Organismal-based research across institutions using working group model:

Evolution/Genes

Phenotypes

Processes demography/ dispersal

Landscape/SES

Task: identify key processes, data gaps, available data to address the BIG GEM3 Questions:
(Identify model inputs from basic research to build predictive model using alternative scenarios)

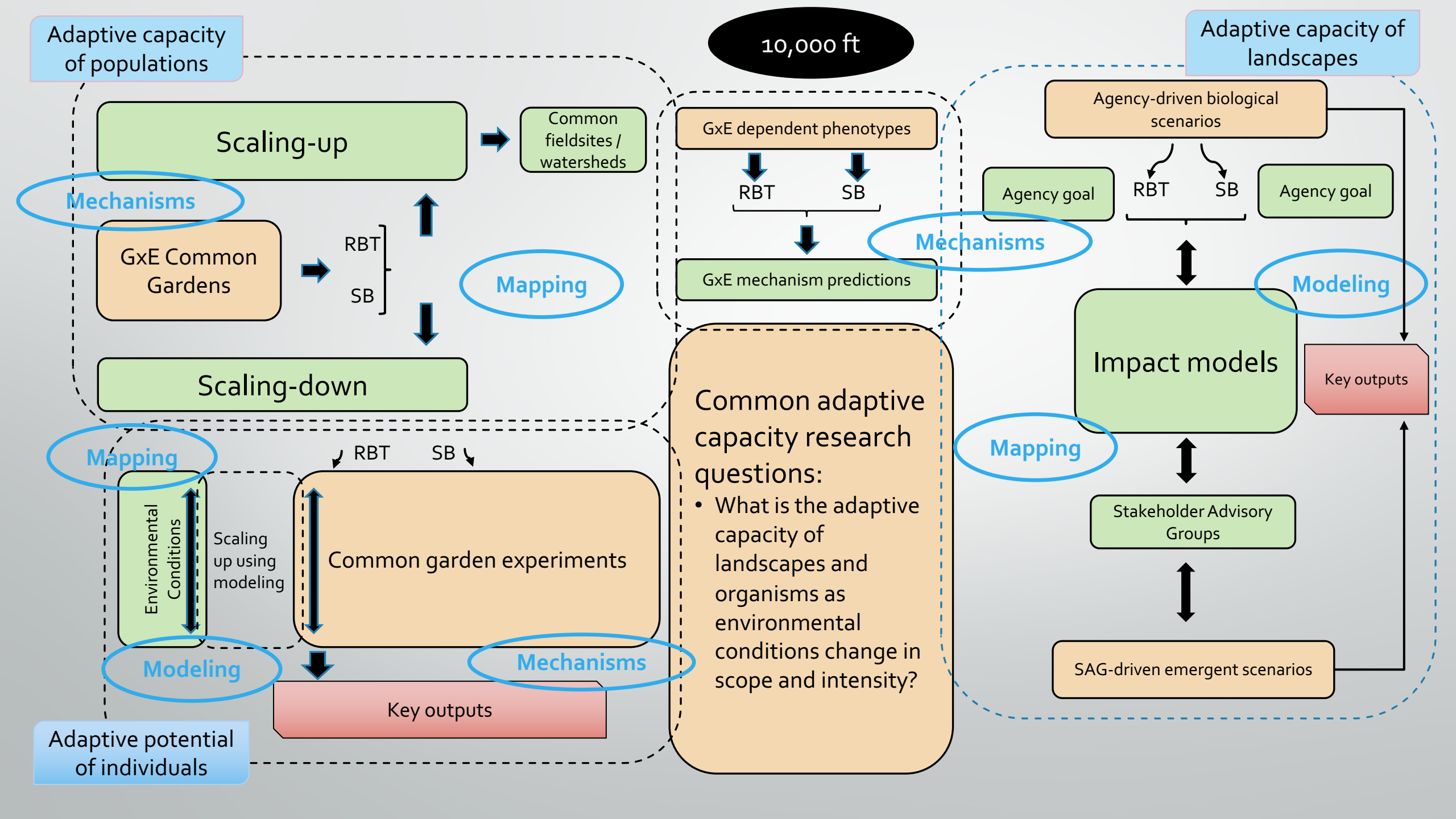
How does adaptive capacity vary across landscape axes/gradients?
How does landscape change influence organismal adaptive capacity?
What organismal population attributes predict adaptive capacity across landscape gradients?

