Developing and Implementing Adaptive Management Plans for Mitigation Sites

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Presented at “Mitigation in Washington: Policy, Tools, and Practice”
Washington Shoreline and Coastal Planners Group Meeting
Keyport, Washington
11 June 2009

Pacific Northwest
NATIONAL LABORATORY

AM Defined and Some Objectives

- *Learn by doing* in a structured process to address key uncertainties facing critical decisions
- Critical decisions with significant uncertainty
- Objectives:
  - Improve performance toward goals
  - Reduce uncertainties
  - Drive decision
  - Save cost
  - Disseminate learning
  - Develop trust
  - Develop credibility
- Can be active, passive, or adaptive learning

Major Components and Steps
(DOI Guidance; Williams et al. 2007)

- Setup Phase
  - Step 1 – Stakeholder involvement
  - Step 2 – Objectives
  - Step 3 – Management actions
  - Step 4 – Models
  - Step 5 – Monitoring plans
- Iterative Phase
  - Step 6 – Decision making
  - Step 7 – Follow-up monitoring
  - Step 8 – Assessment
  - Step 9 – Iteration

Goal

Model

Evaluation Framework

Guiding Principles

1. Simple = not complex, easy to understand
2. Accurate
3. Timely
4. Relevant (to decisions and decision makers)
5. Feasible
6. “User friendly”
7. Serves key objectives = provides critical information to support continuation of the program
8. Has multiple (cumulative) benefits = is directly related to organization’s mission; is complimentary with other similar efforts
9. “Transparent”

Some Definitions

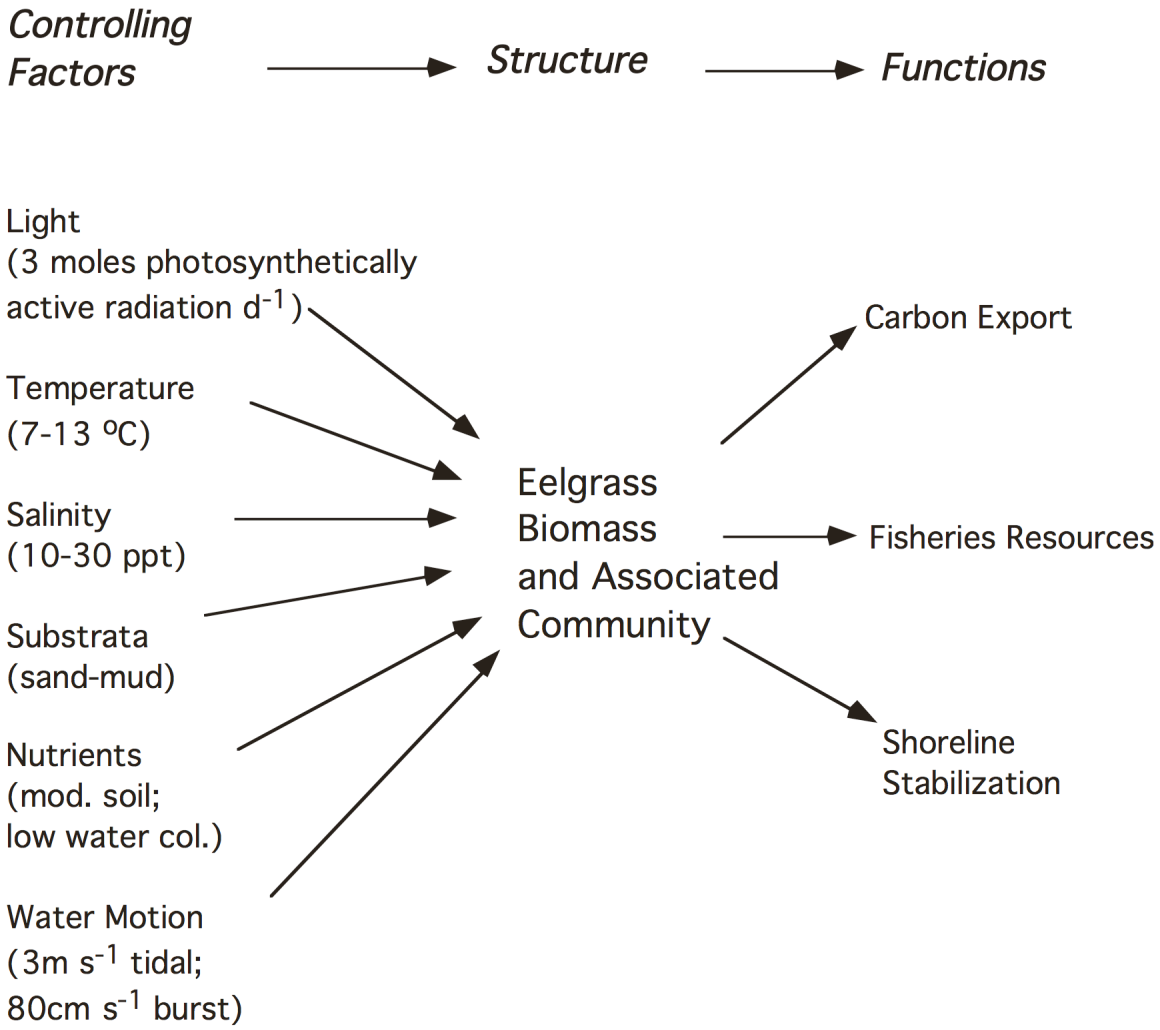
- Goal = the purpose of the project
- Objective = specific task to be accomplished
- Management action = physical or other effort
- Performance metric* = parameter used to indicate effect of actions
- Performance criterion* = threshold value for the performance metric indicating task is accomplished
- Trigger = threshold value that initiates an action or decision
- Decision makers = those who decide what management actions to take and when

*Requires sampling and analysis design and protocols

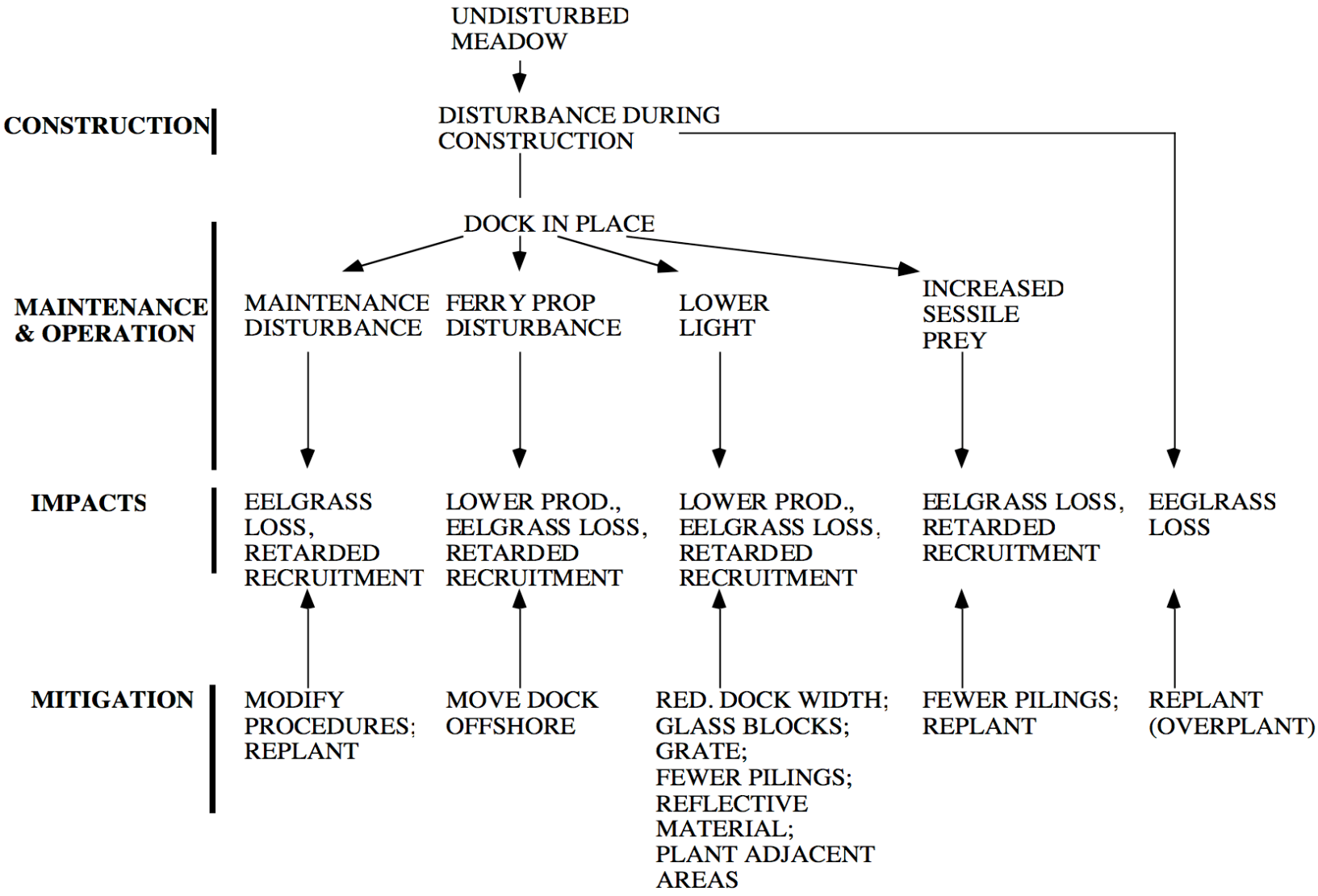
Models and Decision Making

- Link management actions to outcomes
- Conceptual
- Numerical
- Formalize what is known and what is not known
- Highlight critical uncertainties
- Evaluate tradeoffs of scenarios using models
- Structured Decisions
  - “Smart Choices” (Hammond, Keeney and Raiffa 1999)

Conceptual Model Example



Conceptual Model Example



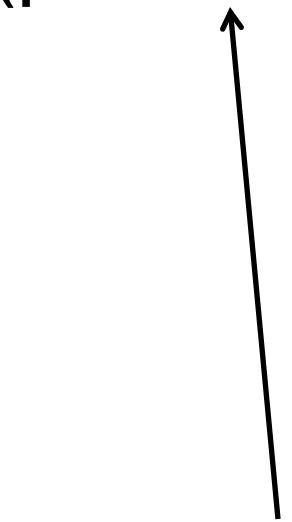
Organizing Model

Net Ecosystem Improvement (NEI) Score

Score = (Δfunction) (area) (probability)

Organizing Model

Score = (Δfunction) (area) (probability)



Level of disturbance
Strategy employed
Stochastic events
Past results in system

Organizing Model

Score = (Δfunction) (area) (probability)

