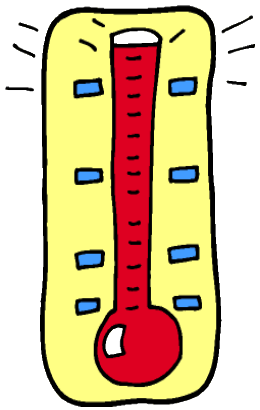
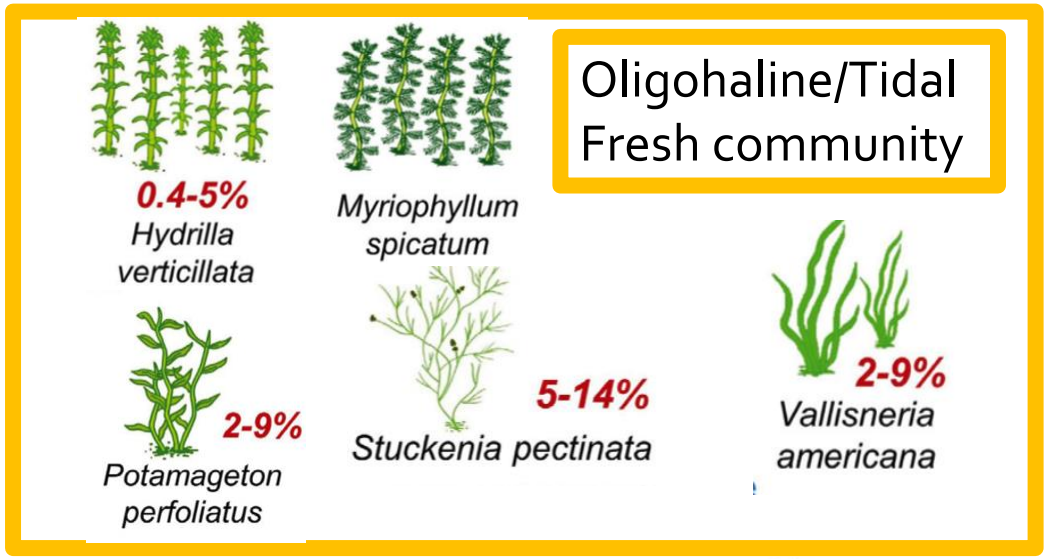
Envisioning the future for Chesapeake Bay SAV under climate change

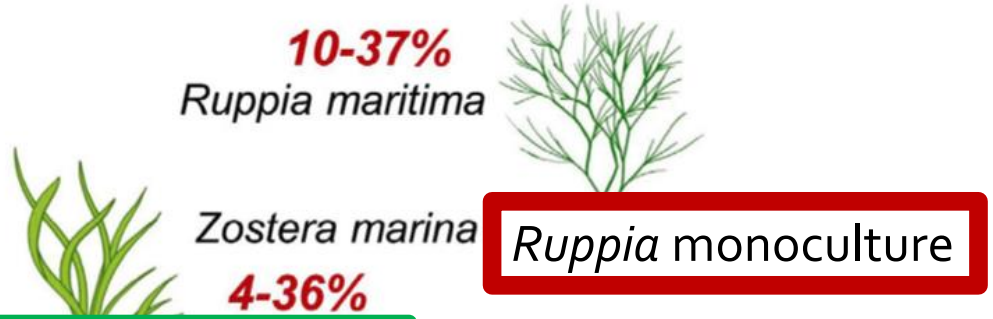
Marc Hensel, Chris Patrick, Jon Lefcheck, Dave Wilcox

