What does restoration success look like?

What are we restoring?

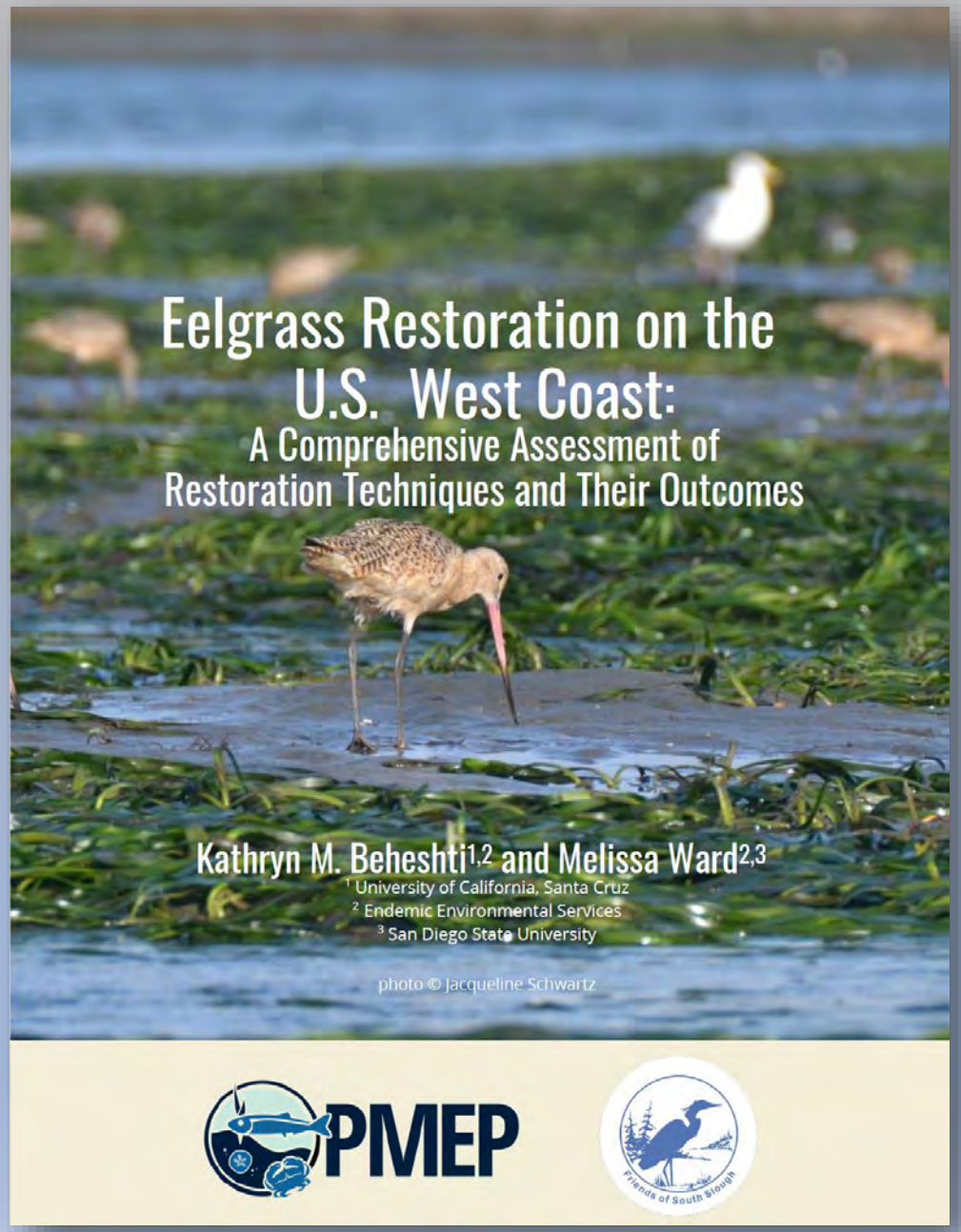
What are we restoring to?