Habitat size
Wetted area
Channel area
Channel edge
Tidal prism

Level of disturbance
Strategy employed
Stochastic events
Past results in system

Organizing Model

Score = (Δfunction) (area) (probability)

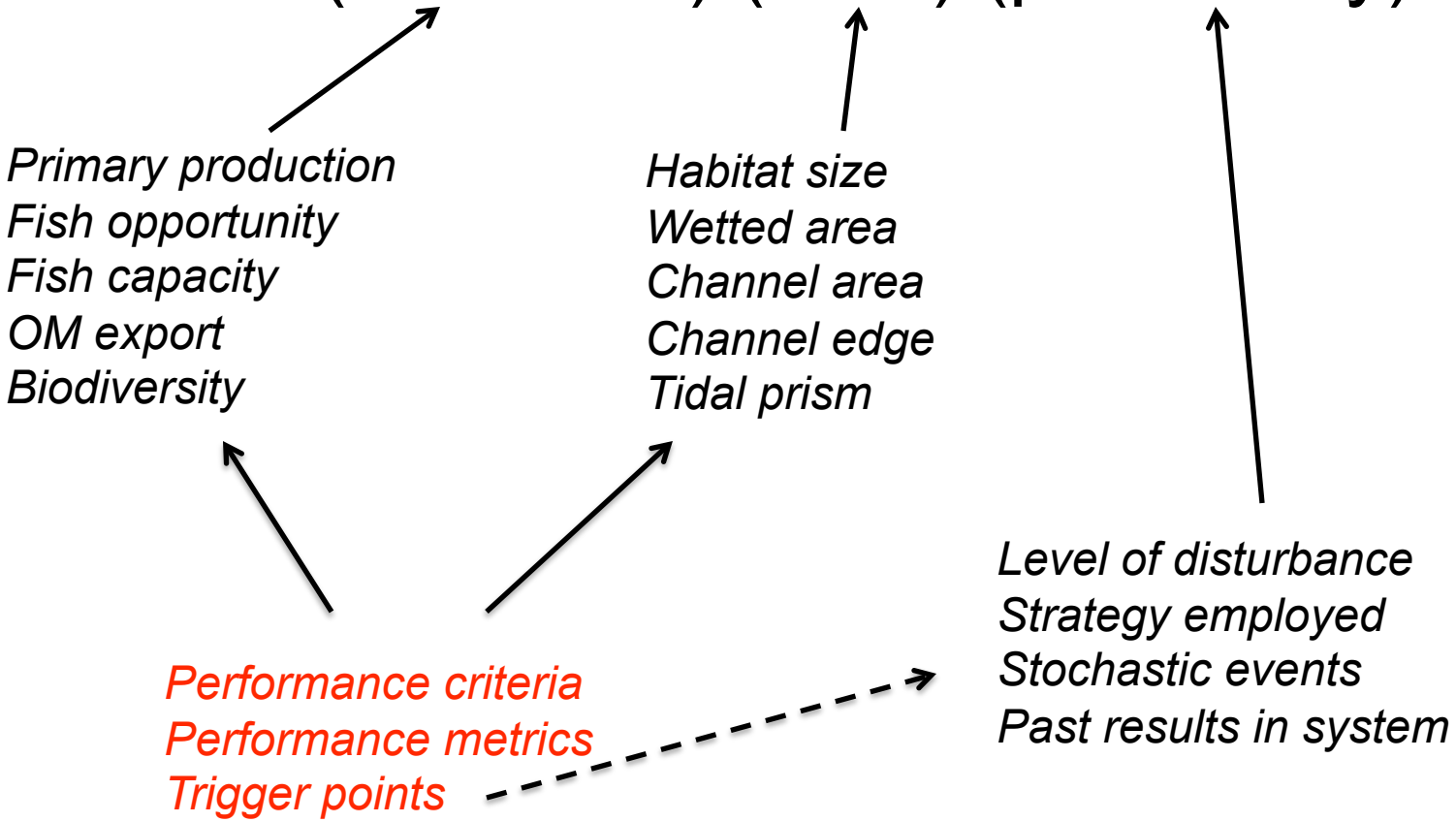
Primary production
Fish opportunity
Fish capacity
OM export
Biodiversity

Habitat size
Wetted area
Channel area
Channel edge
Tidal prism

Level of disturbance
Strategy employed
Stochastic events
Past results in system

Organizing Model

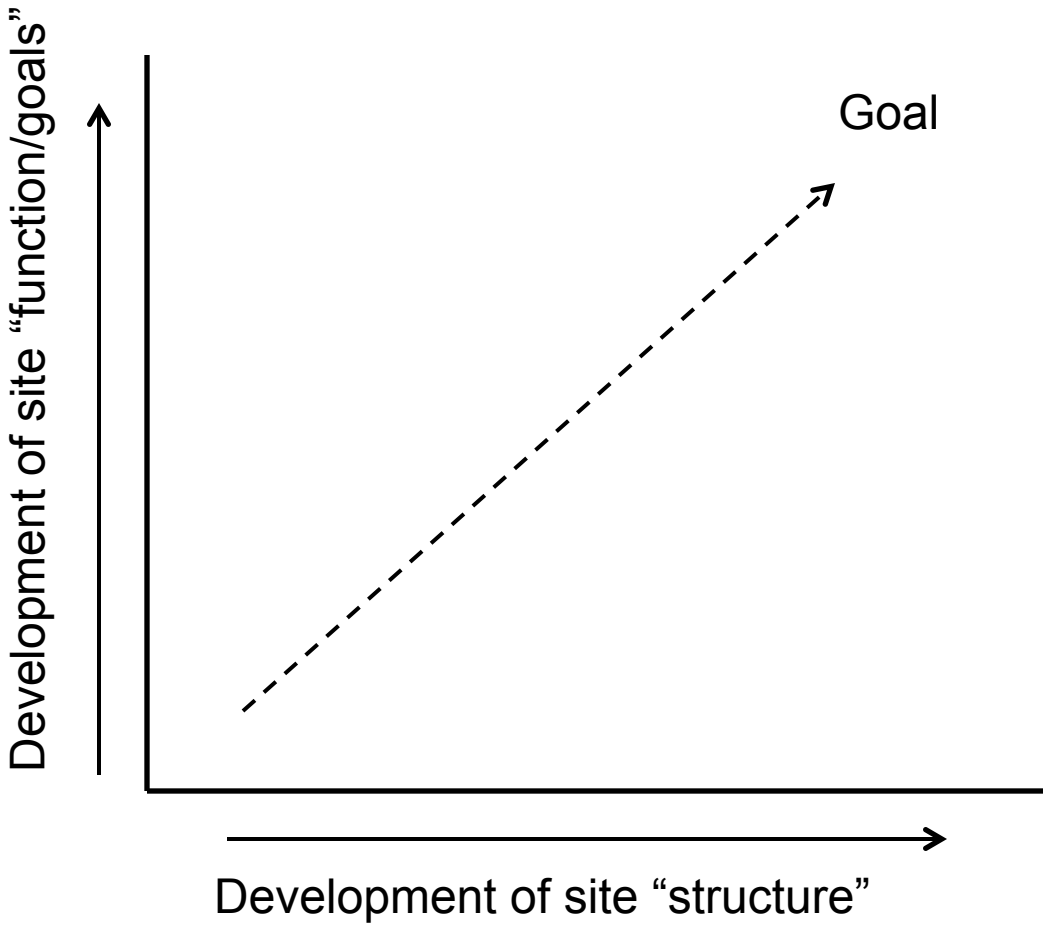
Score = (Δfunction) (area) (probability)



General Alternative Actions if System not Meeting Goals – *Define and Use Triggers*

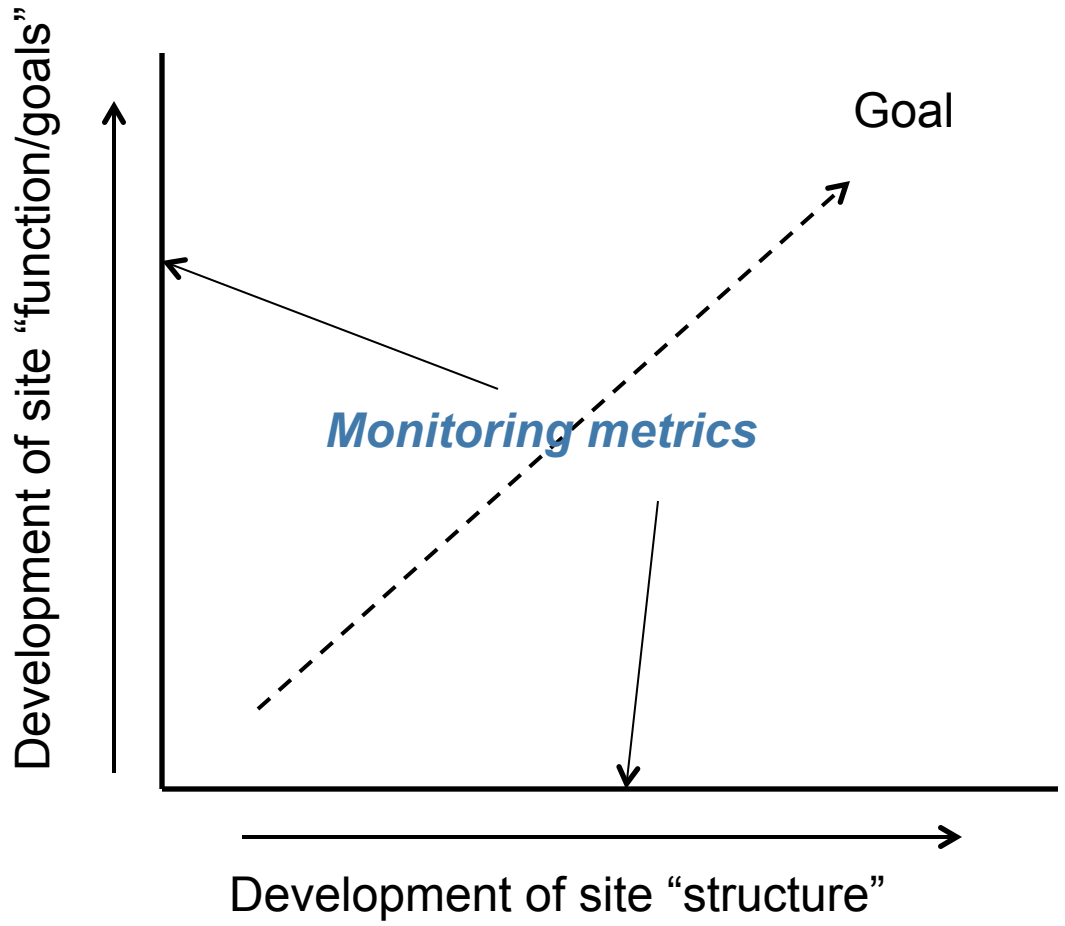
- Do nothing -
  - System not old enough
  - Anomalous, short-term disturbance
- Do something -
  - Implement one or more corrective actions
  - Conduct a study to determine problem
  - Supplement with new site
- Change the goal -
  - System is doing well enough, revised goal is acceptable
  - Alternate goal is better than original goal
  - Fixing system to meet goal would be cost-prohibitive