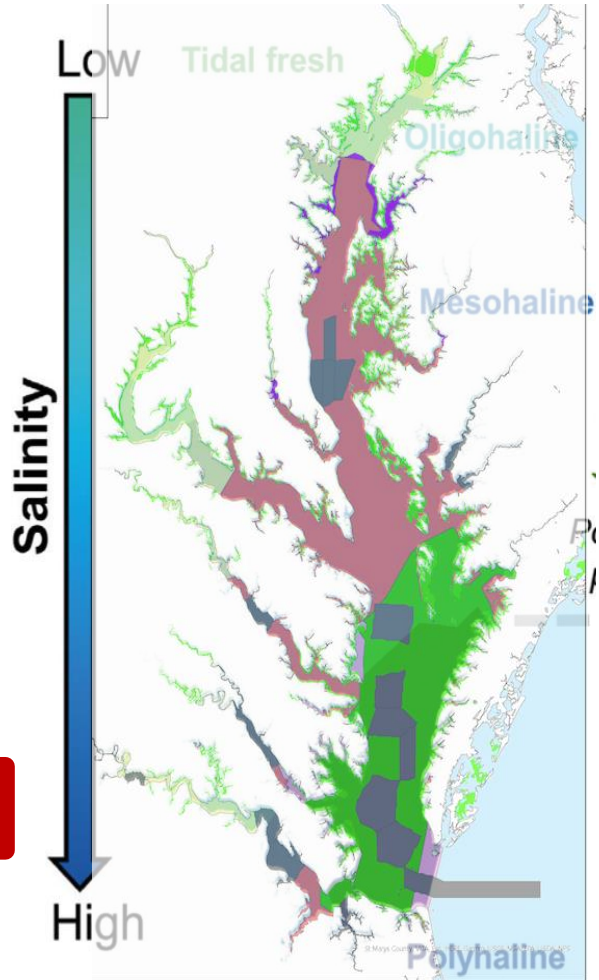
Modelling WG

1.11.23

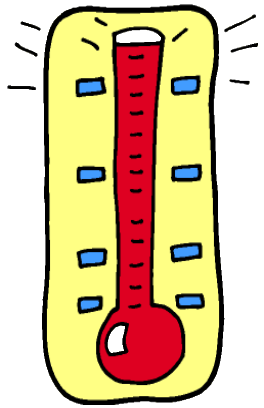


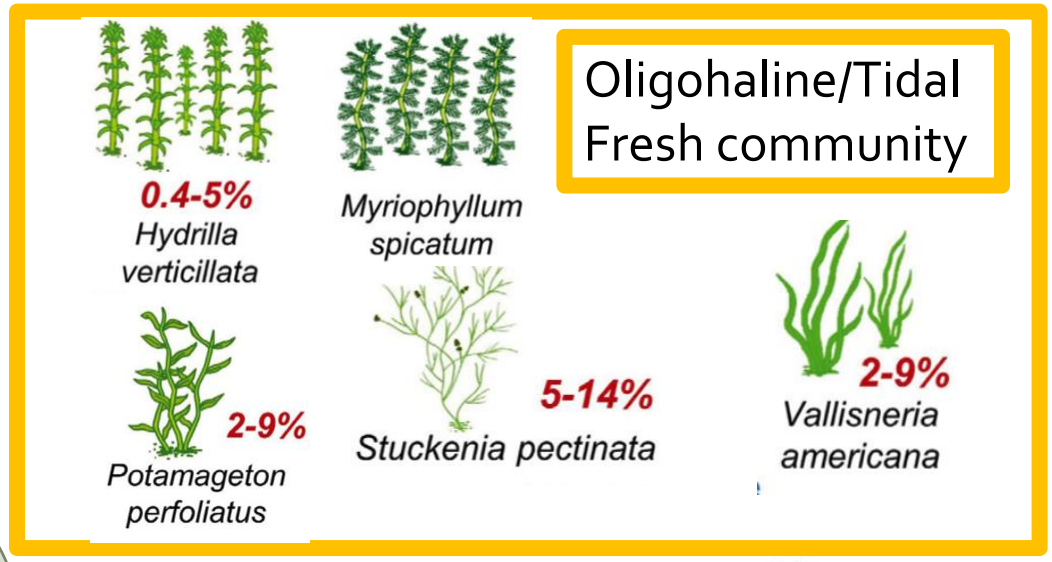


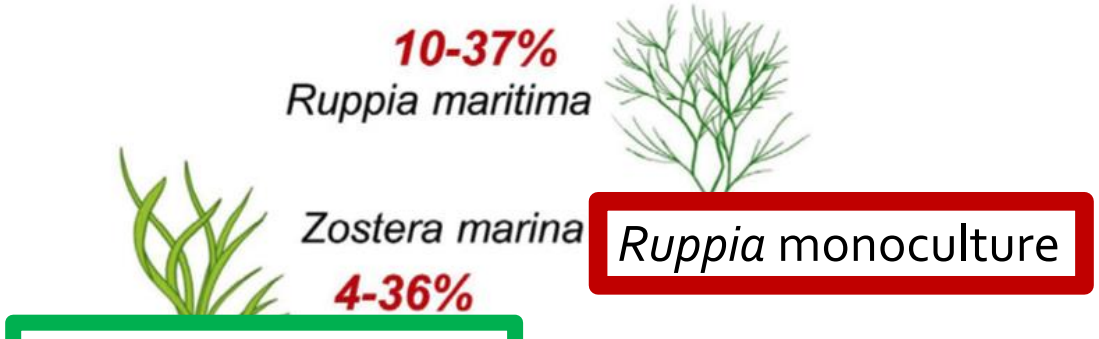


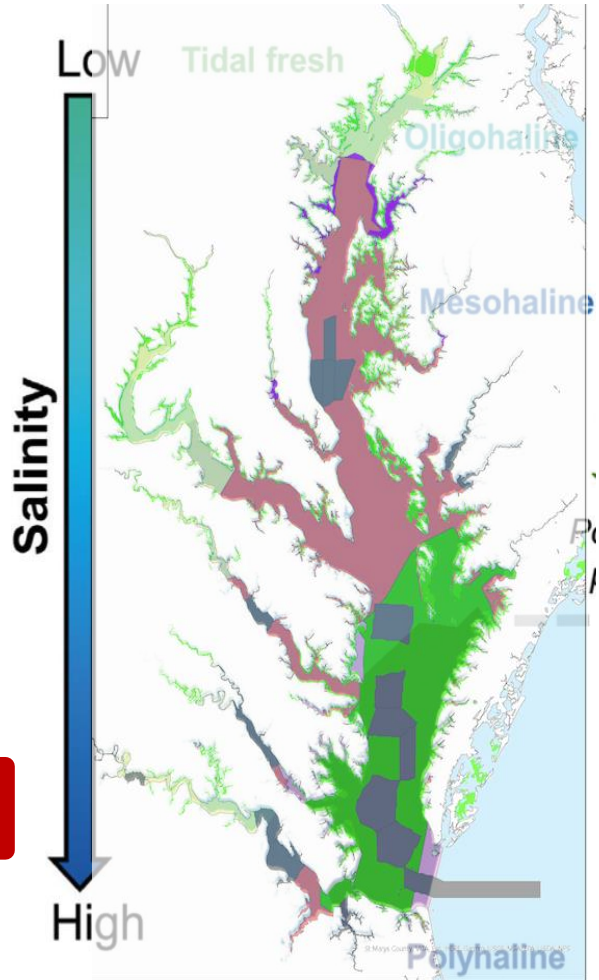


How will climate change and human activities affect the major communities of submersed aquatic vegetation in the Chesapeake Bay?



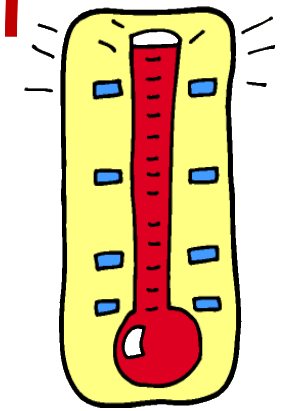






How will climate change and human activities affect the major communities of seagrass and aquatic vegetation in the Chesapeake Bay?

Climate change



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Temperature rise Rainfall variability

Human activities

No further nutrient reductions

OR

More nutrient reductions

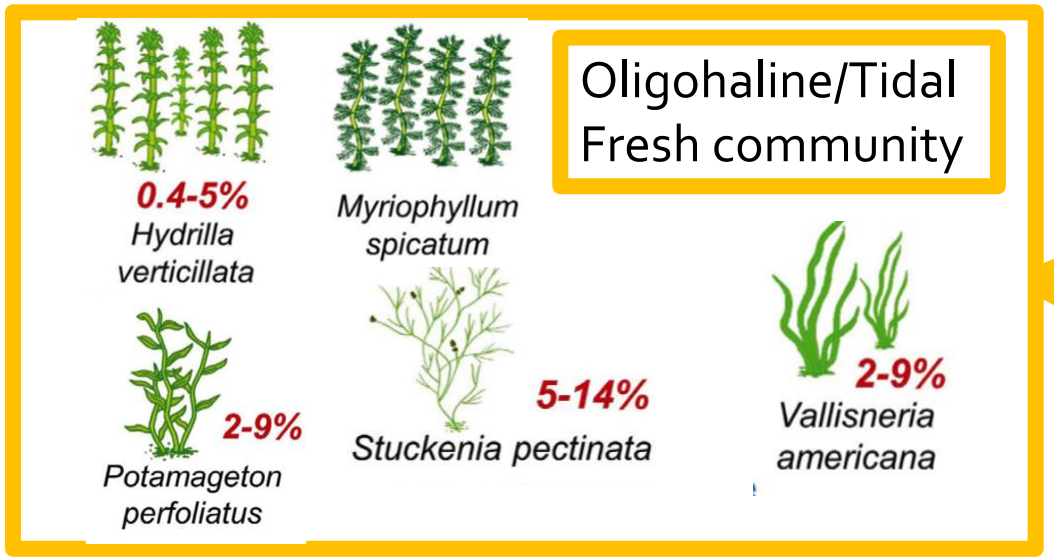
Predicting the future in three steps|

Step 1: How have past environmental conditions affected SAV communities?

Step 2: How will environmental conditions shift with climate change & with human activities?

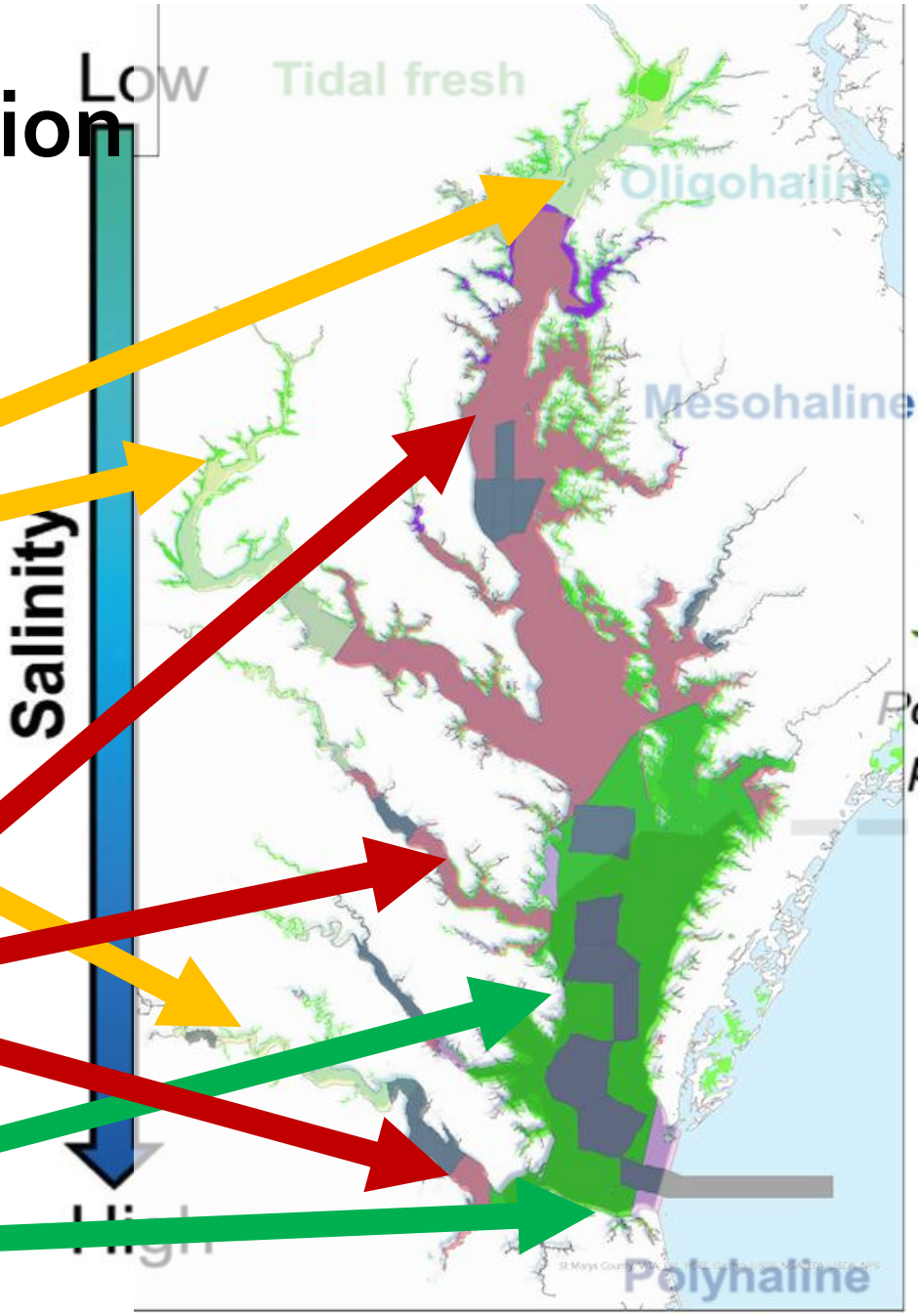
Step 3: How will shifting conditions and shifting species affect SAV meadow coverage into the future?