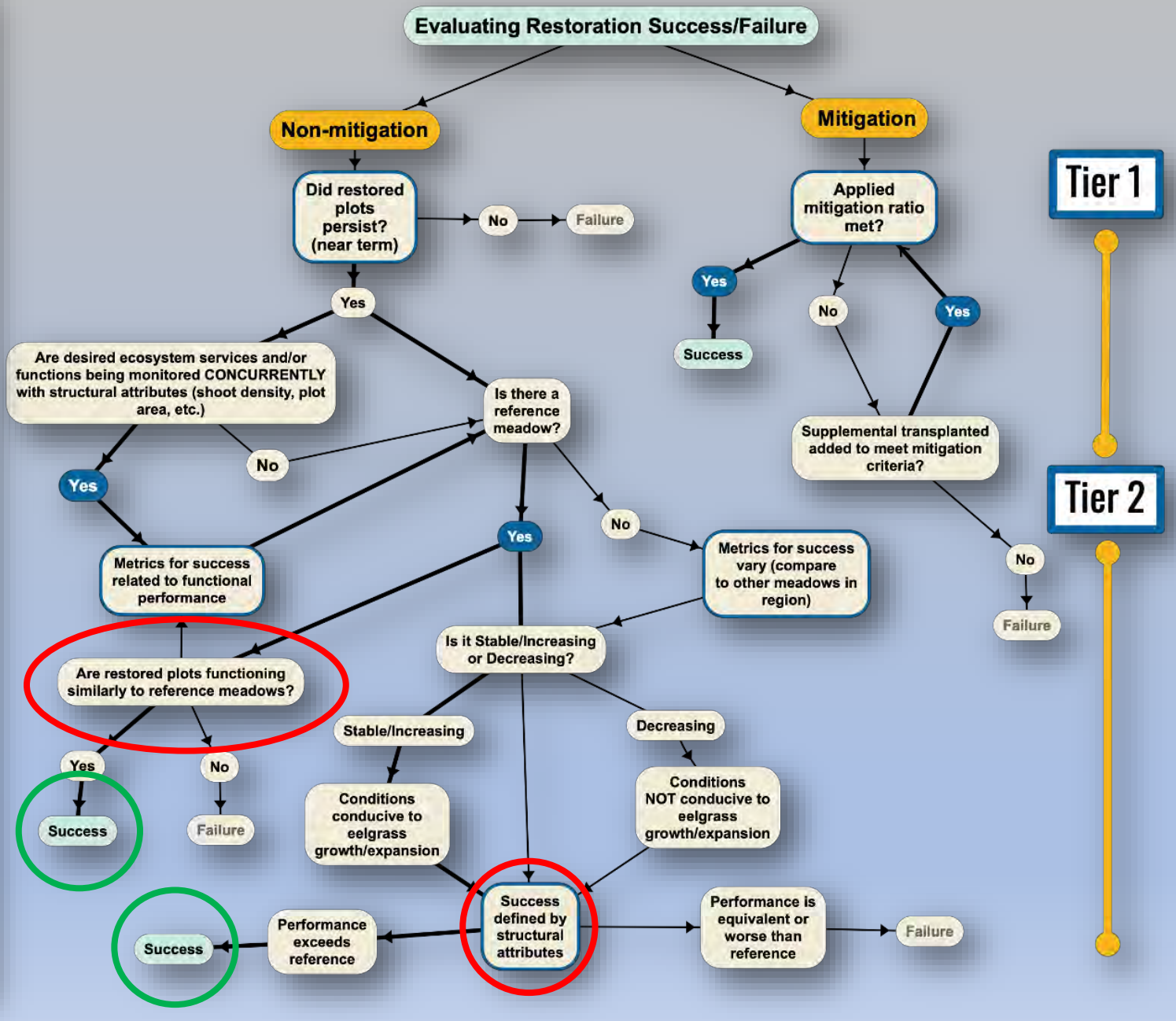
How do we know when we get there?

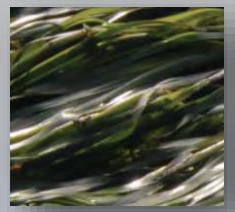
Some intentional provocation

- Our restoration goals are wrong
- Our monitoring approach is wrong
- We can’t manage for climate resilience

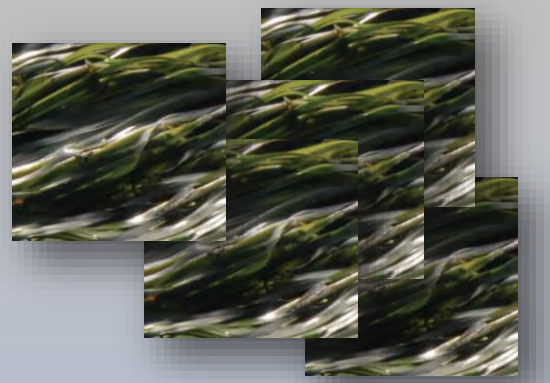
https://northtosouthdesigns.com/products/i-just-like-to-stir-the-pot-wooden-spoon


Eelgrass Restoration on the U.S. West Coast:
A Comprehensive Assessment of Restoration Techniques and Their Outcomes
Kathryn M. Beheshti[1,2] and Melissa Ward[2,3]
[1] University of California, Santa Cruz
[2] Endemic Environmental Services
[3] San Diego State University
photo © Jacqueline Schwartz
PMEP
Friends of South Slough


Evaluating Restoration Success/Failure
Non-mitigation
Mitigation
Did restored plots persist? (near term)
No
Failure
Yes
Are desired ecosystem services and/or functions being monitored CONCURRENTLY with structural attributes (shoot density, plot area, etc.)
Yes
No
Is there a reference meadow?
Yes
No
Metrics for success related to functional performance
Are restored plots functioning similarly to reference meadows?
Yes
Success
No
Failure
Metrics for success vary (compare to other meadows in region)
Is it Stable/Increasing or Decreasing?
Stable/Increasing
Conditions conducive to eelgrass growth/expansion
Decreasing
Conditions NOT conducive to eelgrass growth/expansion
Success defined by structural attributes
Performance exceeds reference
Success
Performance is equivalent or worse than reference
Failure
Applied mitigation ratio met?
Yes
Success
No
Yes
Supplemental transplanted added to meet mitigation criteria?
No
Failure
Tier 1
Tier 2



Restoration action



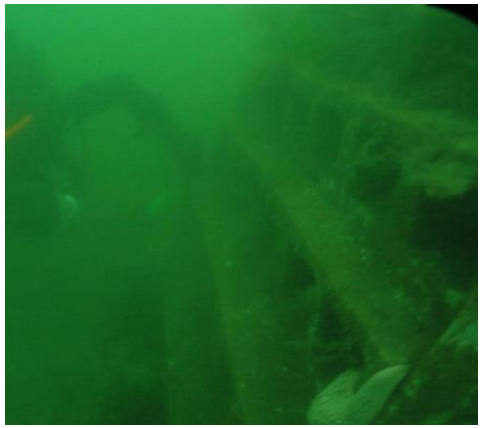
Success?

Restoration action

Success!