Framework



Need some way to track all projects in a common framework

Framework



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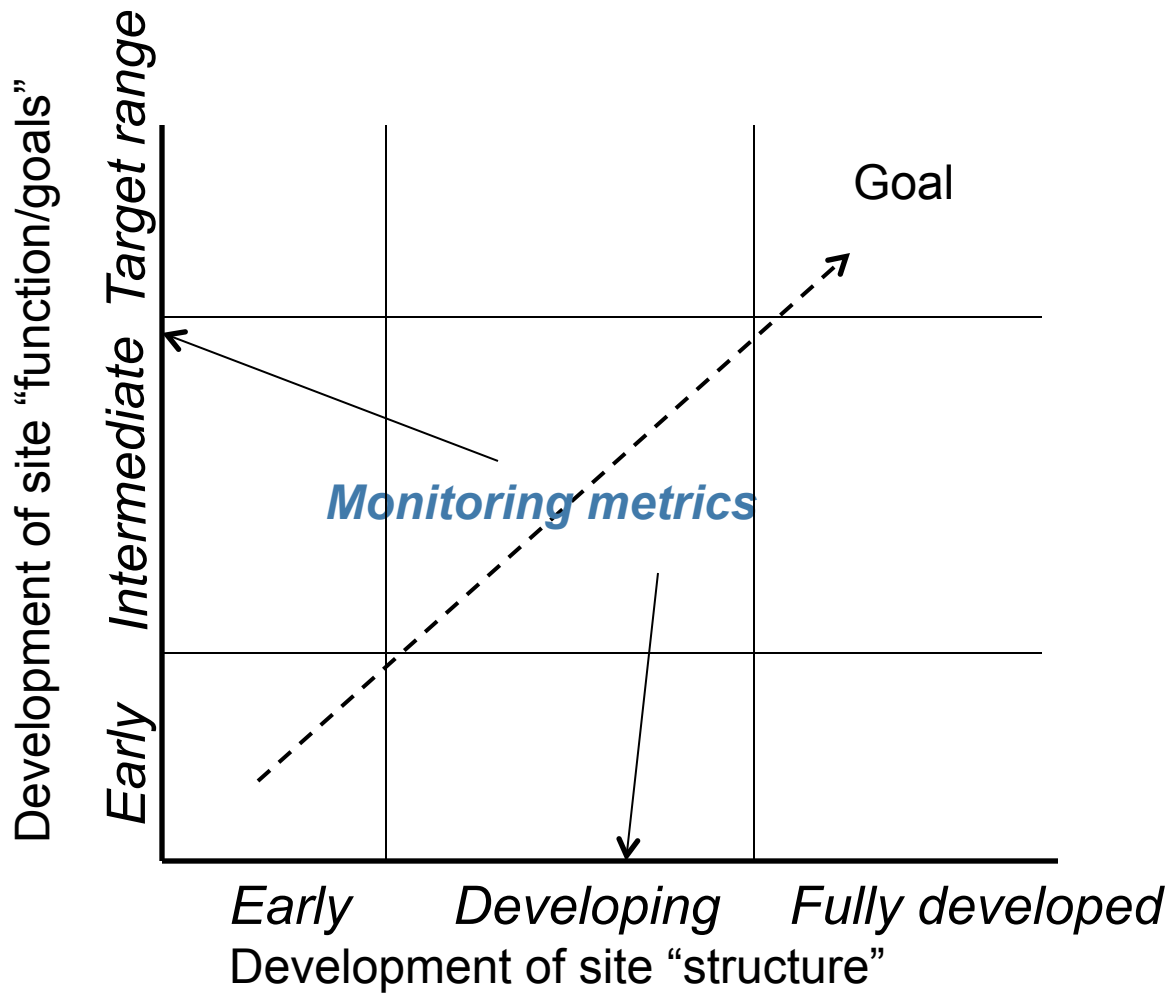

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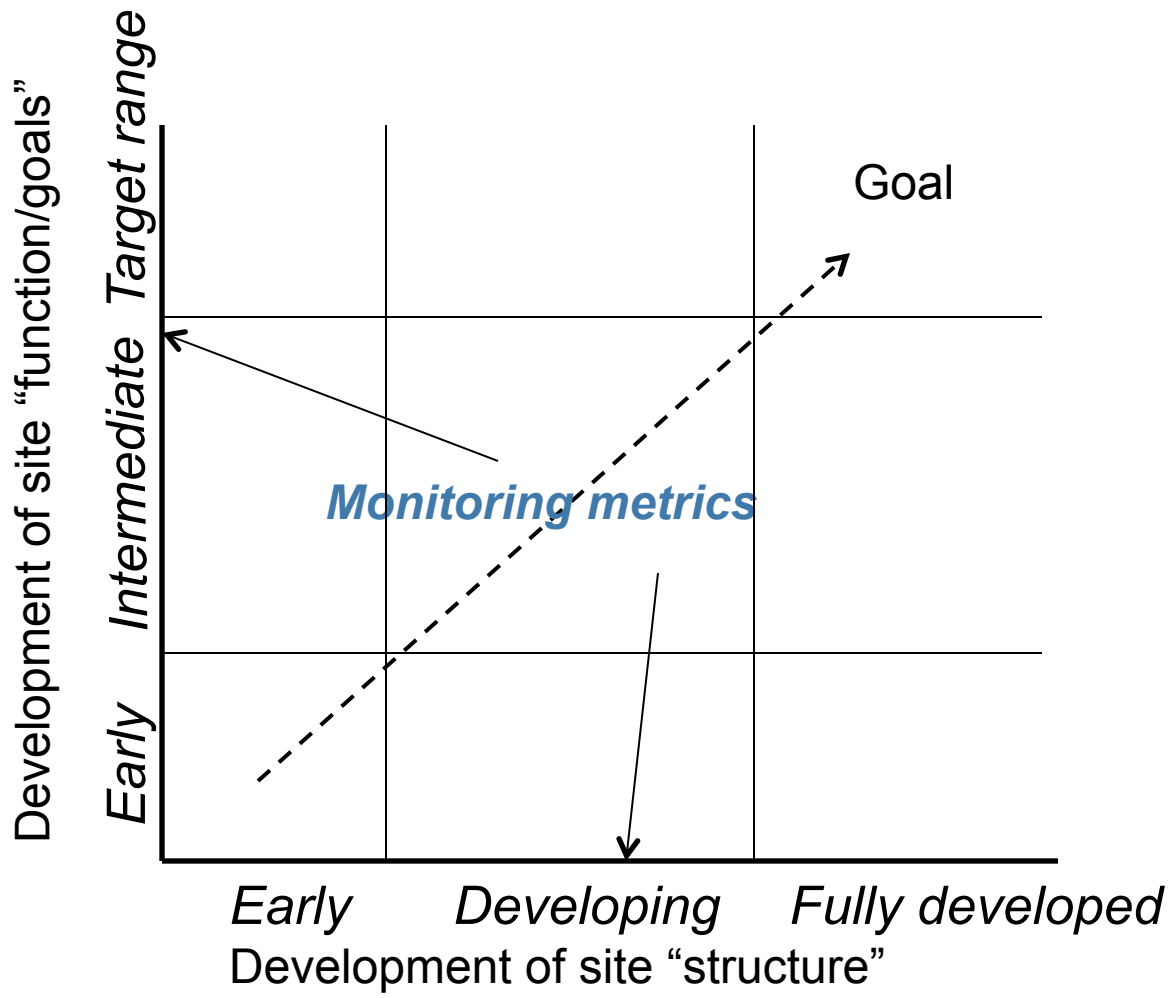
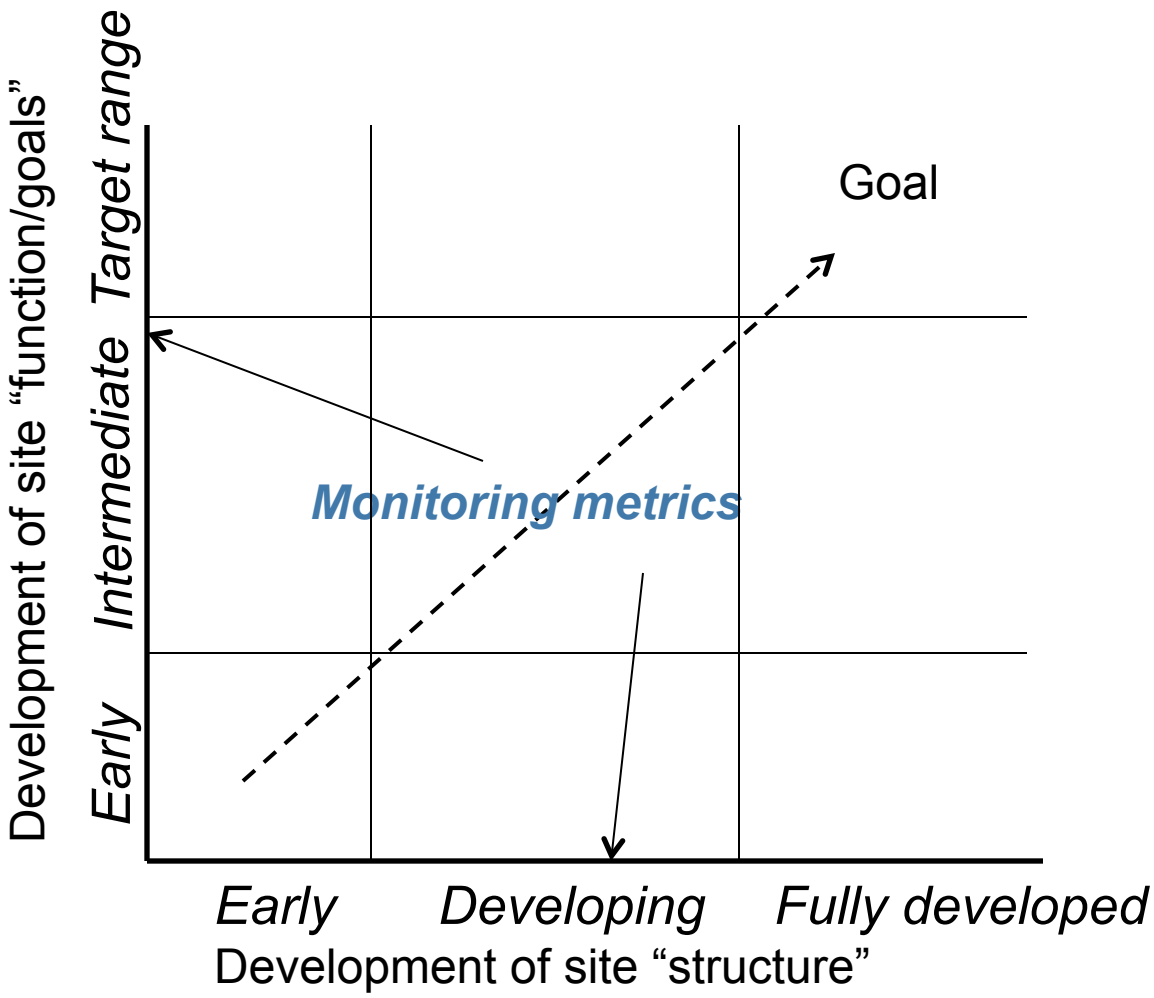