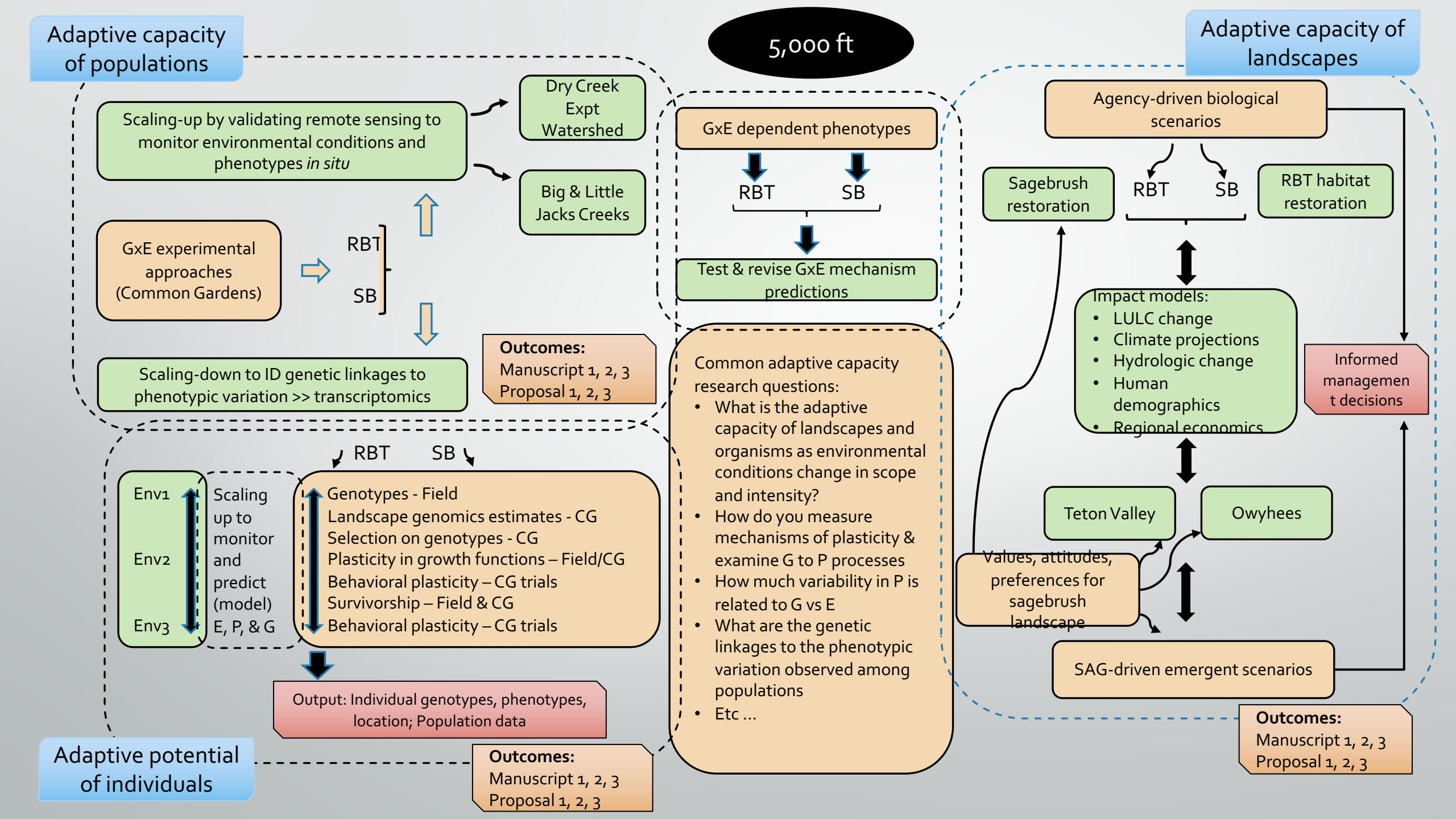
Use SB and RBT as model organisms;
Example priority areas of inquiry – To what? For whom? At what scale? For what purpose? :

Develop models for adaptive capacity genome-phenome

Do organismal demographic, physiological, ecological, population attributes predict AC across landscapes?