Step 1: ID major communities of Chesapeake Bay seagrass and vegetation

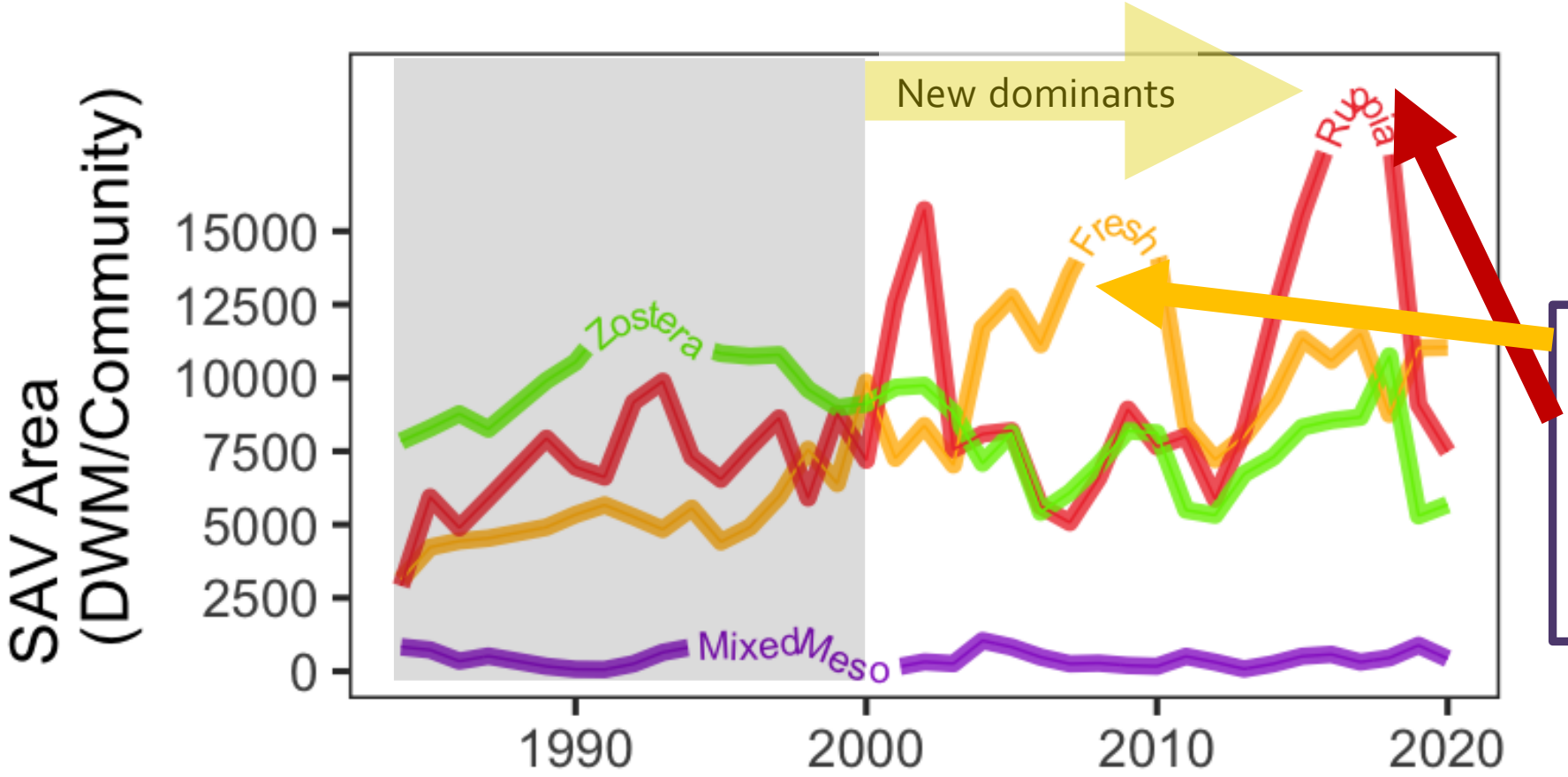


Ruppia monoculture

Zostera monoculture

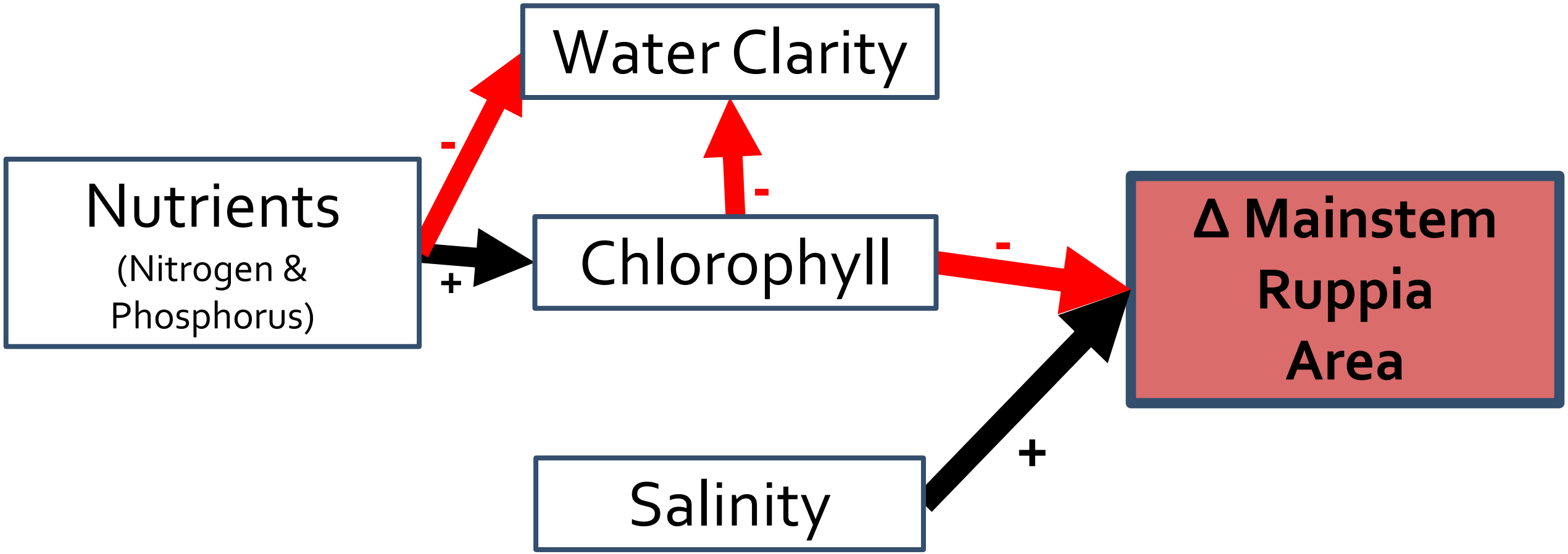


Step 1: Dominant communities have changed over time in response to climate and management