Need some way to track all projects in a common framework

Practitioner Input:
specify these three levels of development for site and function with a time line

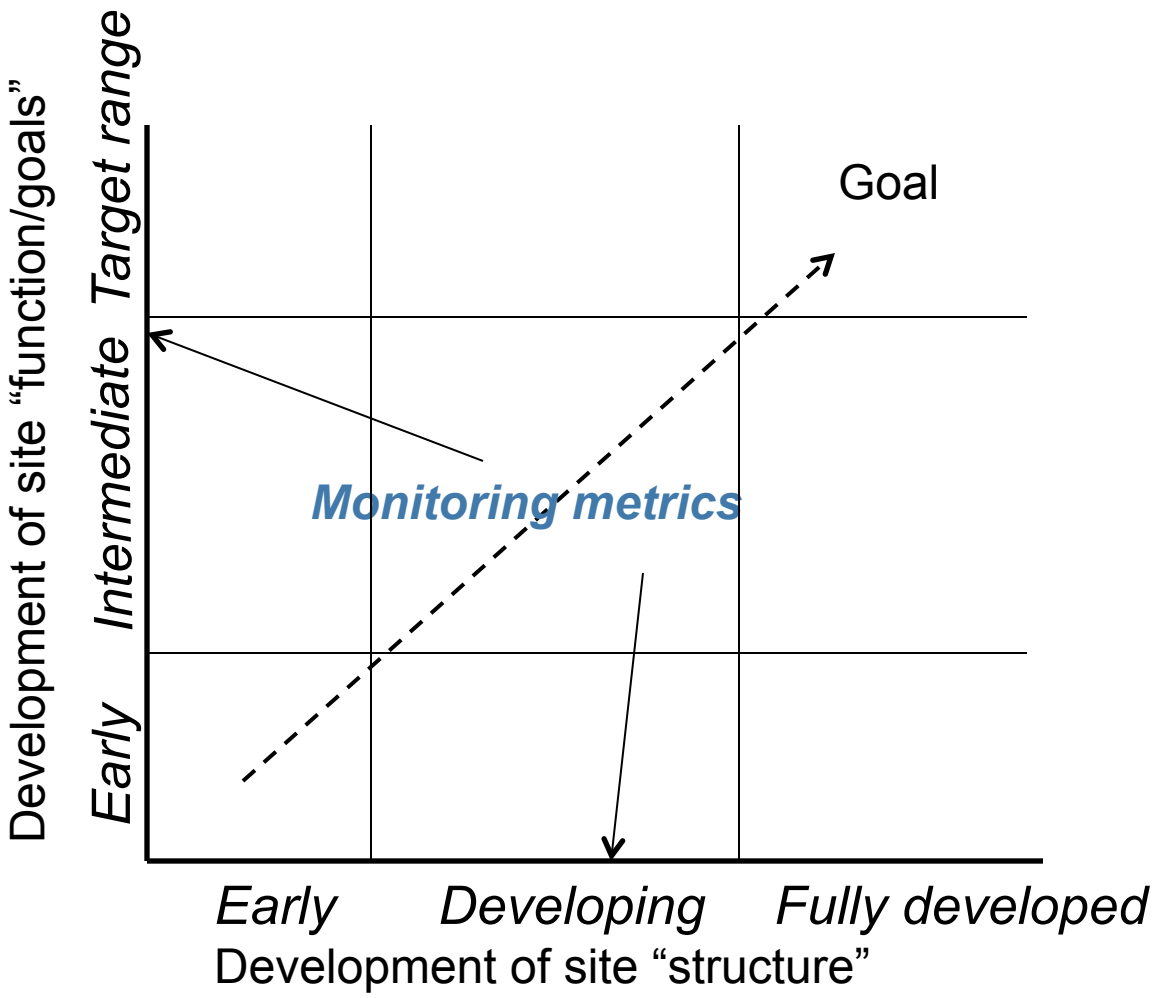
Framework



Need some way to track all projects in a common framework

Practitioner Input:
describe why the site and/or functions are not meeting their time line

Framework

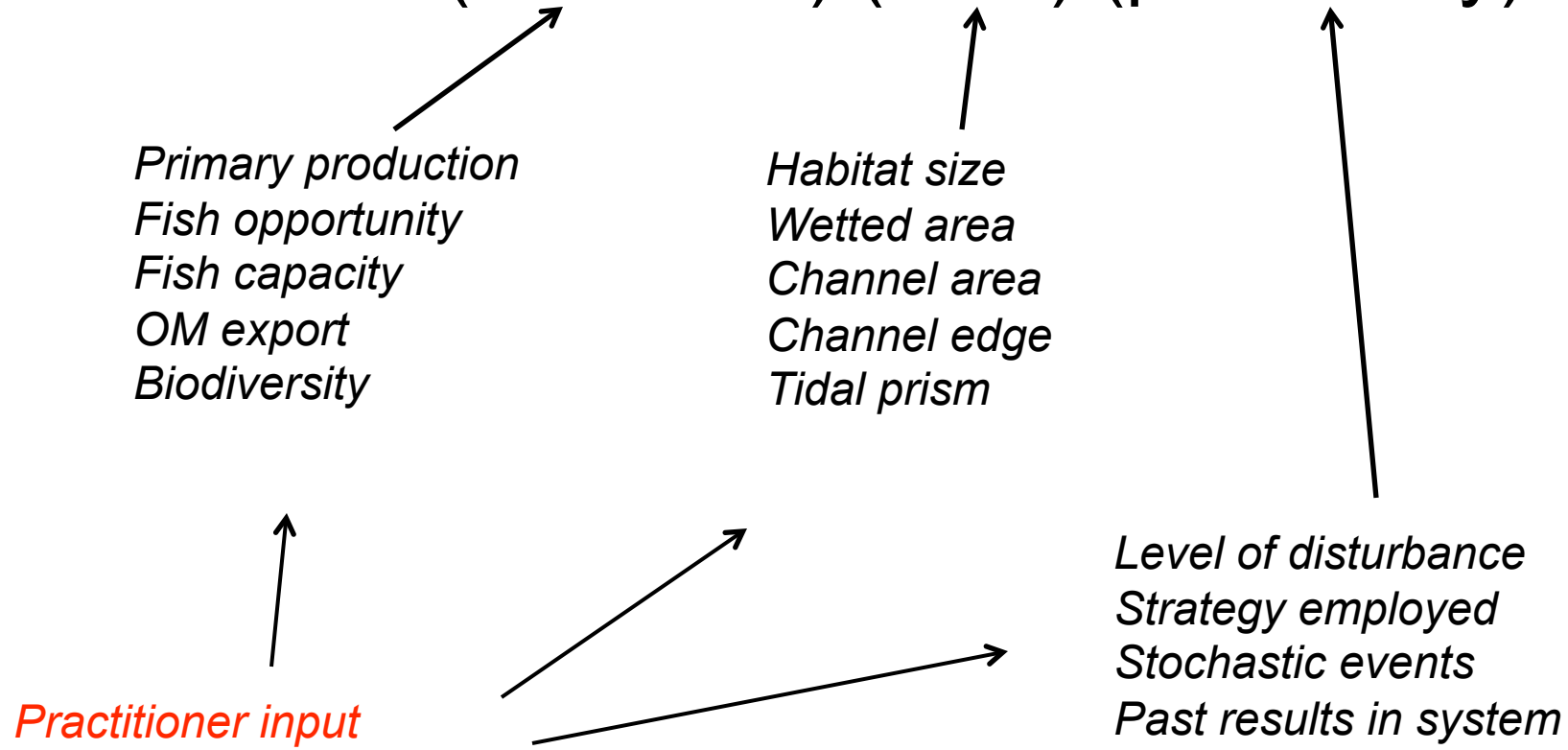


Need some way to track all projects in a common framework

Practitioner Input:
describe assessment of actions, and why

Organizing Model

Score = (Δfunction) (area) (probability)



Organizing Model

Score = (Δfunction) (area) (probability)

Primary production
Proportion of site with wetland vegetation cover intermediate

Habitat size
Wetted area
Only half of site is wet during growing season, lower than predicted

Practitioner input

Strategy employed
Flooding of houses dictated that new tide gate be closed more often

General Alternative Actions if System not Meeting Goals

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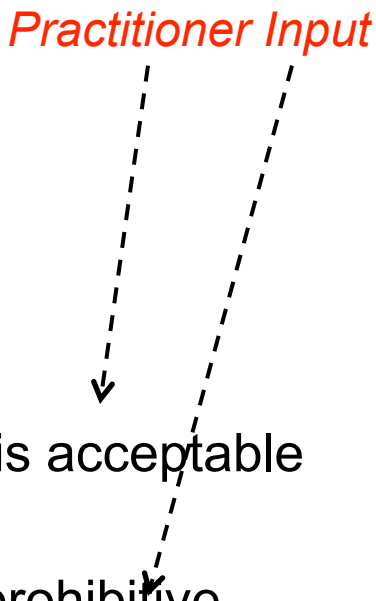