So, we should count things that aren’t seagrass:

- Presence/Absence
- Abundance
- Length or weight
- Derived indices like community structure and diversity

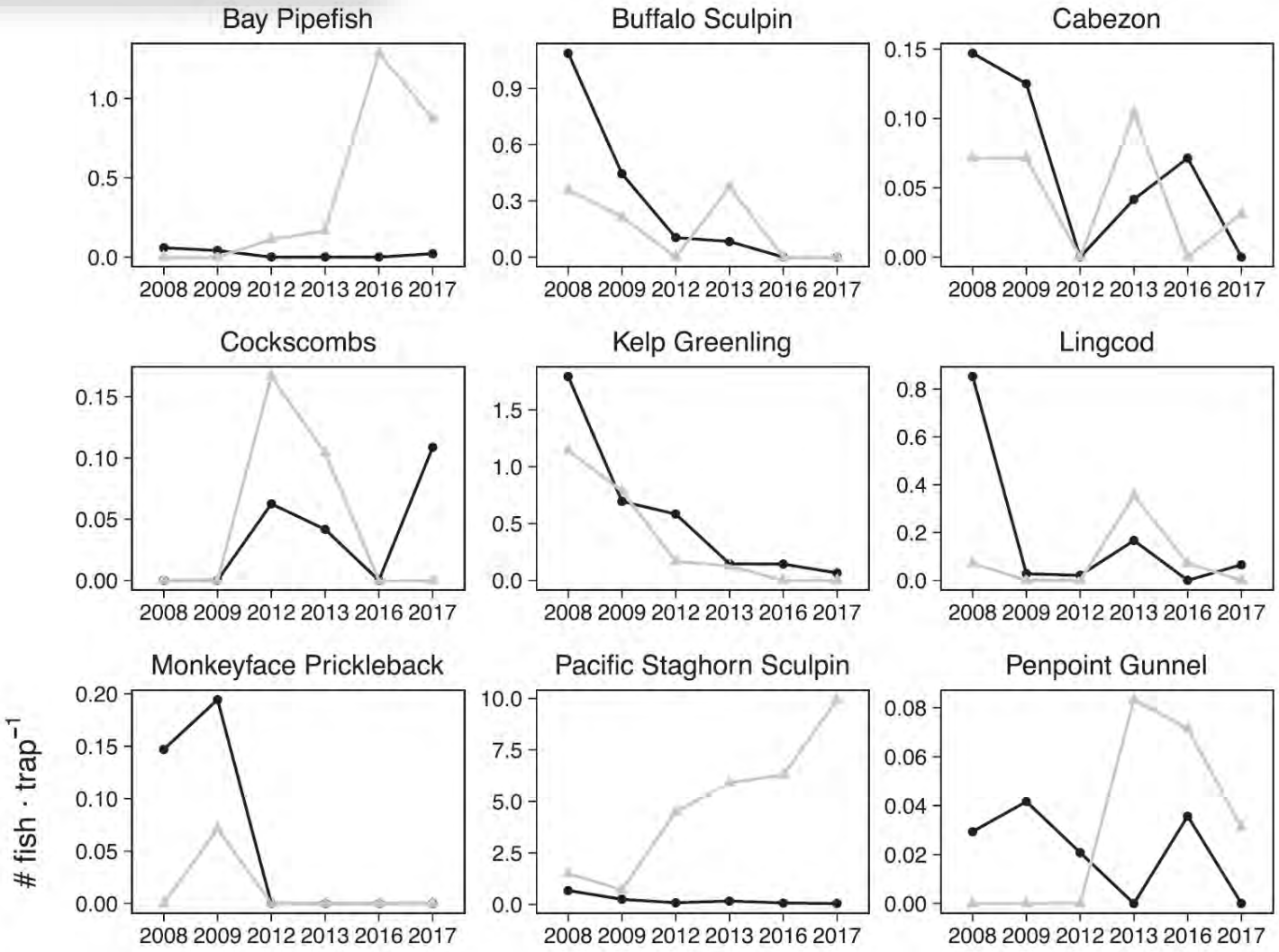


Temporal and habitat differences in the juvenile demersal fish community at a marine-dominated northeast Pacific estuary