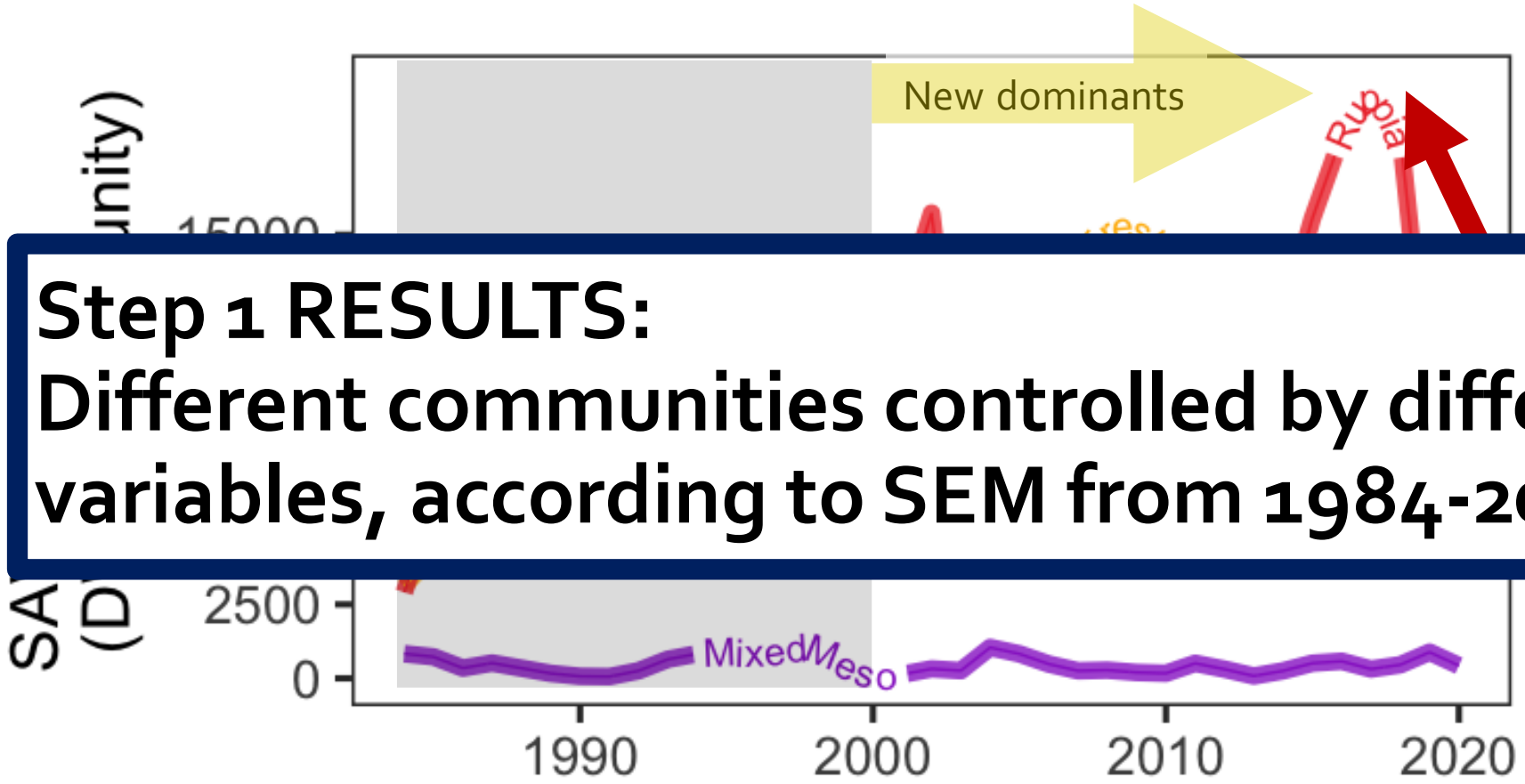
Tidal fresh and widgeongrass are the dominant communities now

Structural Equation Modelling example from *Ruppia* community



Δ Widg: $R^2_c = 0.59$

Step 1: Dominant communities have changed over time in response to climate and management



Step 1 RESULTS:
Different communities controlled by different seasonal variables, according to SEM from 1984-2020

communities now

Predicting the future in three steps|

Step 1: How have past environmental conditions affected seagrass communities?

-New dominants are controlled by flow of nutrients from watershed

Step 2: How will environmental conditions shift with climate change & with human activities?

Step 3: How will shifting conditions and shifting species affect seagrass meadow coverage into the future?

Predicting the future in three steps|

Step 1: How have past environmental conditions affected seagrass communities?

-New dominants are controlled by flow of nutrients from watershed

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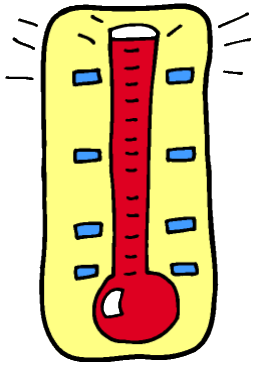
Step 3: How will shifting conditions and shifting species affect seagrass meadow coverage into the future?

Step 2: Two future scenarios from CBP Modelling data|

No Further Action

CC only

No further nutrient reductions



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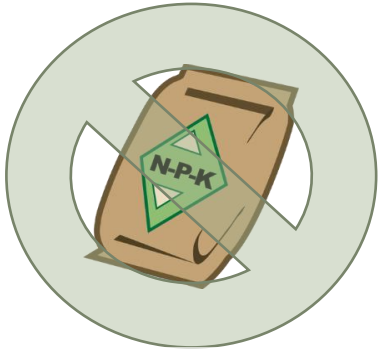
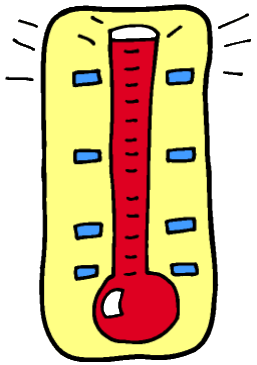
Temperature rise Rainfall variability