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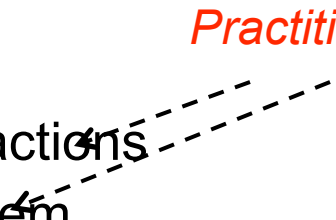
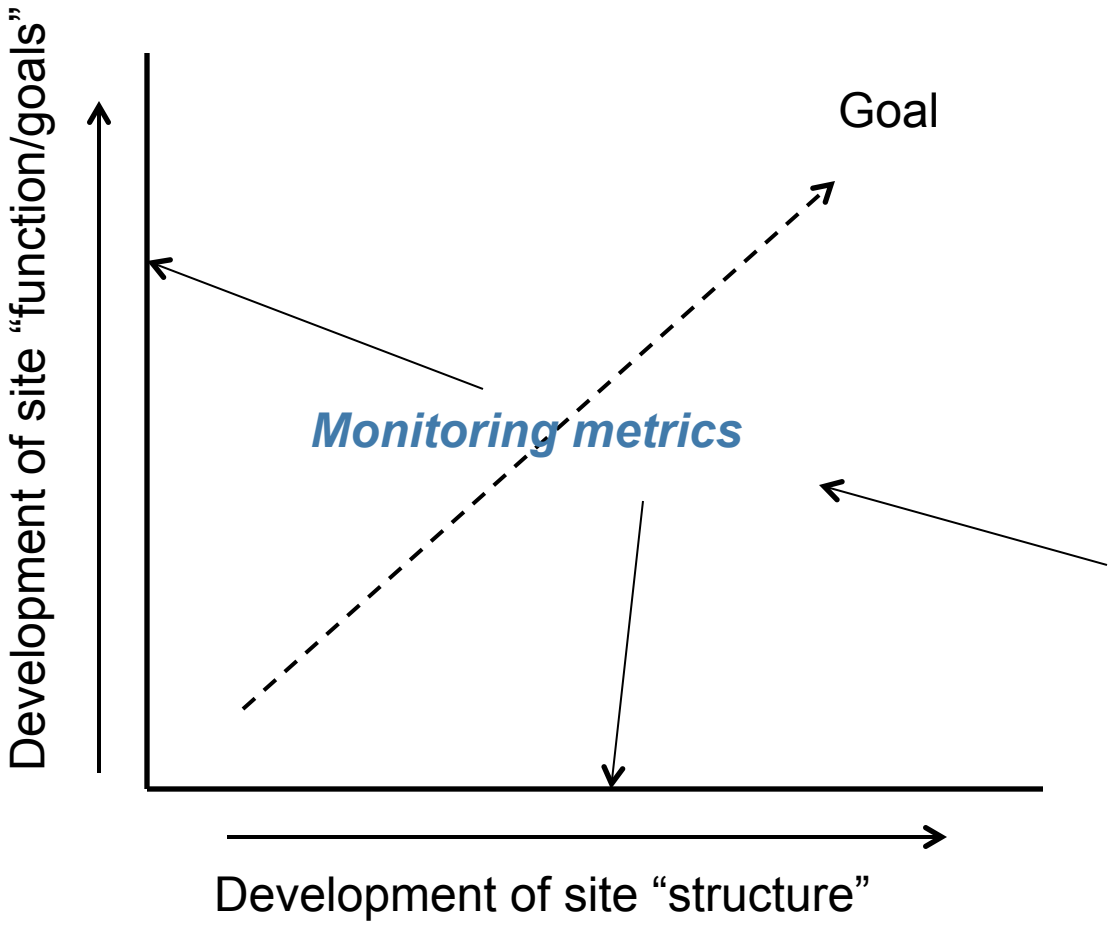


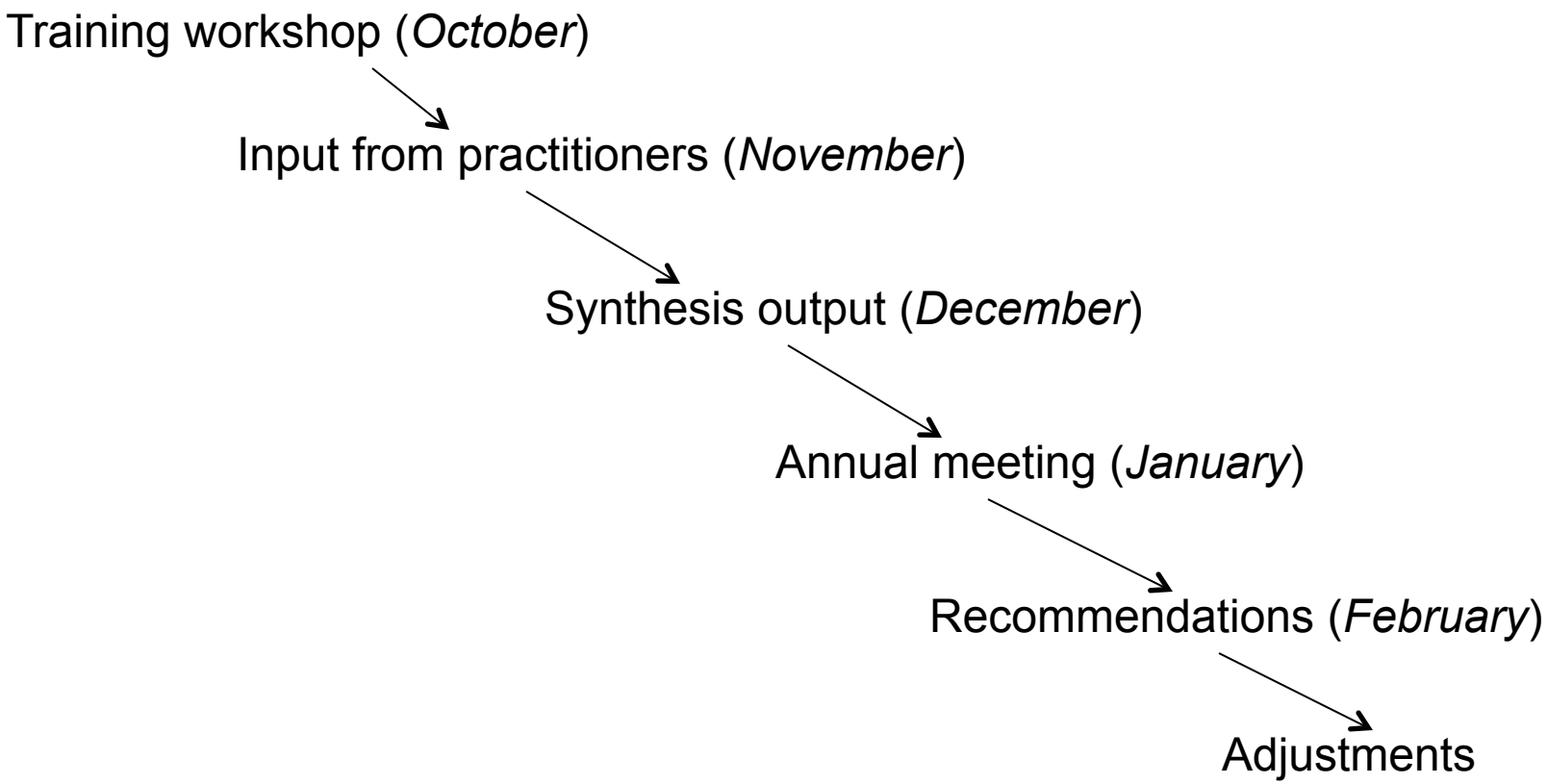
Framework



Need some way to track all projects in a common framework

Practitioner Input: Needed to modify the vegetation protocol because cows ate the markers, and quadrat size was inadequate

Process

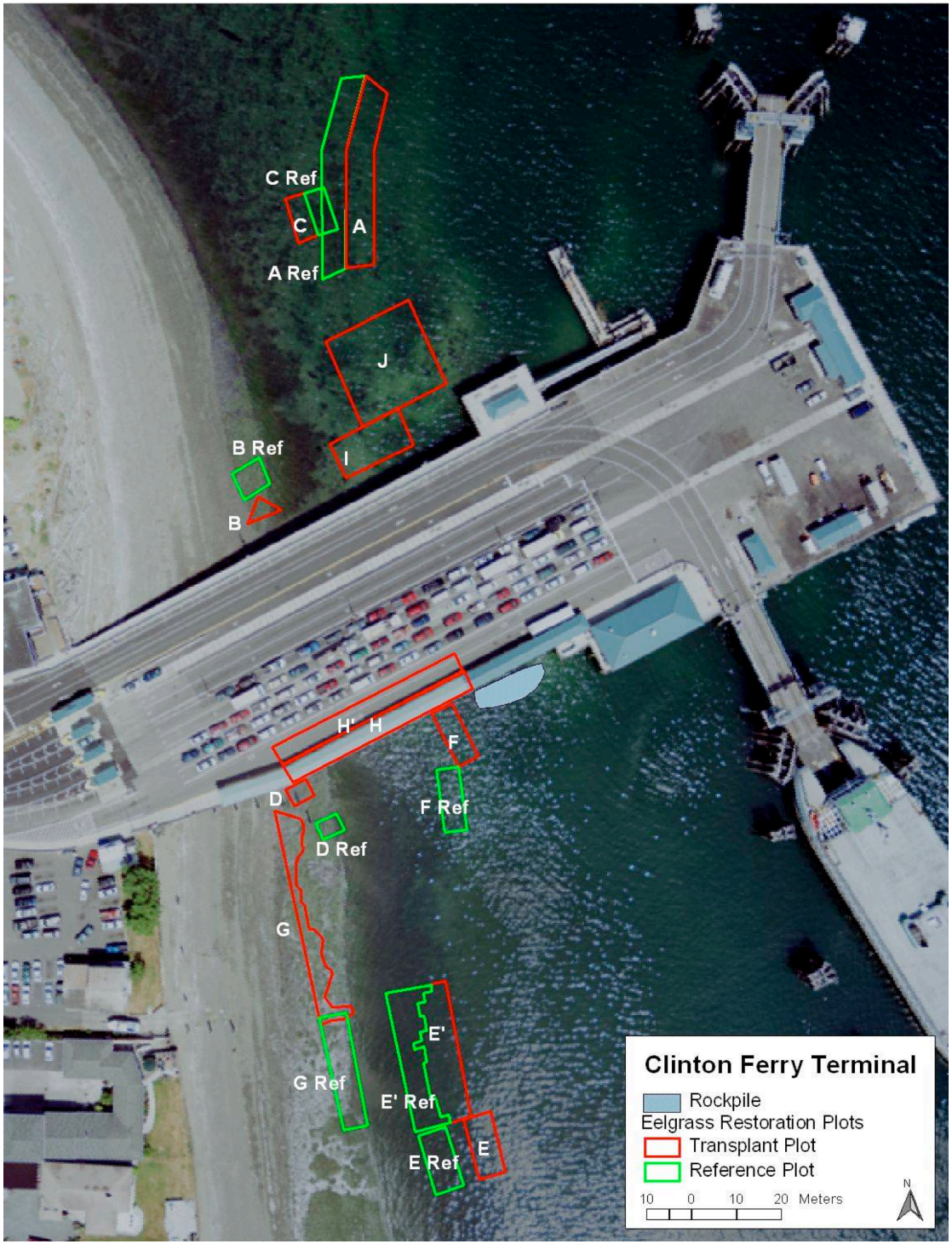

Training workshop (*October*)
Input from practitioners (*November*)
Synthesis output (*December*)
Annual meeting (*January*)
Recommendations (*February*)
Adjustments