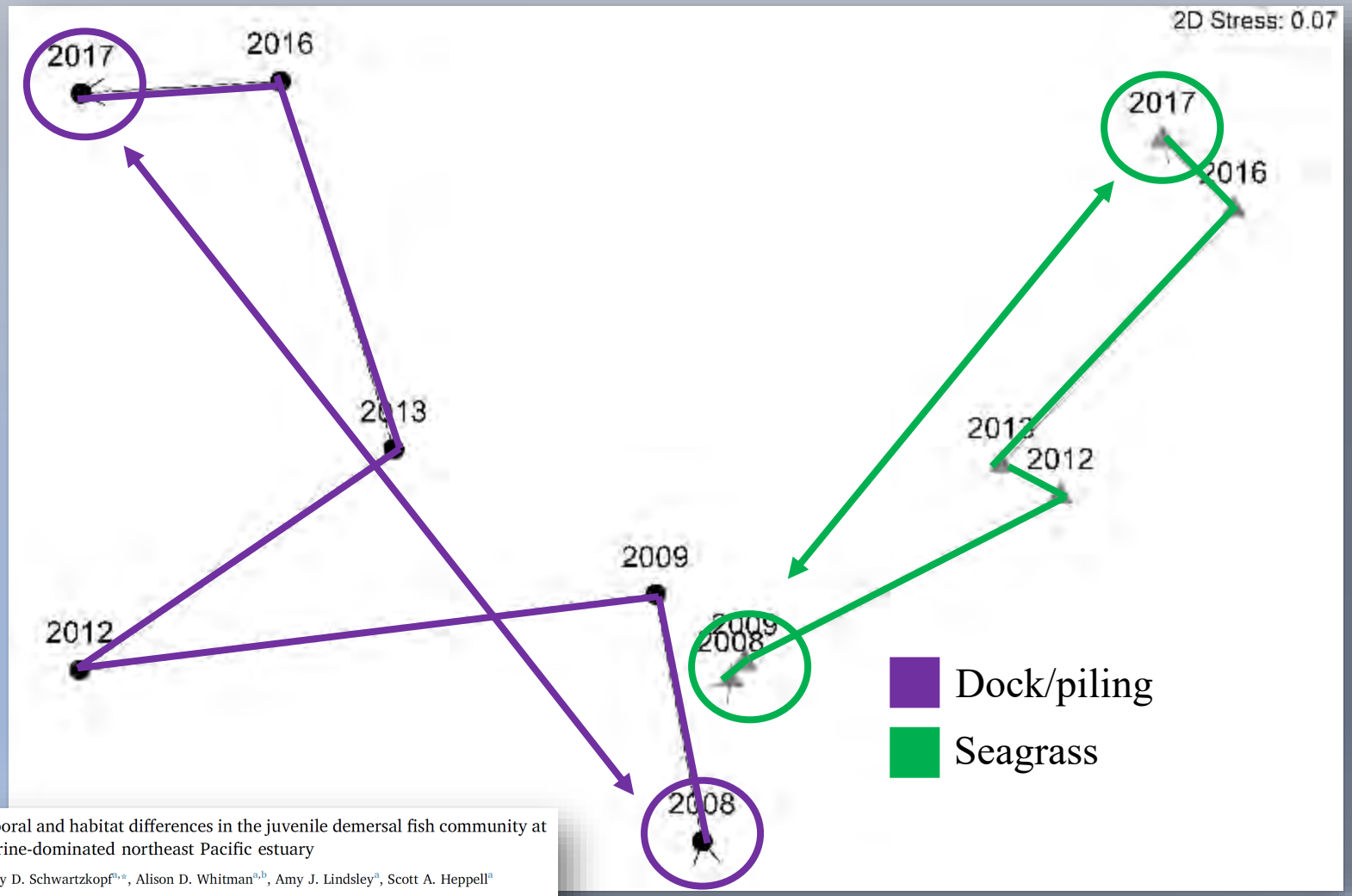
Brittany D. Schwartzkopf[a,*], Alison D. Whitman[a,b], Amy J. Lindsley[a], Scott A. Heppell[a]

[a] Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, OR 97331, USA
[b] Marine Resources Program, Oregon Department of Fish and Wildlife, 2040 SE Marine Science Drive, Newport, OR 97365, USA

Fisheries Research 227 (2020)



Fish community change in natural and artificial habitats



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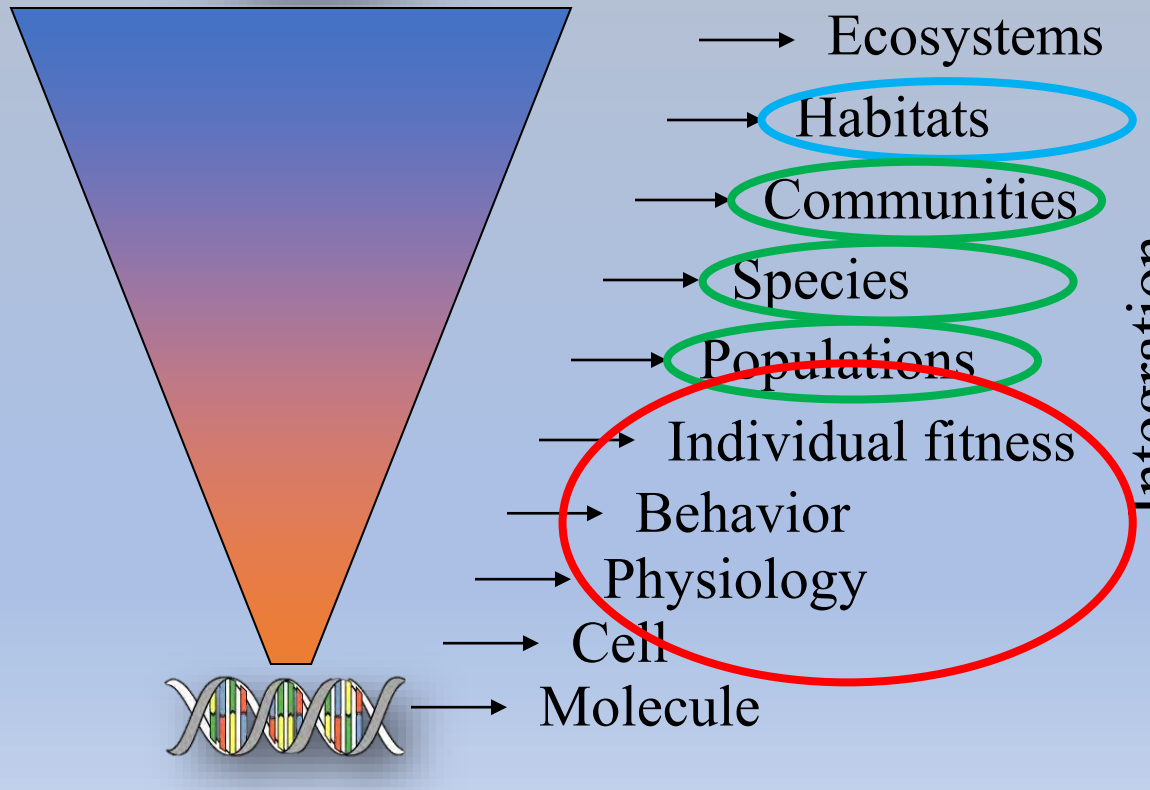
- Community structure varies
  - Between habitats
  - Over time
- Greater stability in seagrass

Two paths diverge in Yaquina Bay,
By time or hand, I cannot say
For one path indeed lay grassy fair
The other trod by human air
And be one traveler, long I stood
And hoped nature restored it would

-Robert Frost?