Nutrient Reductions

WIP



More nutrient reductions



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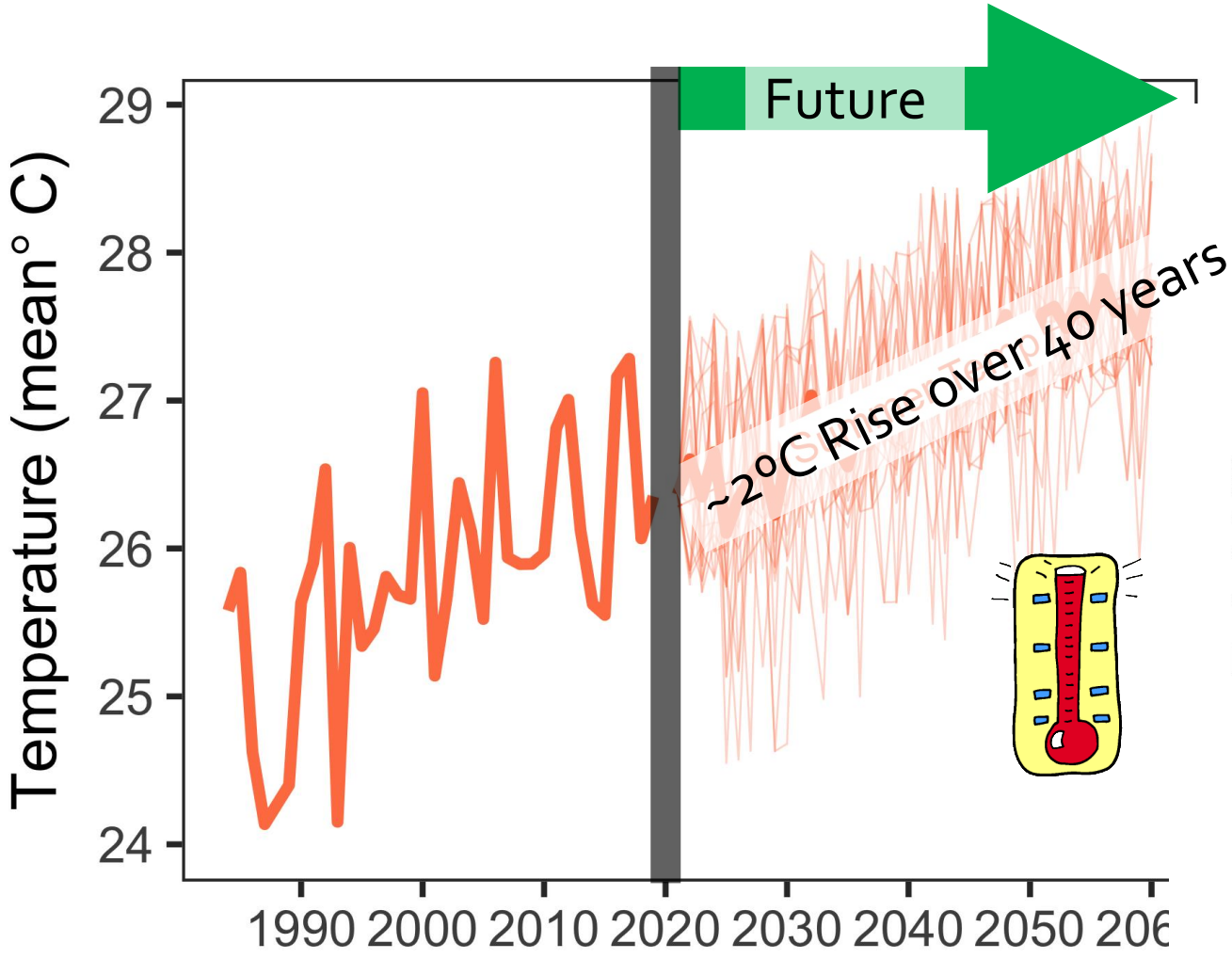
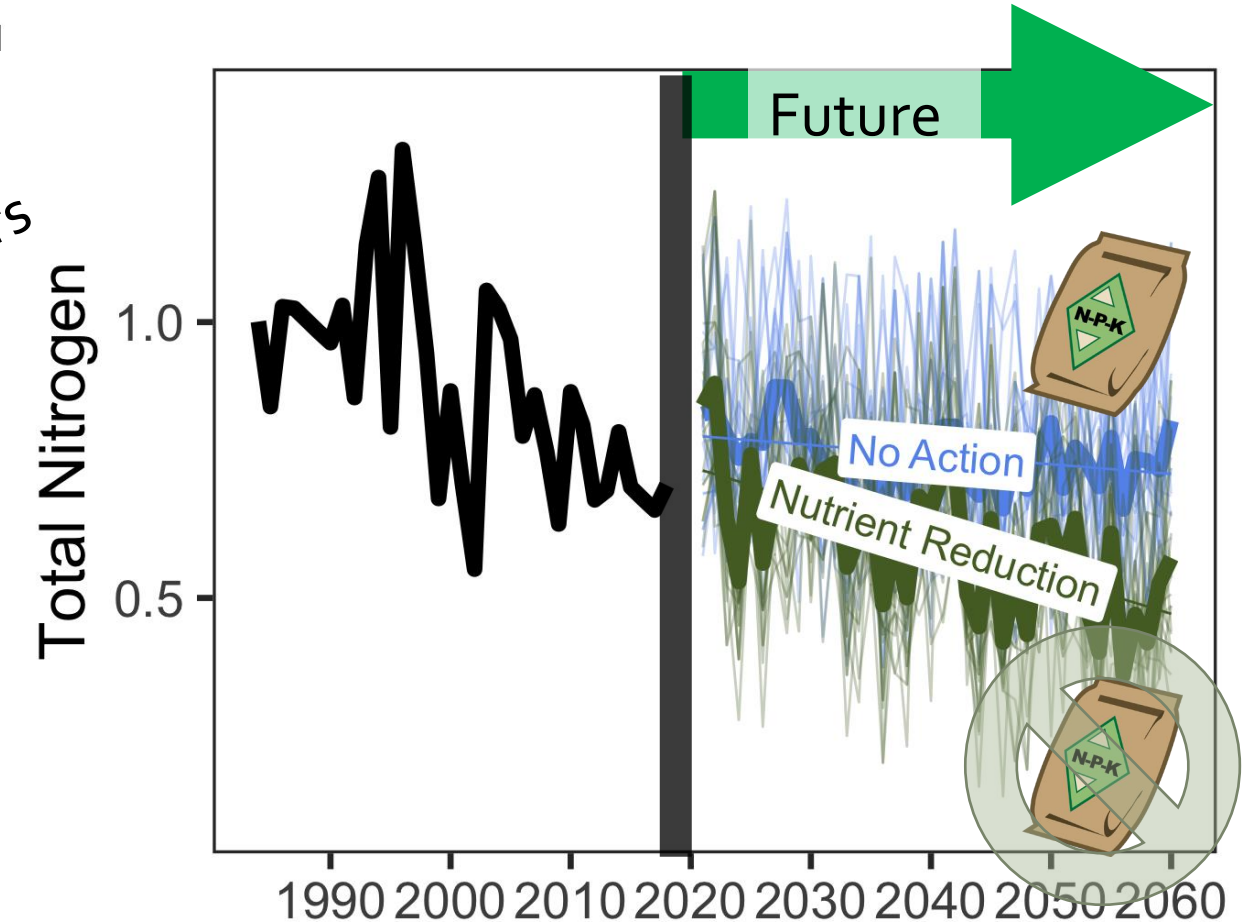
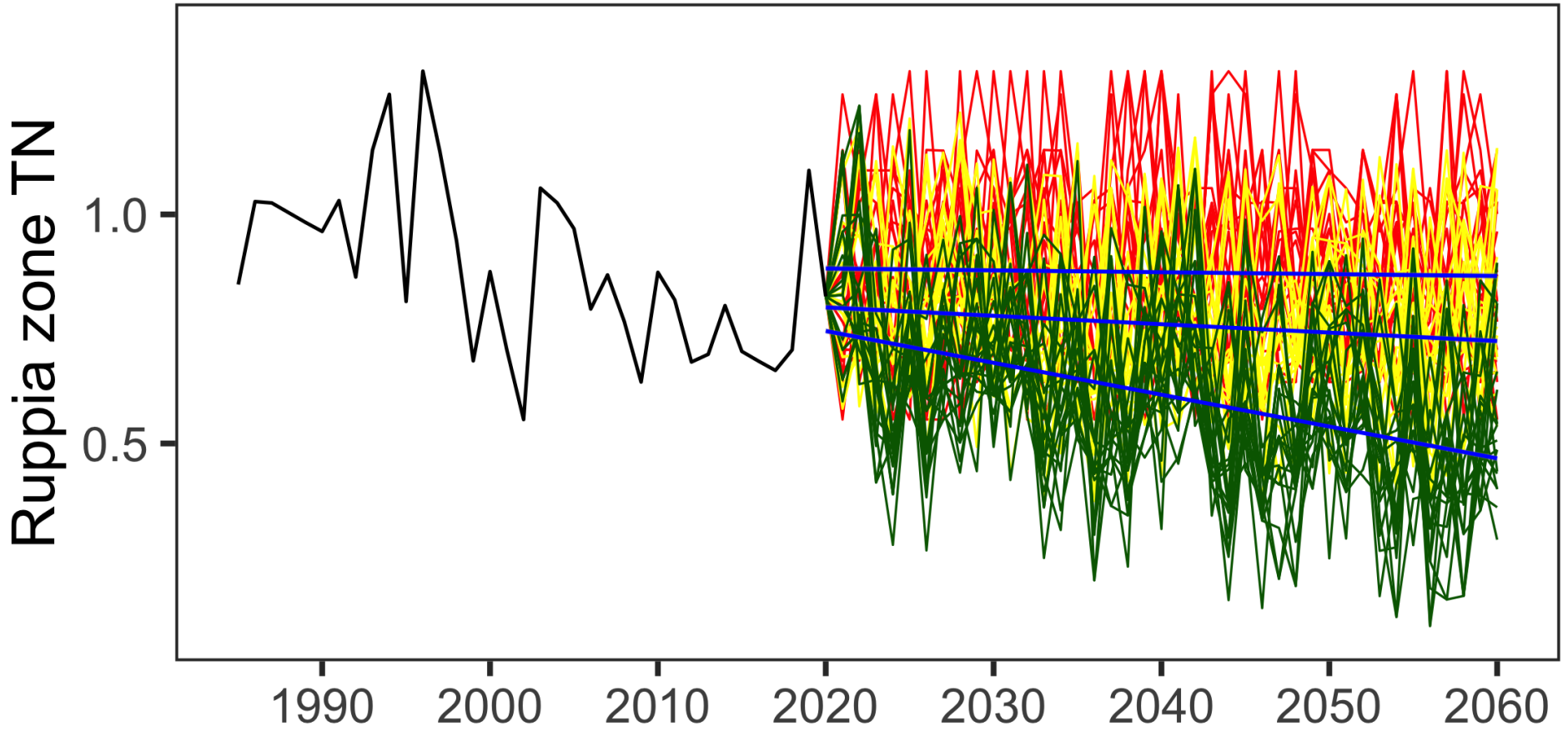
Temperature rise Rainfall variability

Step 2: Temperature increase, rainfall variation in both further nutrient reductions vs no action