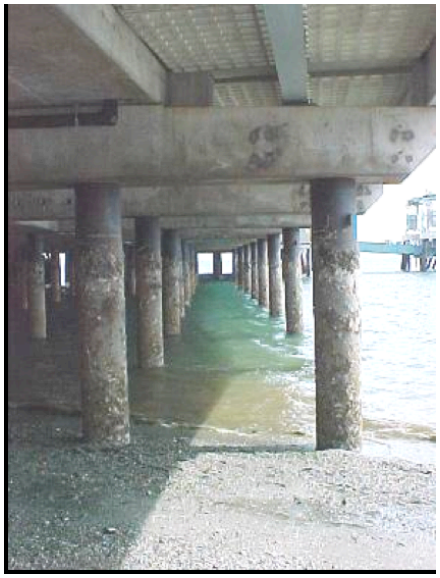
Synthesis Products

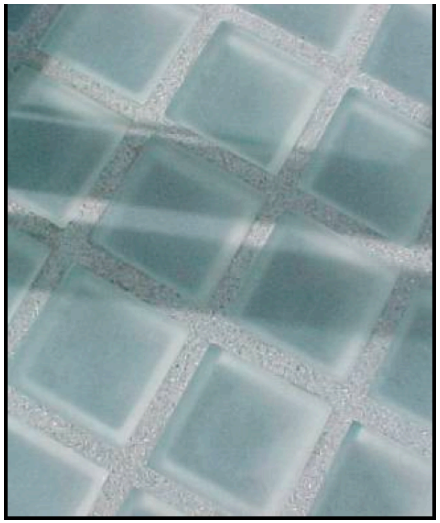
- Feedback to
  - Stakeholders
  - Practitioners
  - Sponsors
  - Public
  - Other agencies
  - Researchers
- Products
  - Maps
  - Results summaries - data plots
  - Narratives
  - Recommendations

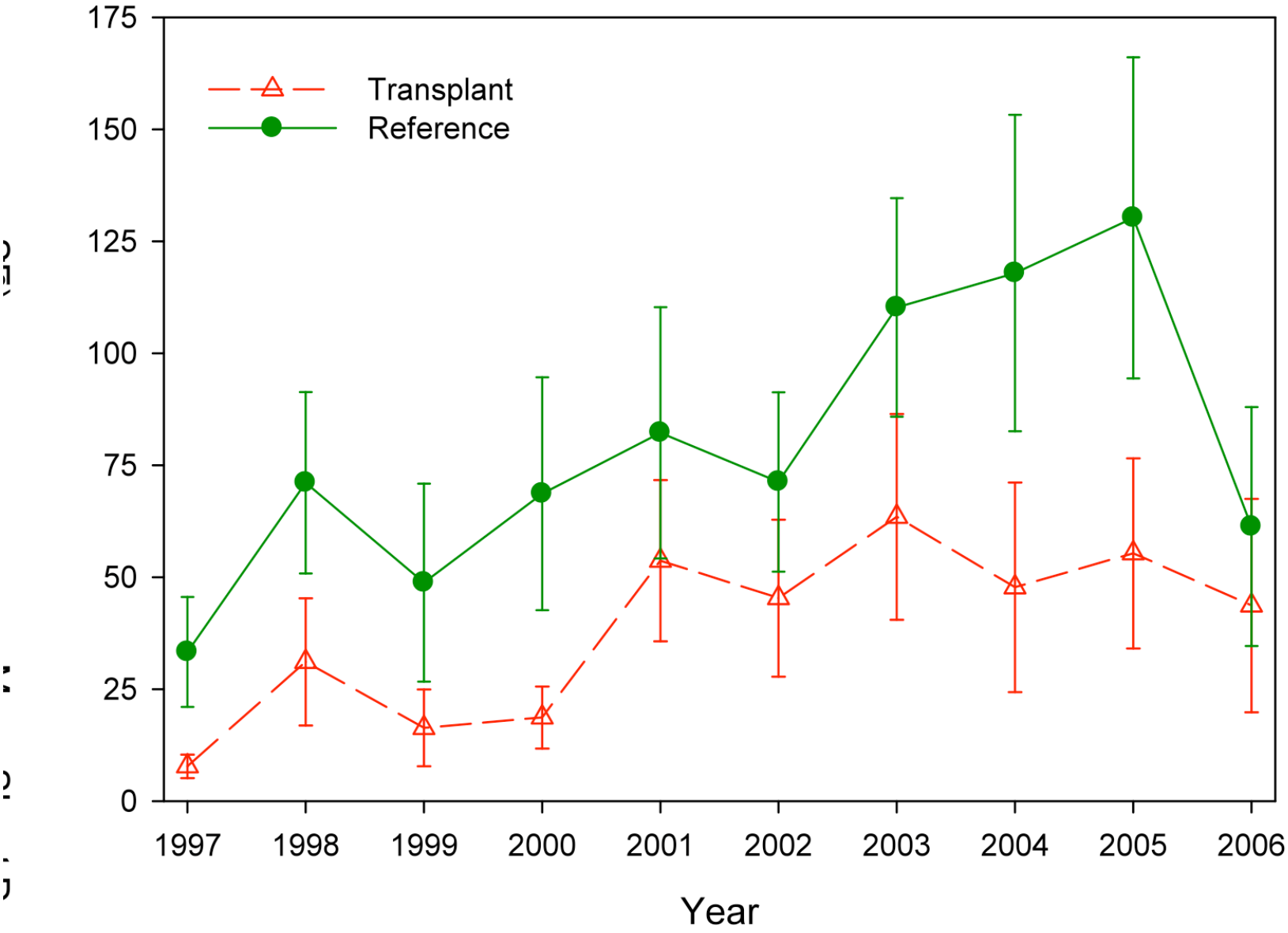
Example - *Eelgrass restoration at ferry terminals in Puget Sound*

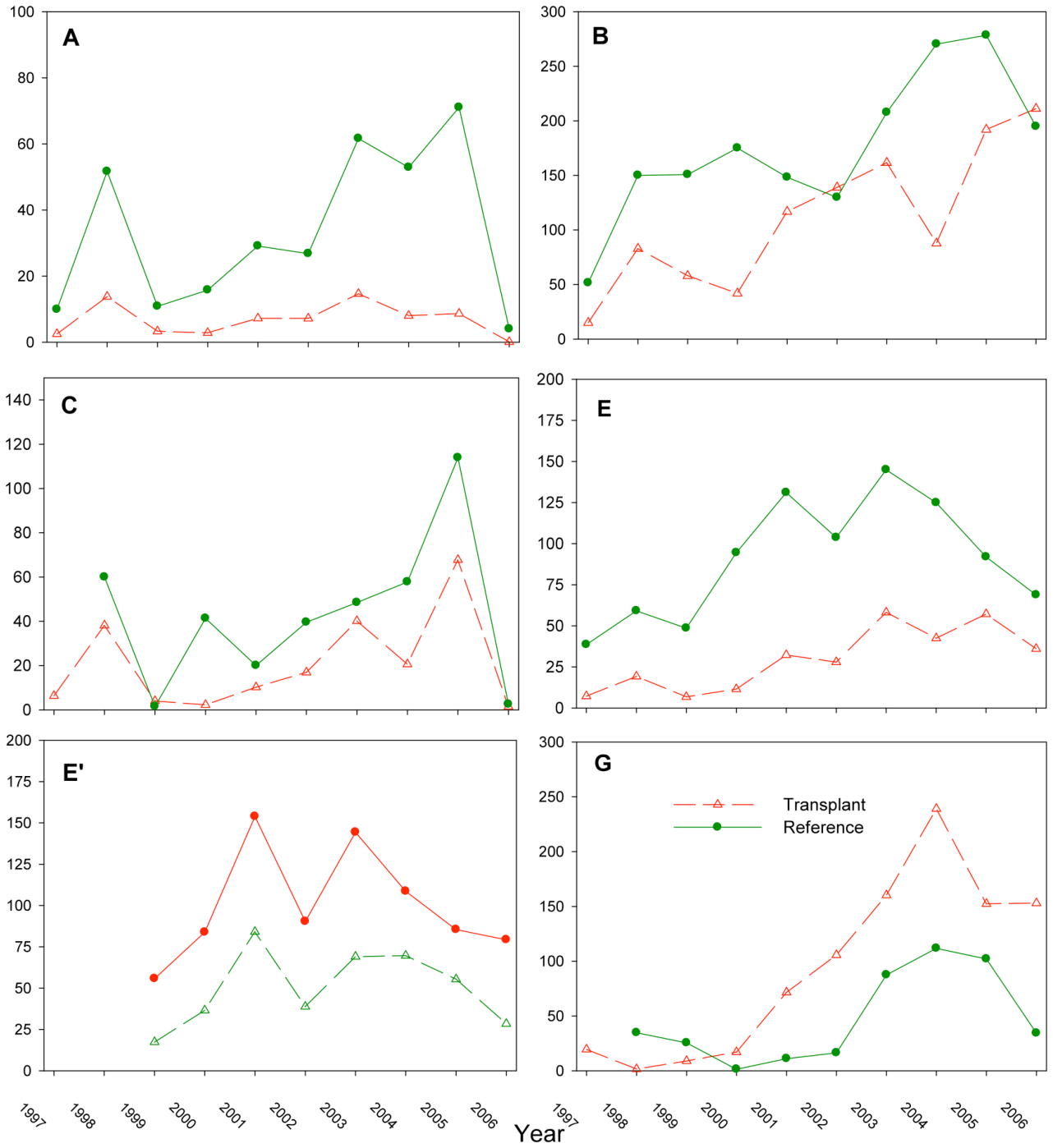
- Need to expand and rebuild 20 terminals
- Eelgrass is at risk
- Goals –
  - net ecosystem improvement
  - explore methods and technologies
  - provide guidance for future dock
- Directed research on requirements and specific stressors
- Planting and monitoring
  - Implement design alternatives
  - Overcompensate to provide net increase
  - Try some experimental actions, glass blocks, planting methods,