The big picture

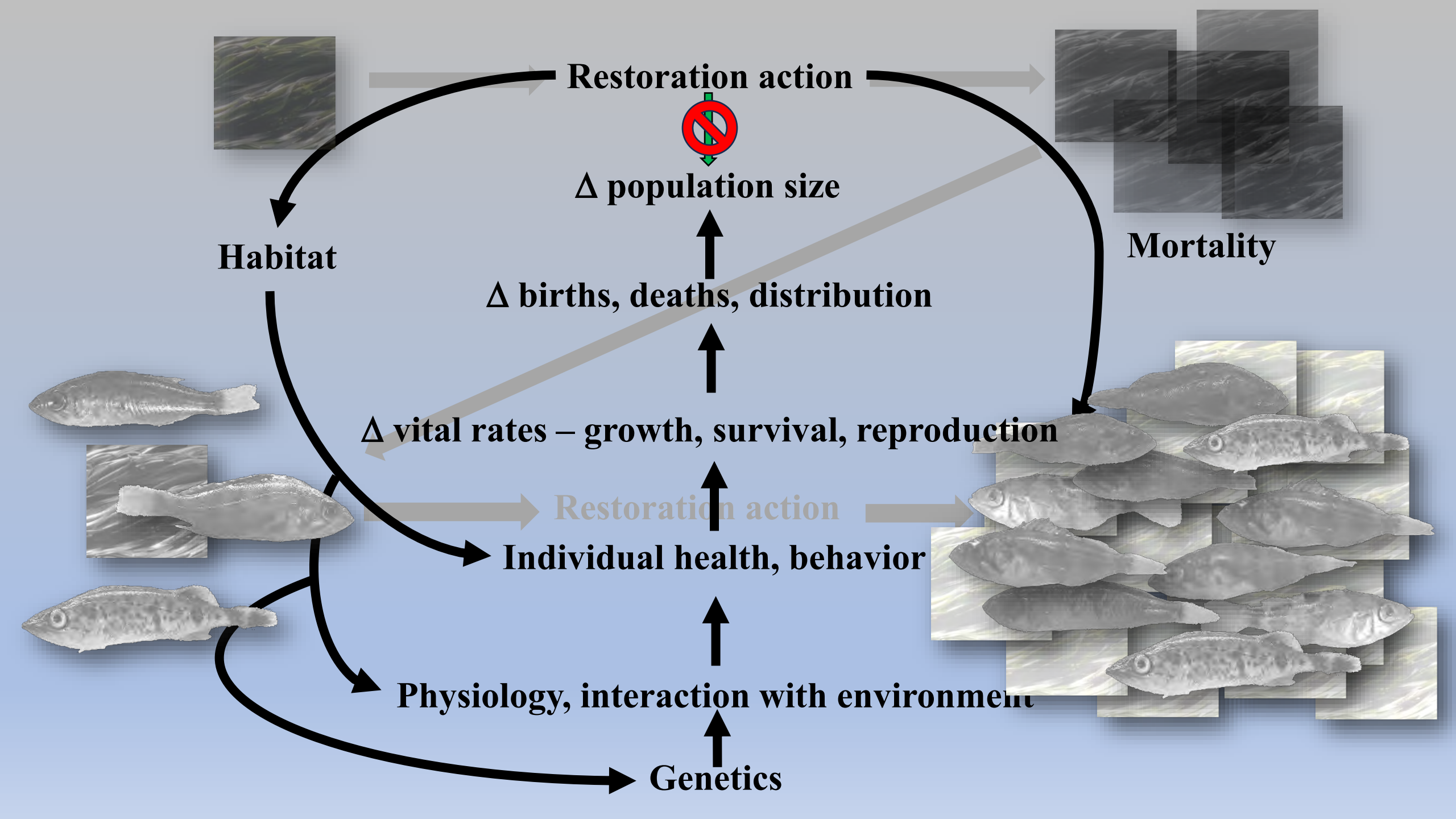


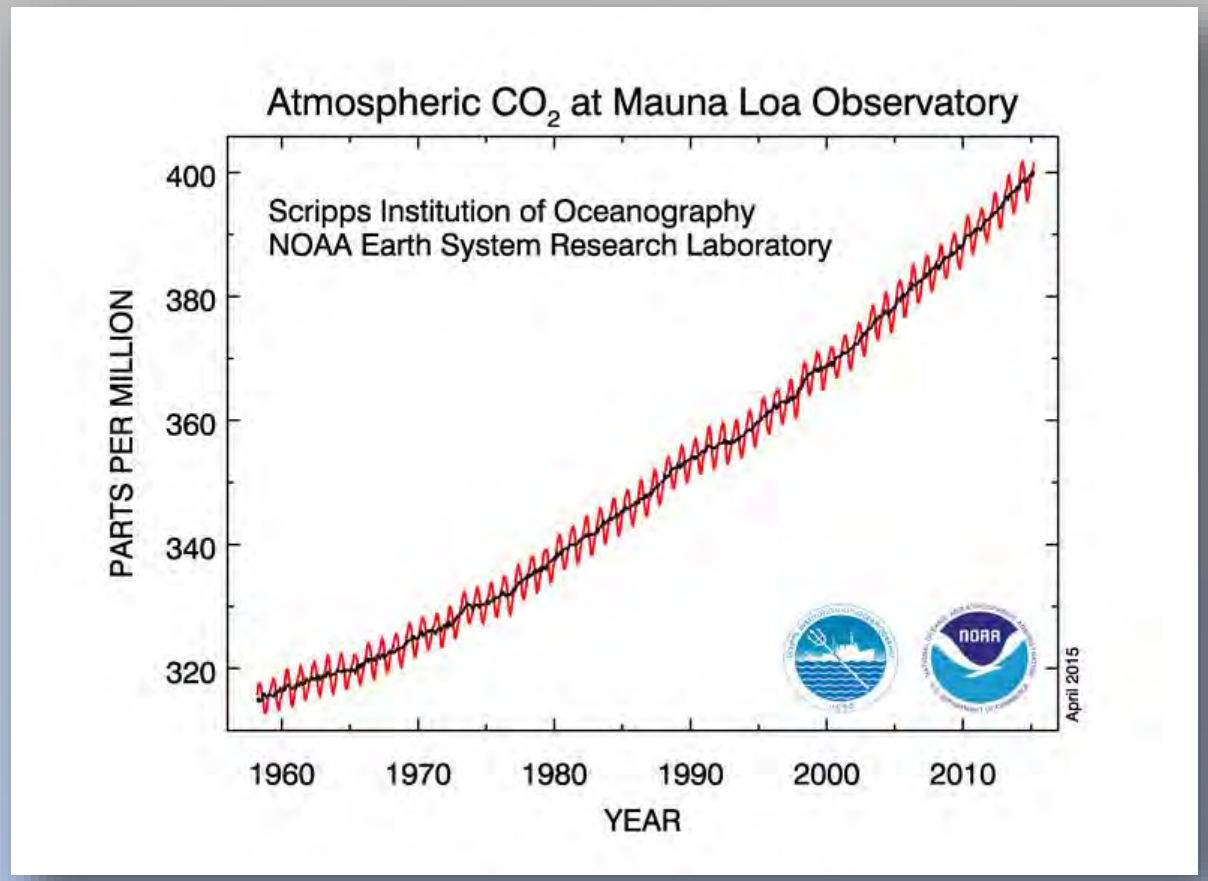
System understanding
- Restoration
- Management

The little picture

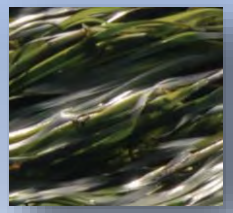
Why we should do more than count

- Other measures may help us understand the *causes* of recovery or decline
  - Identification of proximate factors for a change in births, deaths, or distribution
- Other measures may help us understand changing system function and process
- Other measures may help us formulate better restoration strategies
  - How to provide what animals need, based on mechanistic understanding
- It is possible to do everything right to restore a system, but the forces controlling populations may occur outside the system being managed
  - In those situations, how do we evaluate "success"?
- There are events happening on the planet now that have never happened before, and animals will need to deal with these issues. Correlating environmental data with population trends will not be able to predict future response to these changes


Restoration action
Δ population size
Habitat
Mortality
Δ births, deaths, distribution
Δ vital rates – growth, survival, reproduction
Restoration action
Individual health, behavior
Physiology, interaction with environment
Genetics