But they were deceived, for another scenario was made

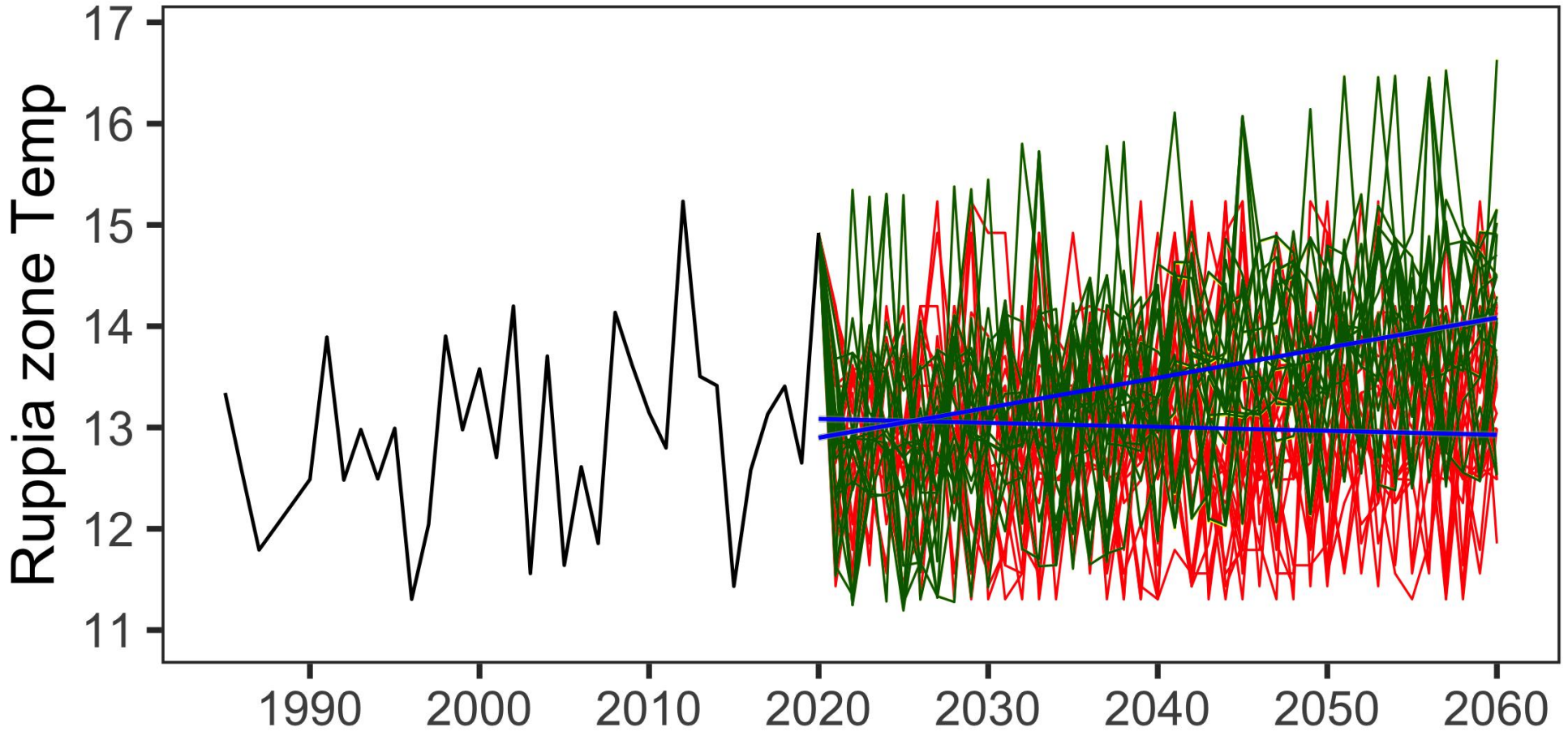


Past Is Future

No Further Action

Nutrient Reduction

But they were deceived, for another scenario was made



No Further Action

Nutrient Reduction

Past Is Future

Predicting the future in three steps|

Step 1: How have past environmental conditions affected seagrass communities?

-New dominants are controlled by flow of nutrients from watershed

Step 2: How will environmental conditions shift with climate change & with human activities?

-Created 3 scenarios:

No Further Action = Temp rise, Nutrient levels stagnant

Nutrient Reduction = Temp rise, Nutrient levels decrease

Past Is Future = No Climate Change, Nutrient levels stagnant

Step 3: How will shifting conditions and shifting species affect seagrass meadow coverage into the future?

Predicting the future in three steps|

Step 1: How have past environmental conditions affected seagrass communities?

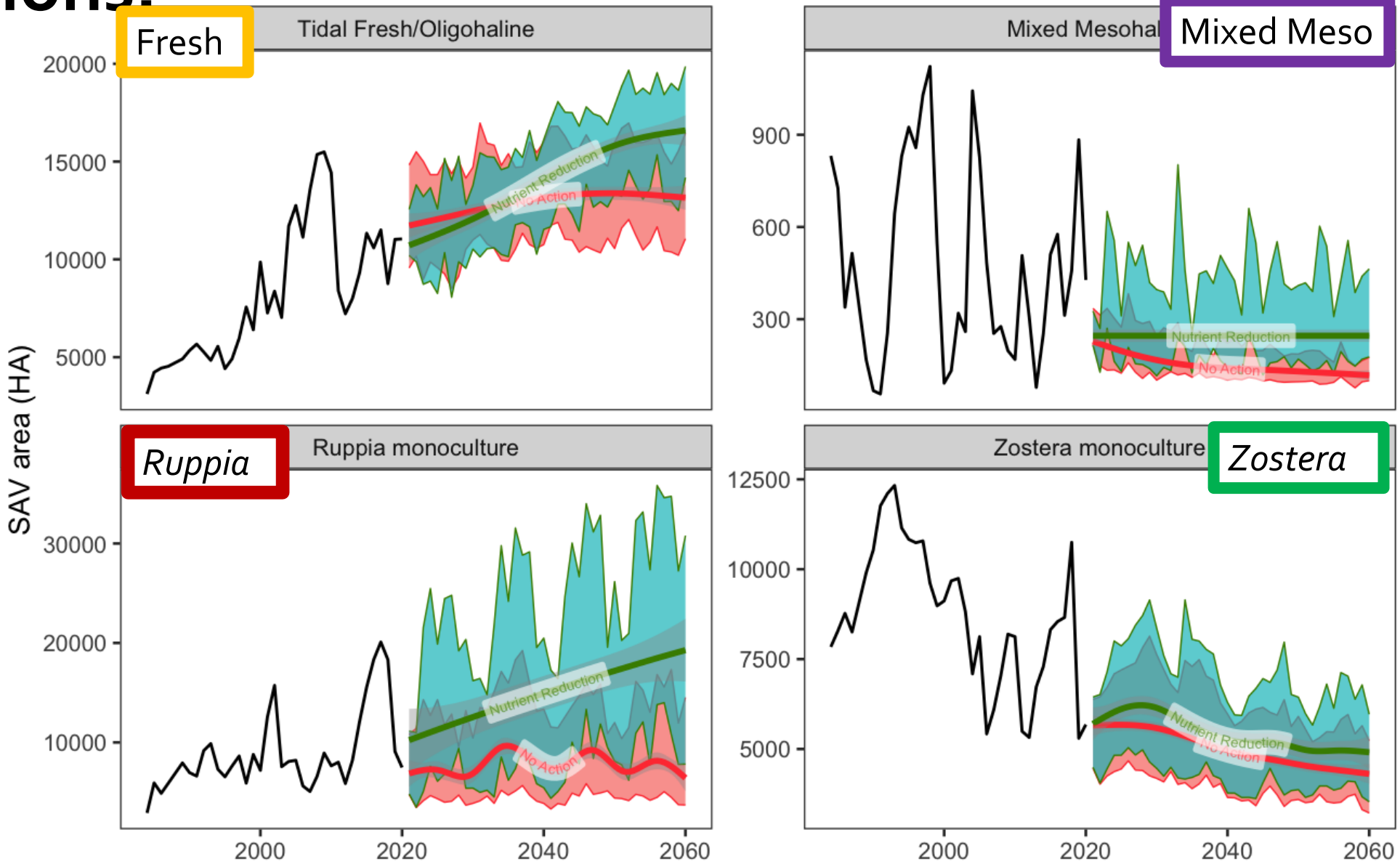
-New dominants are controlled by flow of nutrients from watershed

Step 2: How will environmental conditions shift with climate change & with human activities?