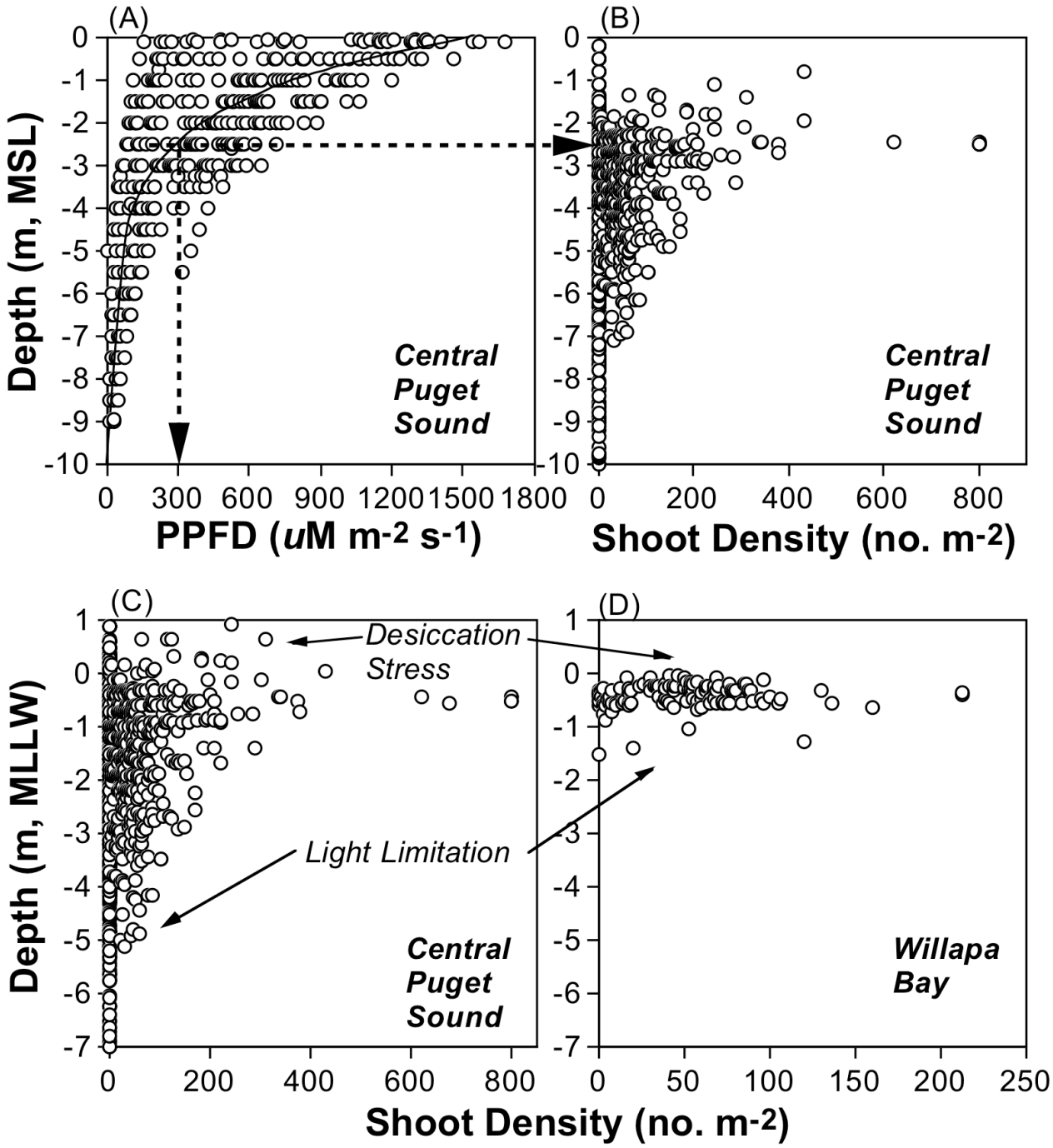

C Ref
C
A
A Ref
J
I
B Ref
B
H' H
F
F Ref
D
D Ref
G
E'
G Ref
E' Ref
E
E Ref
Clinton Ferry Terminal
Rockpile
Eelgrass Restoration Plots
Transplant Plot
Reference Plot
10 0 10 20 Meters
N

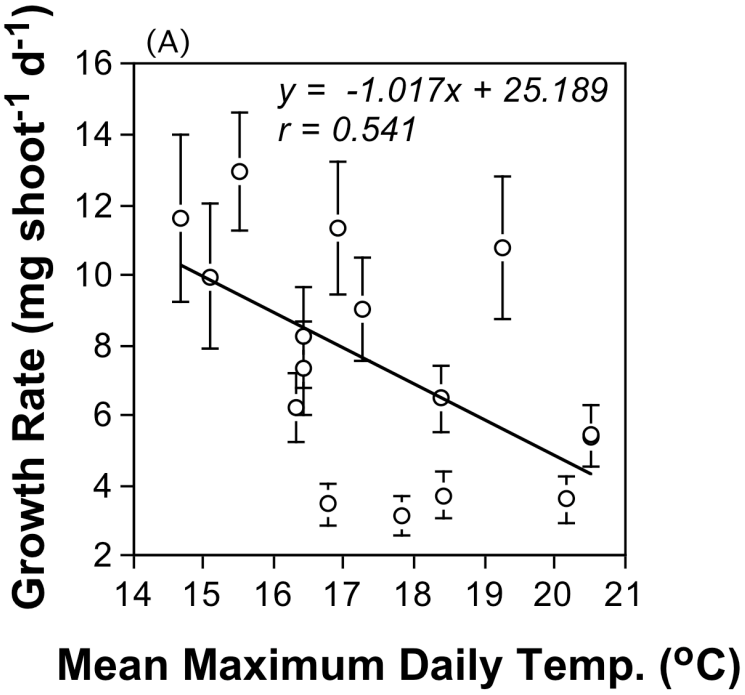


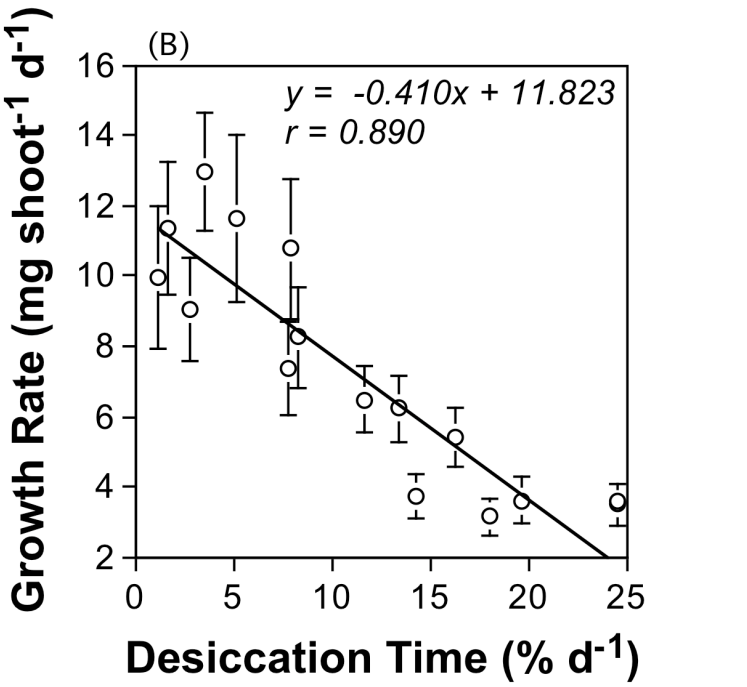


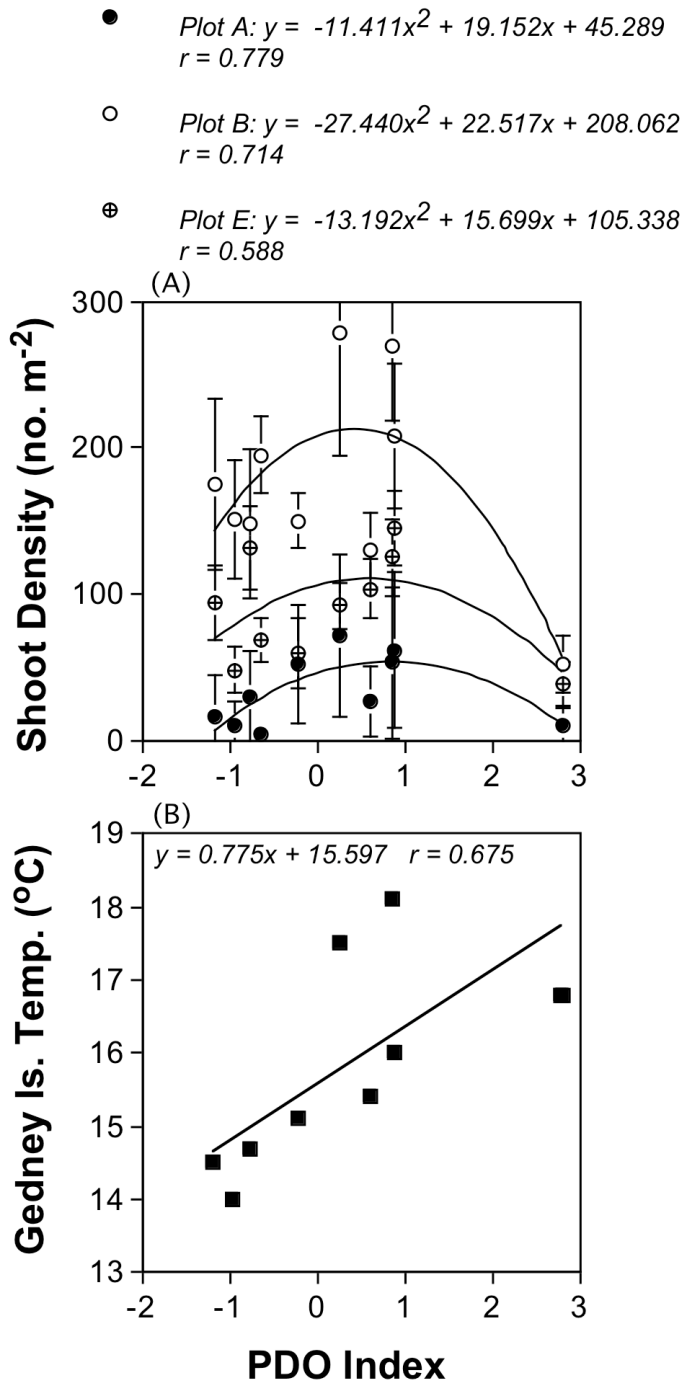

175
150
125
100
75
50
25
0
Transplant
Reference
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year