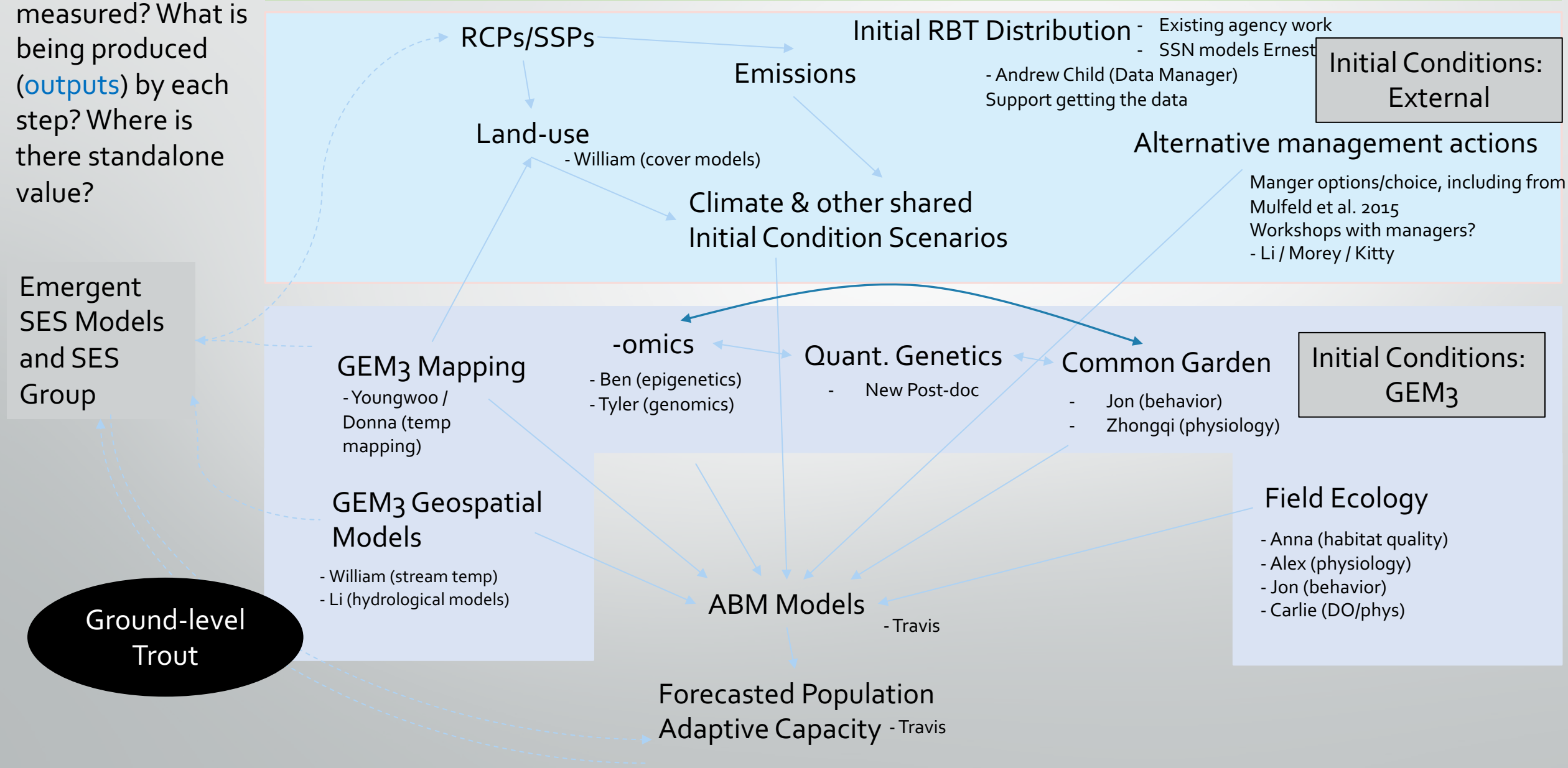
Landscape/SES historical distribution data, new research topics


Adaptive capacity of populations
10,000 ft
Adaptive capacity of landscapes
Scaling-up
Common fieldsites / watersheds
Mechanisms
GxE Common Gardens
RBT
SB
Mapping
Scaling-down
GxE dependent phenotypes
RBT
SB
GxE mechanism predictions
Mechanisms
Agency-driven biological scenarios
Agency goal
RBT
SB
Agency goal
Modeling
Impact models
Key outputs
Mapping
Stakeholder Advisory Groups
SAG-driven emergent scenarios
Mapping
RBT
SB
Environmental Conditions
Scaling up using modeling
Common garden experiments
Modeling
Mechanisms
Key outputs
Common adaptive capacity research questions:
• What is the adaptive capacity of landscapes and organisms as environmental conditions change in scope and intensity?
Adaptive potential of individuals