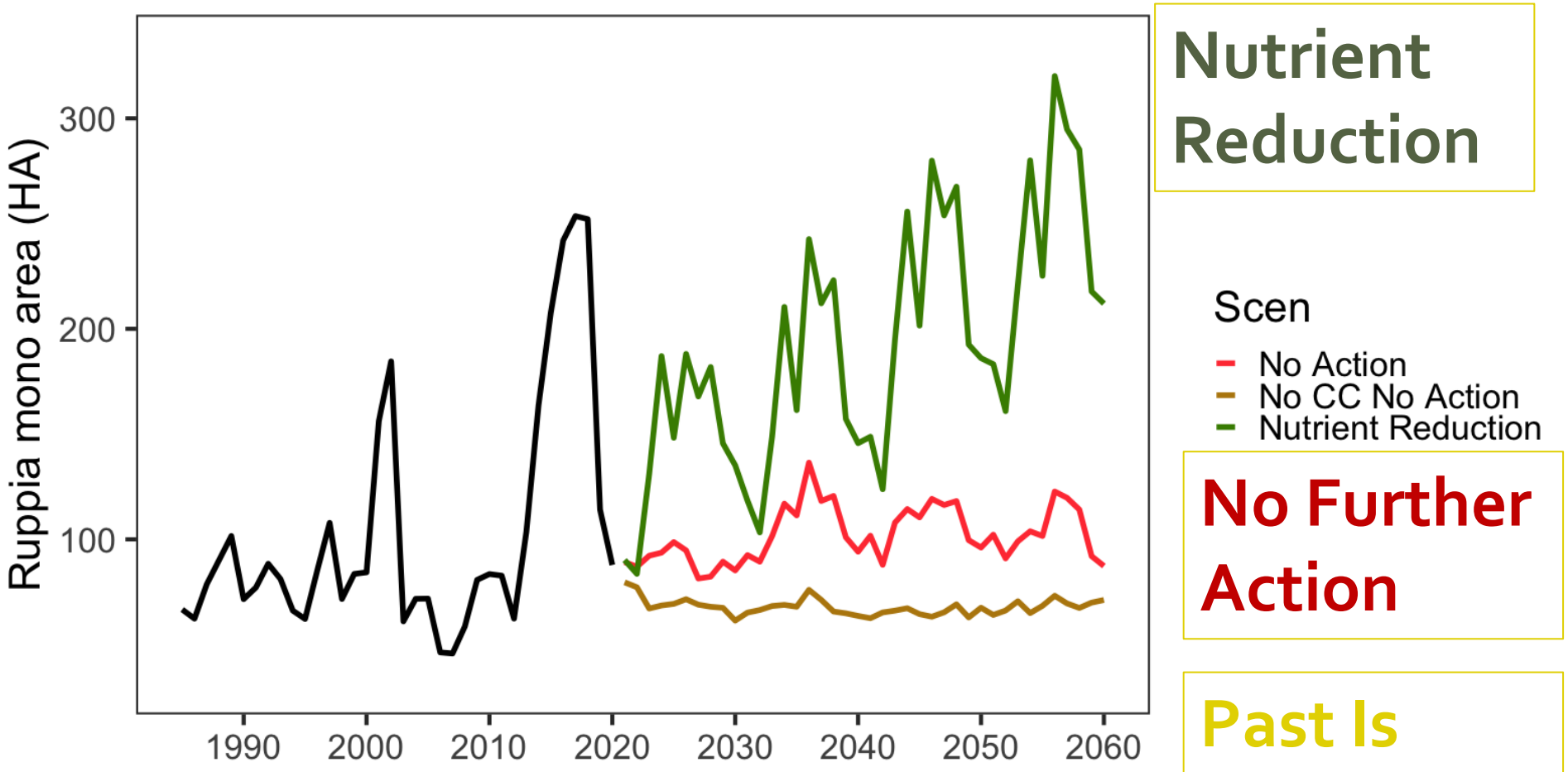
-Created 3 scenarios

Step 3: How will shifting conditions and shifting species affect seagrass meadow coverage into the future?

New dominants respond most positively to nutrient reductions!