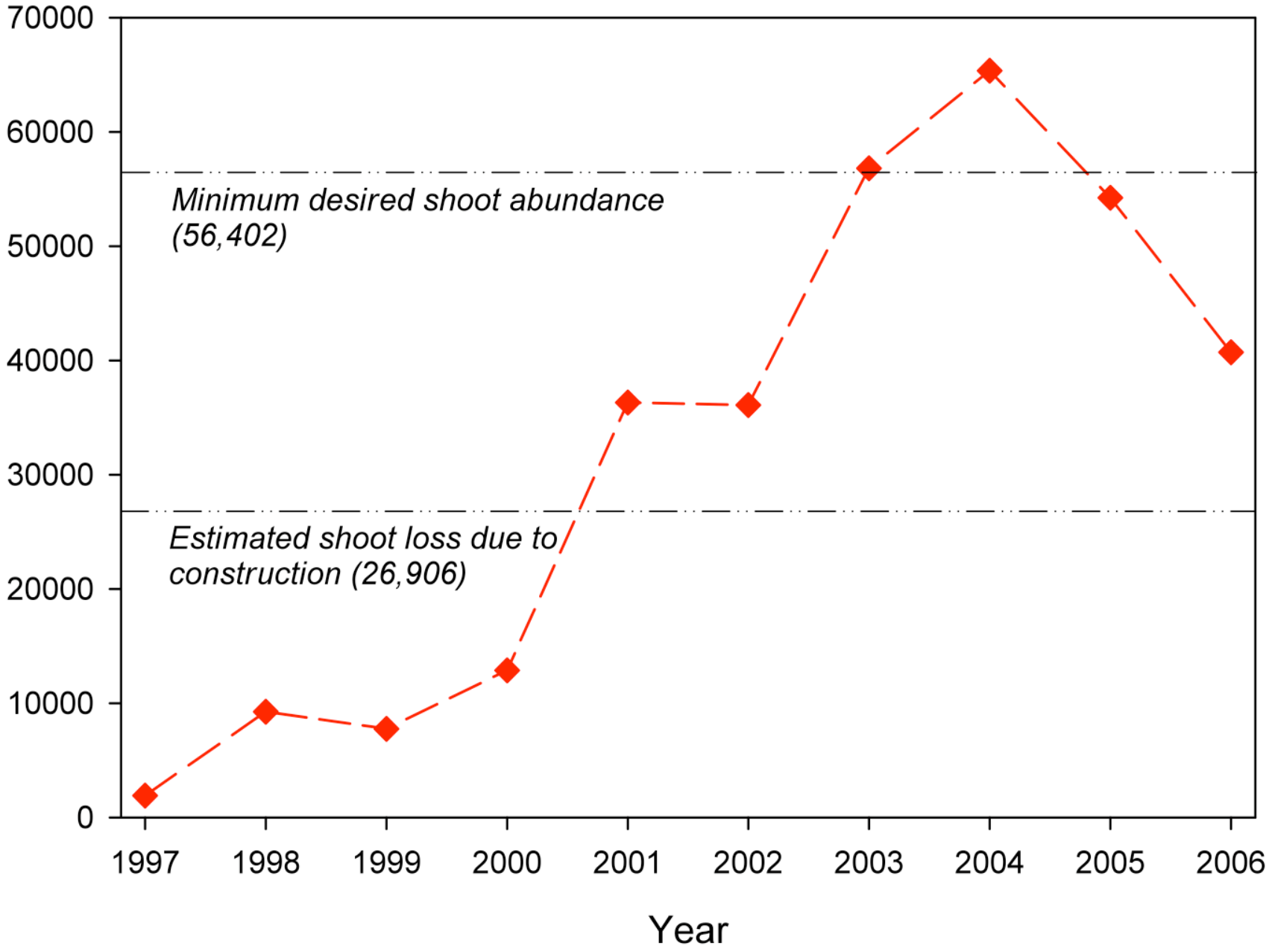

A
B
C
E
E'
G
Transplant
Reference
Year
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006


(A)
(B)
(C)
(D)
Depth (m, MSL)
Depth (m, MLLW)
PPFD (uM m-2 s-1)
Shoot Density (no. m-2)
Central Puget Sound
Willapa Bay
Desiccation Stress
Light Limitation

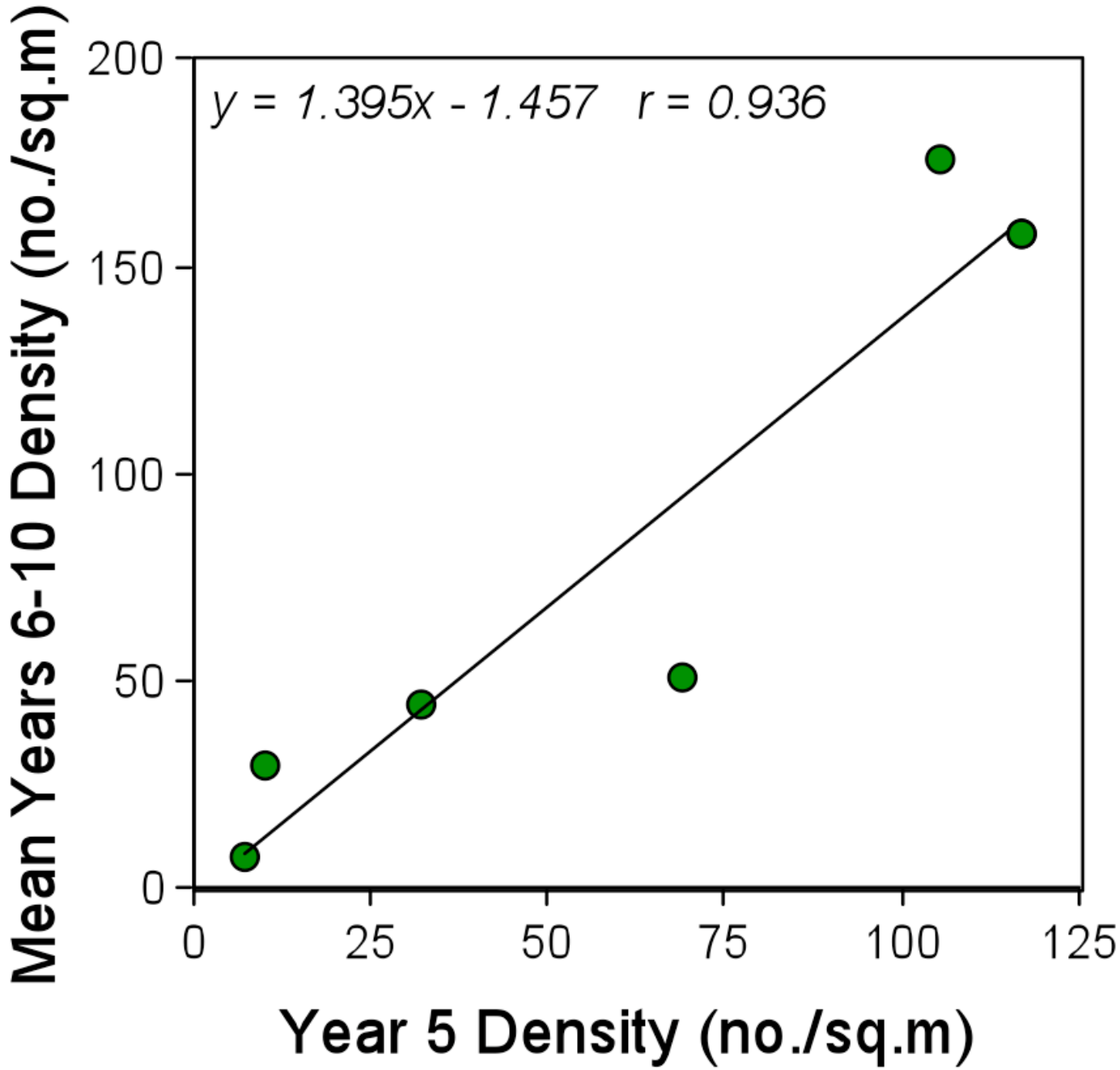

(A)
y = -1.017x + 25.189
r = 0.541
Growth Rate (mg shoot-1 d-1)
Mean Maximum Daily Temp. (ºC)
16
14
12
10
8
6
4
2
14
15
16
17
18
19
20
21


(B)
y = -0.410x + 11.823
r = 0.890
Growth Rate (mg shoot-1 d-1)
Desiccation Time (% d-1)
16
14
12
10
8
6
4
2
0
5
10
15
20
25


Plot A: y = -11.411x2 + 19.152x + 45.289
r = 0.779
Plot B: y = -27.440x2 + 22.517x + 208.062
r = 0.714
Plot E: y = -13.192x2 + 15.699x + 105.338
r = 0.588
(A)
Shoot Density (no. m-2)
300
200
100
0
-2
-1
0
1
2
3
(B)
y = 0.775x + 15.597 r = 0.675
Gedney Is. Temp. (°C)
19
18
17
16
15
14
13
PDO Index


70000
60000
50000
40000
30000
20000
10000
0
Minimum desired shoot abundance
(56,402)
Estimated shoot loss due to
construction (26,906)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year

Criteria	Qualifier	Mitigation Performance Measure	Performance as of 2006	Meets Performance Measure
NO NET LOSS	All areas	Estimate of 26,906 shoots lost to construction	40,717 shoots	YES
Total Shoot Abundance (no. shoots)	All plots	56,402 shoots	40,717 shoots	NO[(a)]
Eelgrass Area (m^2)	All plots	3.9:1 (restored:lost)	5.9:1 (restored:lost)	YES
Eelgrass Area (m^2)	All plots (minus experimental plots)	3.9:1 (restored:lost)	4.6:1 (restored:lost)	YES
Kelp, Seaweed, and Rockfish Habitat	Pile collars and rock pile	Seaweeds, kelp and rockfish present within 3 years	Present (for 3 consecutive years)	YES


y = 1.395x - 1.457 r = 0.936
Mean Years 6-10 Density (no./sq.m)
Year 5 Density (no./sq.m)
0
50
100
150
200
0
25
50
75
100
125

Some “Learning”

- Light requirements
- Light through glass blocks
- Among-site variation
- Issues with reference sites
- Depth vs density effect
- Climate variability effect
- Disturbances (erosion/deposition)
- Evaluation of ‘real goal’
- Long-term density predictions
- Minimum viable populations
- Carrying capacity
- Set up AM framework up front

AM as applied to Compensatory Mitigation vs Restoration…it's a matter of degree

- Regulatory 'hammer'
- Time frame for performance
- Handling of uncertainties
- Stakeholders
- Volunteer use
- Monitoring level
- Contingencies
- Ability to do experiments
- Ability to model
- Scales of projects
- Dissemination of results
- Other?

Thanks! ron.thom@pnl.gov

Some papers –

- *Adaptively addressing uncertainty in estuarine and near coastal restoration projects*
- *Balancing the need to develop coastal areas with the desire for an ecologically functioning coastal environment: Is net ecosystem improvement possible*
- *Monitoring and adaptive management guidelines for nearshore restoration proposals and projects*
- *Nearshore assessment approach*