Adaptive capacity of populations
5,000 ft
Adaptive capacity of landscapes
Scaling-up by validating remote sensing to monitor environmental conditions and phenotypes *in situ*
Dry Creek Expt Watershed
Big & Little Jacks Creeks
GxE experimental approaches (Common Gardens)
RBT
SB
Scaling-down to ID genetic linkages to phenotypic variation >> transcriptomics
Outcomes:
Manuscript 1, 2, 3
Proposal 1, 2, 3
GxE dependent phenotypes
RBT
SB
Test & revise GxE mechanism predictions
Common adaptive capacity research questions:
• What is the adaptive capacity of landscapes and organisms as environmental conditions change in scope and intensity?
• How do you measure mechanisms of plasticity & examine G to P processes
• How much variability in P is related to G vs E
• What are the genetic linkages to the phenotypic variation observed among populations
• Etc …
Agency-driven biological scenarios
Sagebrush restoration
RBT
SB
RBT habitat restoration
Impact models:
• LULC change
• Climate projections
• Hydrologic change
• Human demographics
• Regional economics
Informed management decisions
Teton Valley
Owyhees
Values, attitudes, preferences for sagebrush landscape
SAG-driven emergent scenarios
Outcomes:
Manuscript 1, 2, 3
Proposal 1, 2, 3
RBT
SB
Env1
Env2
Env3
Scaling up to monitor and predict (model) E, P, & G
Genotypes - Field
Landscape genomics estimates - CG
Selection on genotypes - CG
Plasticity in growth functions – Field/CG
Behavioral plasticity – CG trials
Survivorship – Field & CG
Behavioral plasticity – CG trials
Output: Individual genotypes, phenotypes, location; Population data
Adaptive potential of individuals
Outcomes:
Manuscript 1, 2, 3
Proposal 1, 2, 3

Discussion Going Forward: What variables measured? What is being produced (outputs) by each step? Where is there standalone value?

How does Redband Trout adaptive capacity vary across landscape axes/gradients?
How does landscape change influence Redband Trout adaptive capacity?
What Redband Trout population attributes predict adaptive capacity across landscape gradients?



Discussion Going Forward: What variables measured? What is being produced (outputs) by each step? Where is there standalone value?

How does Sagebrush (SB) adaptive capacity vary across landscape axes/gradients?
How does landscape change influence Sagebrush adaptive capacity?
What Sagebrush population attributes predict adaptive capacity across landscape gradients?

RCPs/SSPs

Initial SB Distribution
- Climate-smart Restoration Tool
- LANDFIRE, GAP, Other

Emissions
- Andrew Child (Data Manager) Support getting the data

Initial Conditions: External

Land-use
- William? (cover models)

Alternative management actions
Manager options/choice, including from Mulfeld et al. 2015
Workshops with managers?
- Li / Morey / Kitty

Climate & other shared Initial Condition Scenarios
https://cfcg.forestry.ubc.ca/projects/climate-data/climatebcwna/
https://adaptwest.databasin.org/pages/adaptwest-climatena

Emergent SES Models and SES Group

GEM3 Mapping
- Youngwoo / Donna (temp mapping)

-omics
- Sven/Anthony (whole genome)
- Leonora (metagenome)
- Lucas (landscape genomics)
- Leonora/Jen F/Kathryn/Molly (associated genomes: GxG)

Quant. Genetics
- Kathryn (herbarium)

Greenhouse-Common Garden
- Sven (clones)
- Keith/Jen (physiology/chemistry)
- Trevor/Peter/Donna (demographics)
- Molly (extended phenotypes)