Climate change



Δ population size

Δ births, deaths, distribution

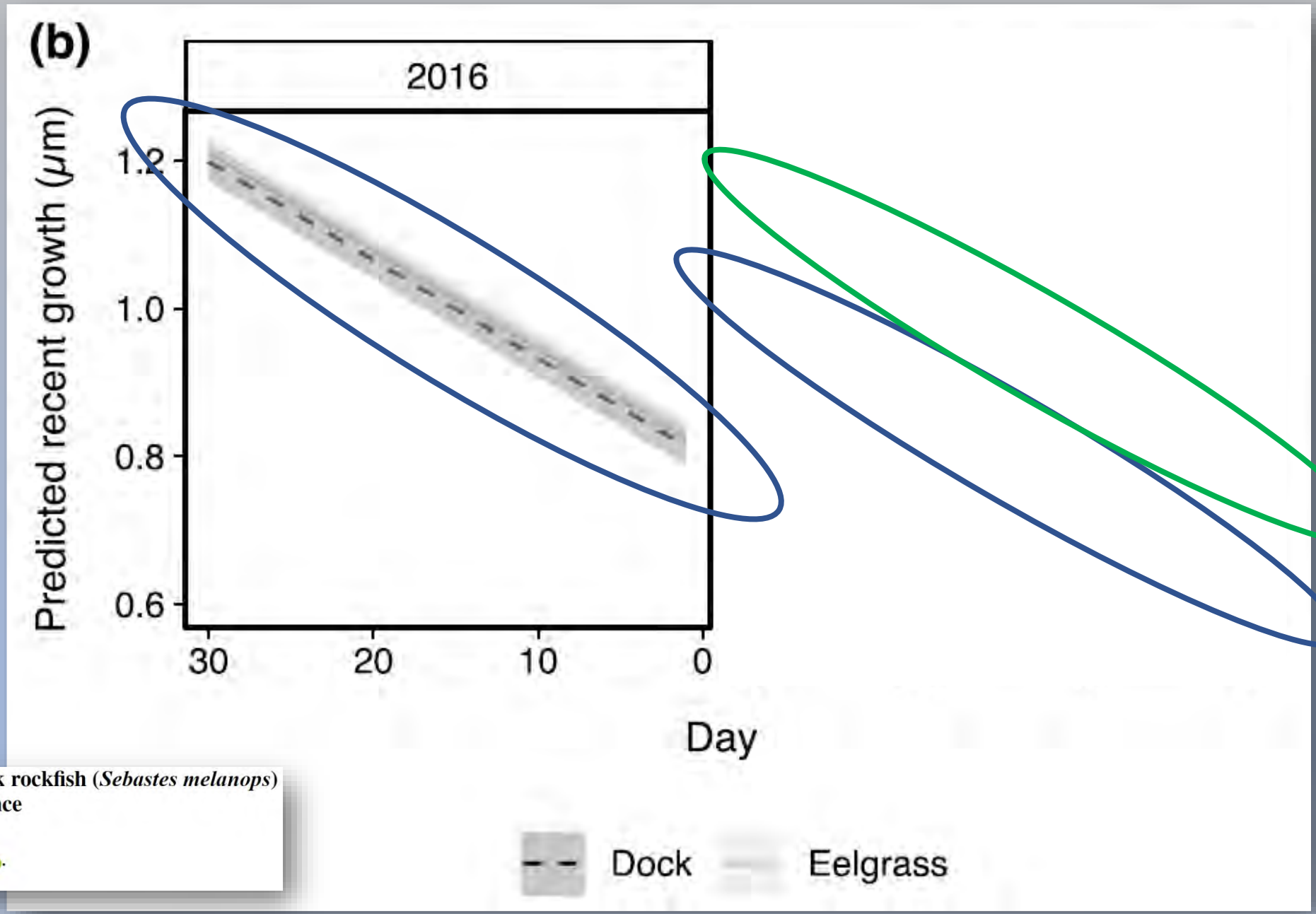
Δ vital rates – growth, survival, reproduction

Individual health, behavior

Physiology, interaction with environment

Genetics

An example of growth-environment linkage



Growth of juvenile black rockfish (*Sebastes melanops*) during estuarine residence

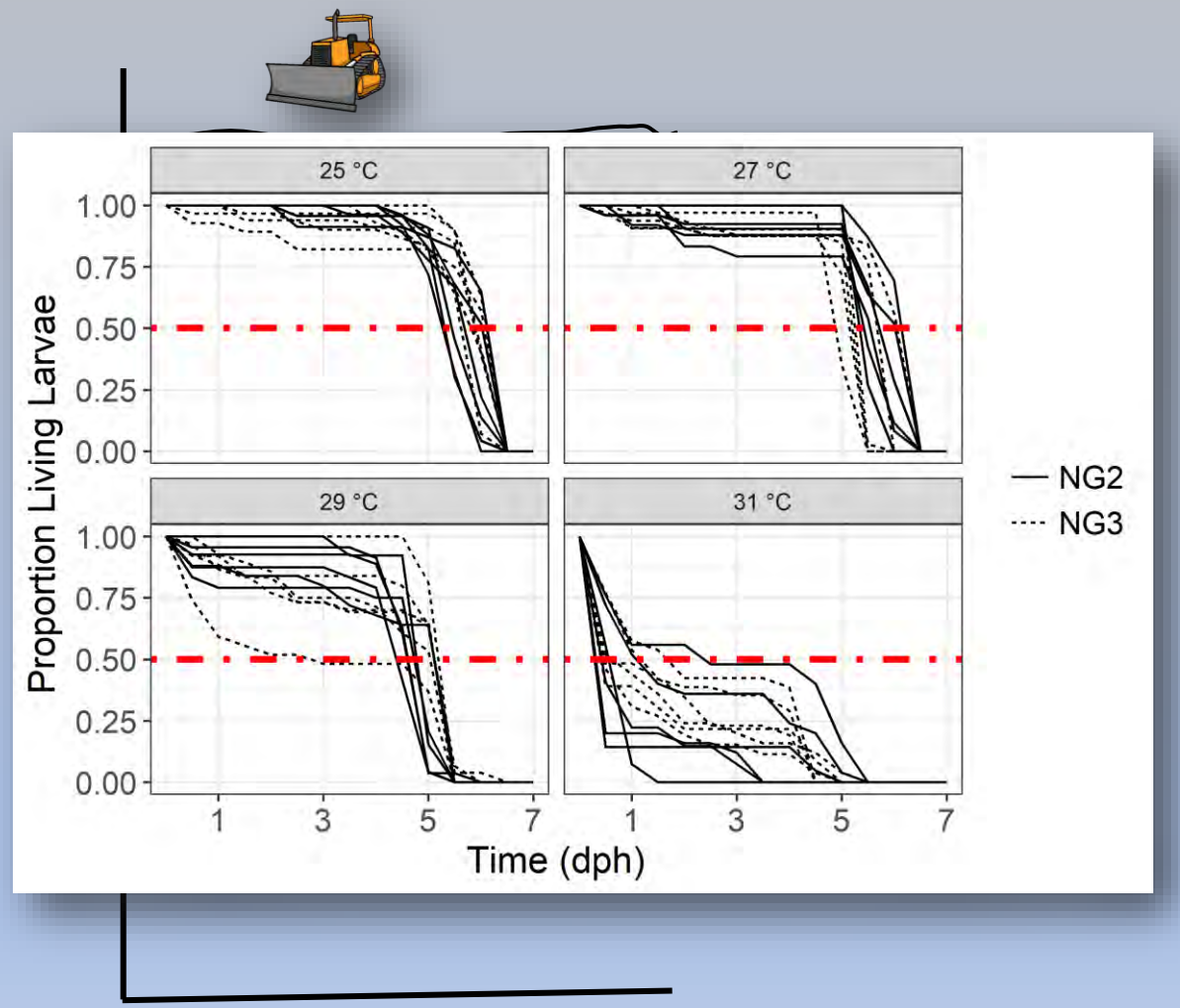
Brittany D. Schwartzkopf · Lorenzo Ciannelli · John C. Garza · Scott A. Heppell