But they were deceived, for another scenario was made



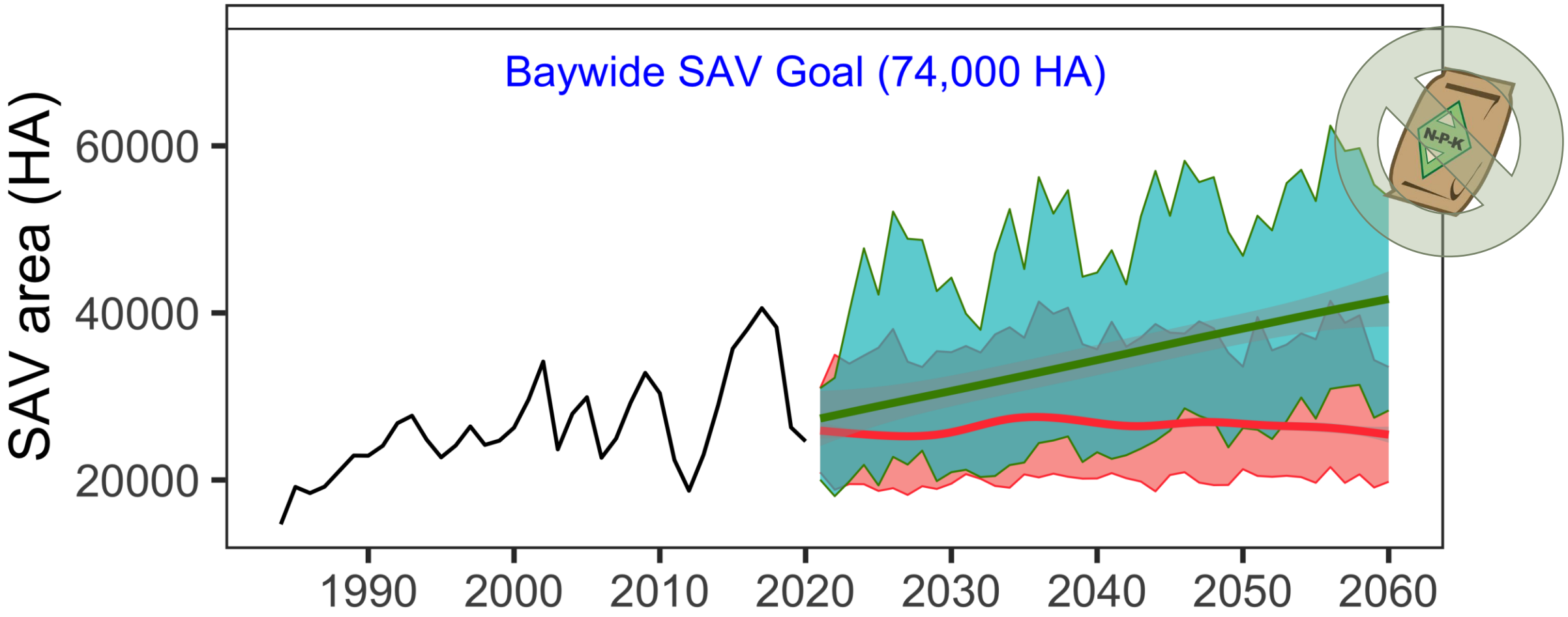
Nutrient Reduction

No Further Action

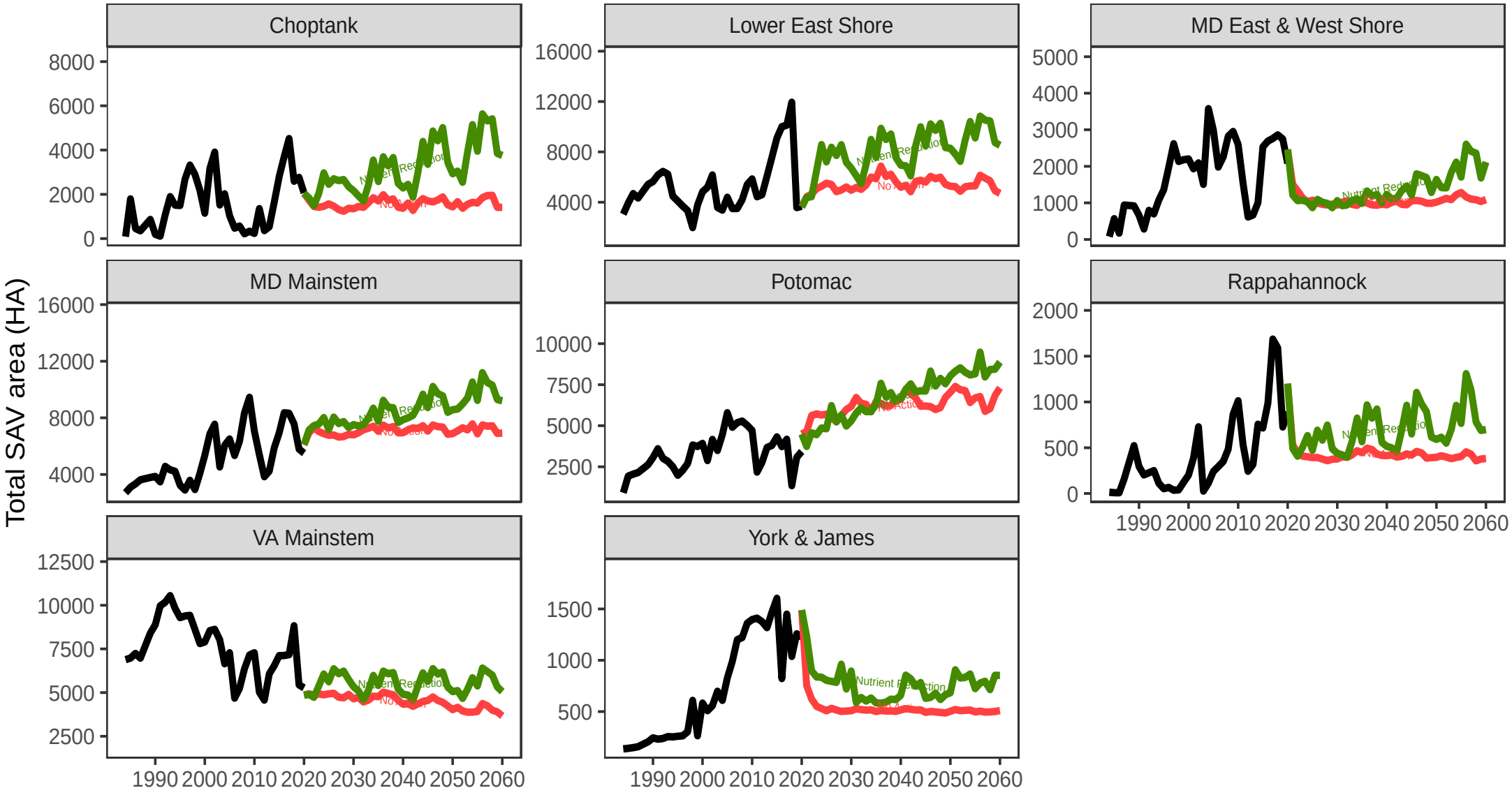
Past Is Future

-note: cyclical "pattern" is bc management is applied every decade. Will fix in post!

0% of No Action simulations reach Baywide goals, 0% of Nutrient reduction simulations reach Baywide goals..but get much closer by 2060!



Gains in Choptank, Lower E Shore, MD mainstem offset losses in York/James, VA mainstem…



SUMMARY|

Temperature increases will widen the shift in dominant species, and management must adjust accordingly.

Nutrient reductions in the tidal fresh/oligohaline & *Ruppia* zones are essential, especially because the new dominants respond best to nutrient management

Active regional habitat management offsets and prevents the effects of global climate change, targeted nutrient management that benefits climate-tolerant species encourages continued recovery (!!)

Step 2: ~~Two~~ Four?? future scenarios from CBP Modelling data|

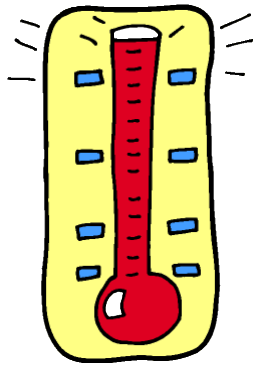
No Further Action

Nutrient Reductions

Want to project out further into the future than 2060? And what about Sea Level Rise?

May need better estimates of accretion and local SLR by community. Current numbers we have say that SAV habitat loss is minimal by 2060…

No further nu



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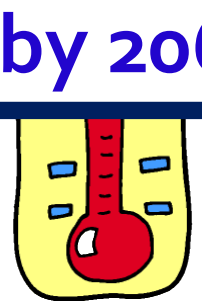

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Temperature rise

Rainfall variability

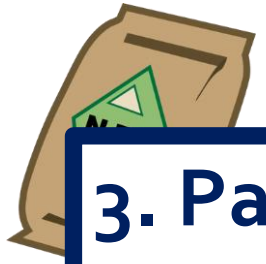
Temperature rise

Rainfall variability

Step 2: ~~Two~~ Four?? future scenarios from CBP Modelling data| Scenarios, Controls, and Realistic Futures

No Further Action

Nutrient Reductions

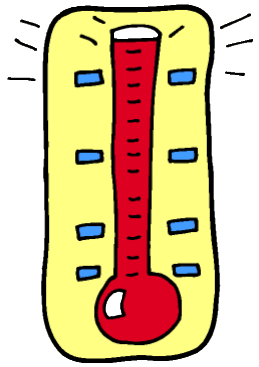


No further nu

3. Past Is Future: No Climate Change and No Nutrient Reductions… redo with hydrology

4. No Climate Change, Nutrient Reductions ???

5…6…7… Modelling Crew can provide with time..

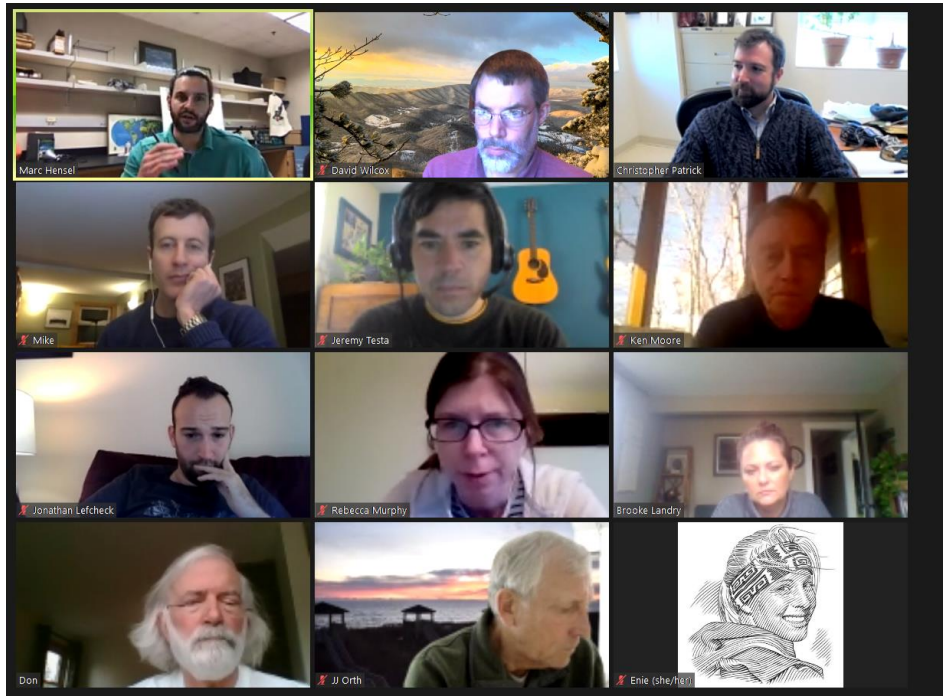


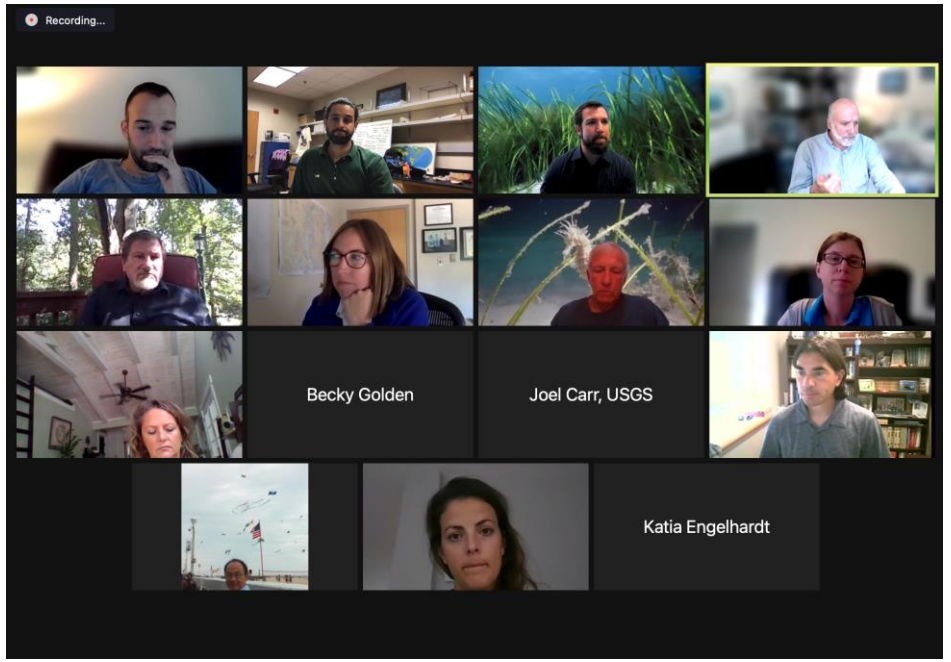
Temperature rise Rainfall variability

Temperature rise Rainfall variability

THANKS to our steering committee!

Robert J. Orth, Bill Dennison, Rebecca Murphy, Jeremy Testa, Matt Fitzpatrick, Katia Engelhardt, Cassie Gurbisz, Karen McGlathery, Aaron Kornbluth, Joel Carr, Lewis Linker, Brooke Landry, Kathrynlynn Theuerkauf, Rebecca Golden





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