Initial Conditions: GEM3

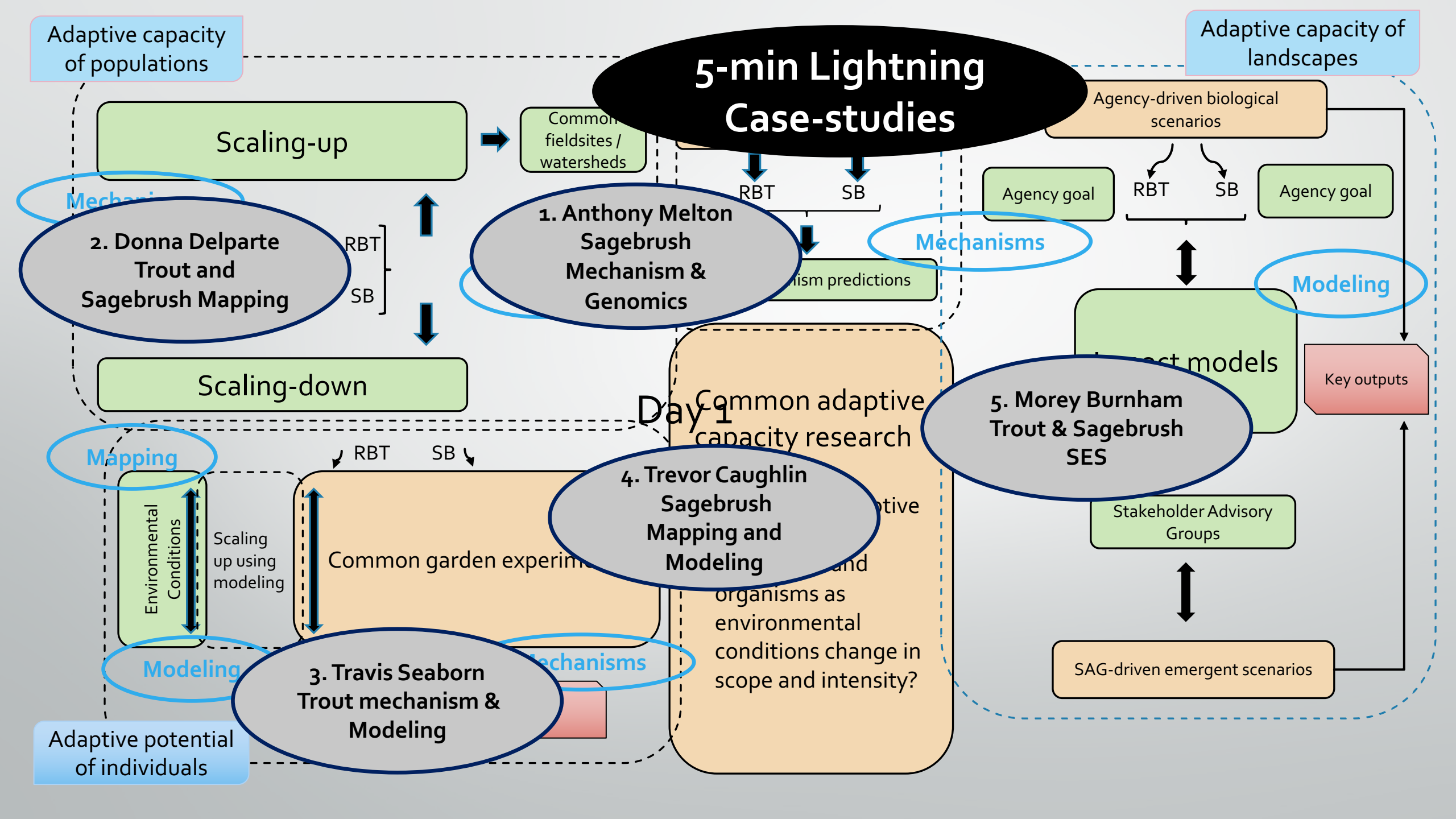
GEM3 Geospatial Models
- Megan (fires)
- Li (hydrological models)

Field Ecology
- Donna/Megan (habitats)
- Marie-Anne /Allison (soils)
- Keith/Jen (physiology/chemistry)
- Donna/Megan? (phenology)
- Trevor/Peter (demographics)
- Leonora/Jacob/Molly/Kathryn/Jen F/Jen C (extended phenotypes/communities: microbes, plants, herbivores, predators, people)

Ground-level Sagebrush

ABM Models
- Trevor/Stephanie/Julie

Forecasted Population Adaptive Capacity - Trevor


Adaptive capacity of populations
5-min Lightning Case-studies
Adaptive capacity of landscapes
Scaling-up
Common fieldsites / watersheds
Agency-driven biological scenarios
RBT
SB
Agency goal
Agency goal
Mechanisms
2. Donna Delparte Trout and Sagebrush Mapping
RBT
SB
1. Anthony Melton Sagebrush Mechanism & Genomics
Modeling
Scaling-down
Day 1
Common adaptive capacity research
5. Morey Burnham Trout & Sagebrush SES
Key outputs
Mapping
RBT
SB
4. Trevor Caughlin Sagebrush Mapping and Modeling
Environmental Conditions
Scaling up using modeling
Common garden experim
organisms as environmental conditions change in scope and intensity?
Stakeholder Advisory Groups
Modeling
3. Travis Seaborn Trout mechanism & Modeling
SAG-driven emergent scenarios
Adaptive potential of individuals