Resistance, Resilience, Adaptation

- Resistance –the ability to withstand change in the face of perturbation –stay the course

- Resilience -the ability to return to “baseline” following a pulse disturbance –deflect and return
  - See 2023 CCIEA

- Adaptation –the ability to change in the face of press disturbance; an alternative stable state?
  - Restore function
  - Manage for maximum adaptive capacity



Acknowledging practical considerations

- Funding is limited
- Time is limited
- Resources are limited
- Expertise may be limited
- Projects may have location-specific objectives
- Projects may have funder-specific objectives
- Projects may have social, cultural, or historical goals
- Some patterns may be universal across systems, while others may be system specific

Within those limitations, what are the *key, critical data* that should *always* be collected

Acknowledging practical considerations

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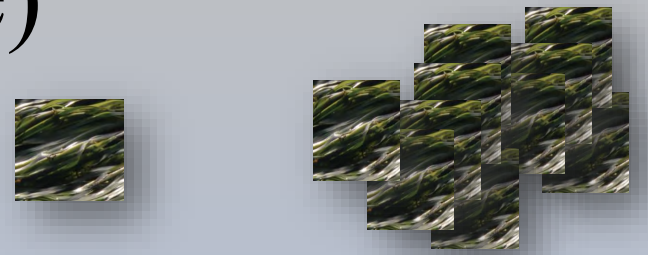
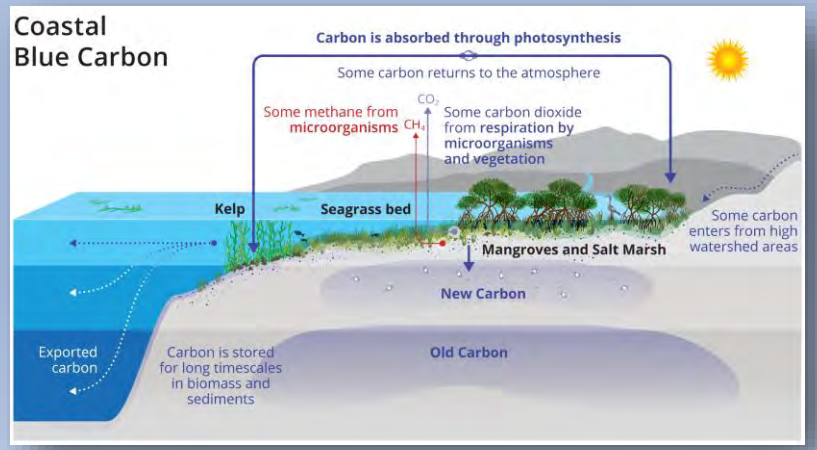
Within those limitations, what are the *key, critical data* that should *always* be collected across restoration actions that help us understand and improve restoration effectiveness?

A starter list (Benchmarks, Time)

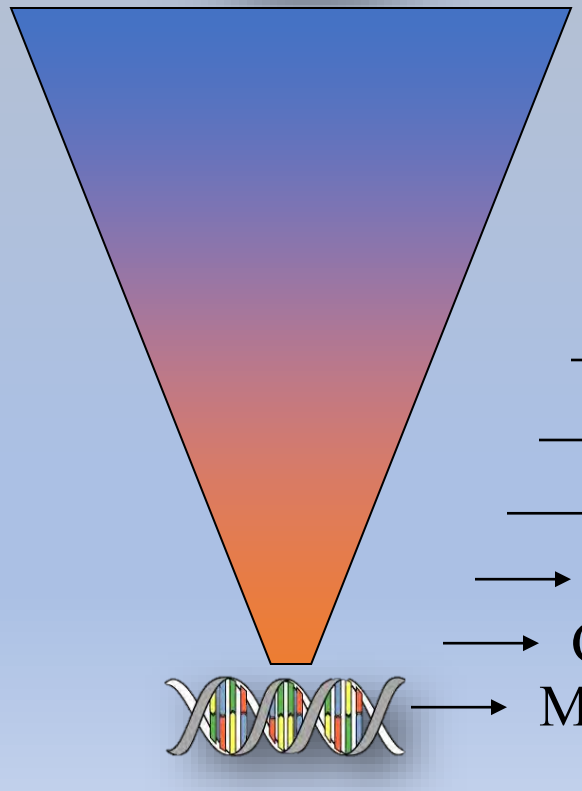
- Seagrass (or whatever habitat type it might be)
- Individual performance
  - Health
  - Growth
  - Disease
- Animal metrics
  - Abundance
  - Length distributions
- Community structure/biodiversity
  - Biodiversity indices
- Ecosystem processes
  - Carbon flux
    - Blue carbon should be a goal
  - Water chemistry
  - Sediment accretion





https://www.climate.gov/news-features/understanding-climate/understanding-blue-carbon

Discuss


Ecosystems
Habitats
Communities
Species
Populations
Individual fitness
Behavior
Physiology
Cell
Molecule
Integrated Effectiveness Monitoring
Unifying theory of the universe