Overview of Elkhorn Slough Nutrient TMDL Science Plan

TETRA TECH

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SCCWRP Established 1969

Stakeholder Advisory Group Meeting

July 9, 2019

From Previous Agenda item: Elkhorn slough nutrient TMDL Science Goals

Science

Synthesize science and use that science to facilitate conversations on eutrophication (biostimulatory) targets protective of Slough beneficial uses

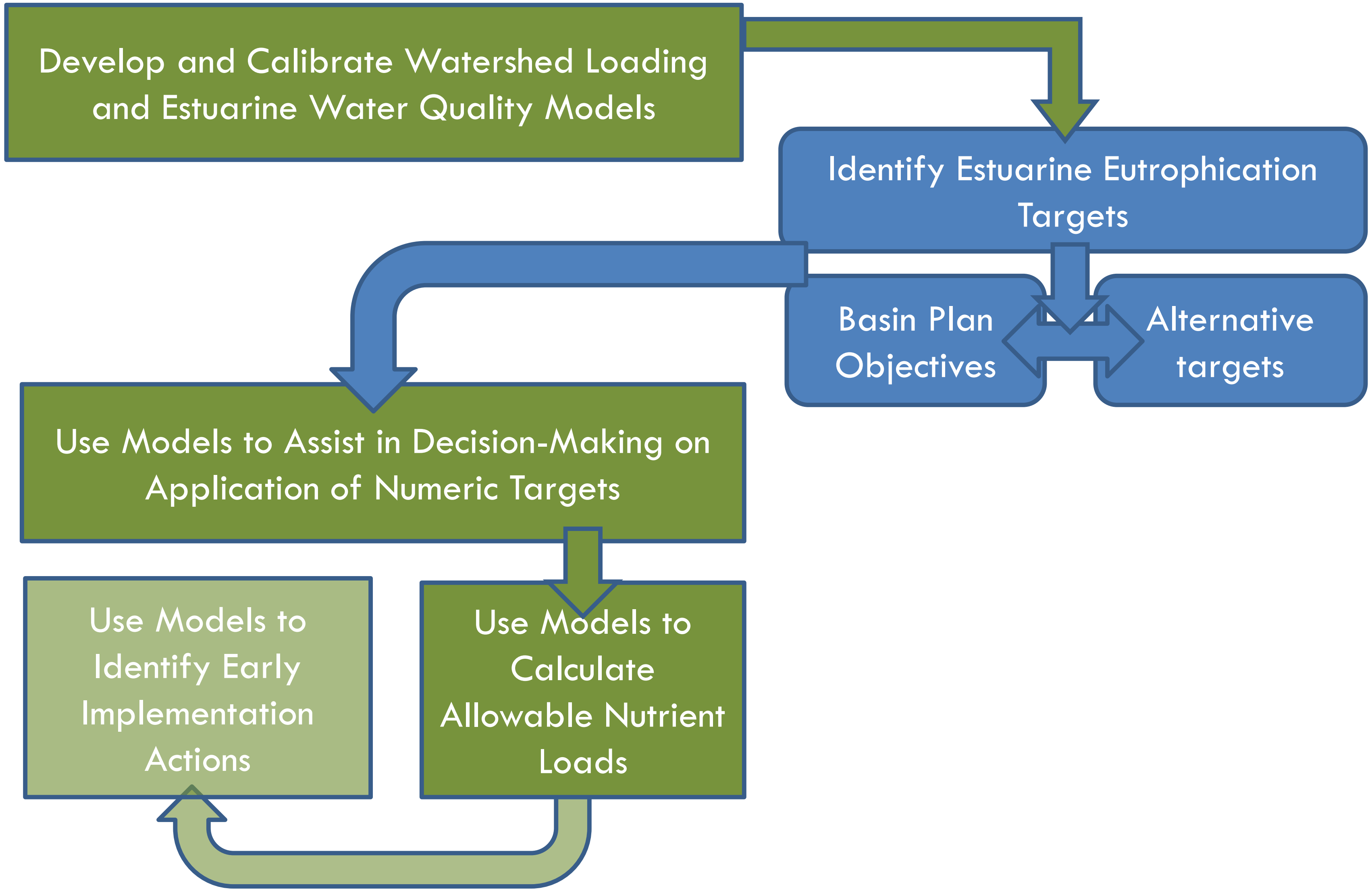
Quantify the relationships between environmental drivers and eutrophication responses in Elkhorn Slough through numerical (computer) modeling

Management:

To quantify the management actions that can result in the remediation of eutrophication in Elkhorn Slough

- Nutrient loads (TMDL)
- Other restoration activities?

Technical Approach Elkhorn Slough Nutrient TMDL Science



Roadmap- Approach to TMDL Science

- Detailed overview of key components—these will frame workplan
  - Synthesis and facilitation of discussion on eutrophication targets
  - Numerical model development and calibration
  - Model application to support decision-making
- Products

Reminder from Earlier: Biostimulatory conditions Could be (partially) managed Through Restoration

Nutrient Management

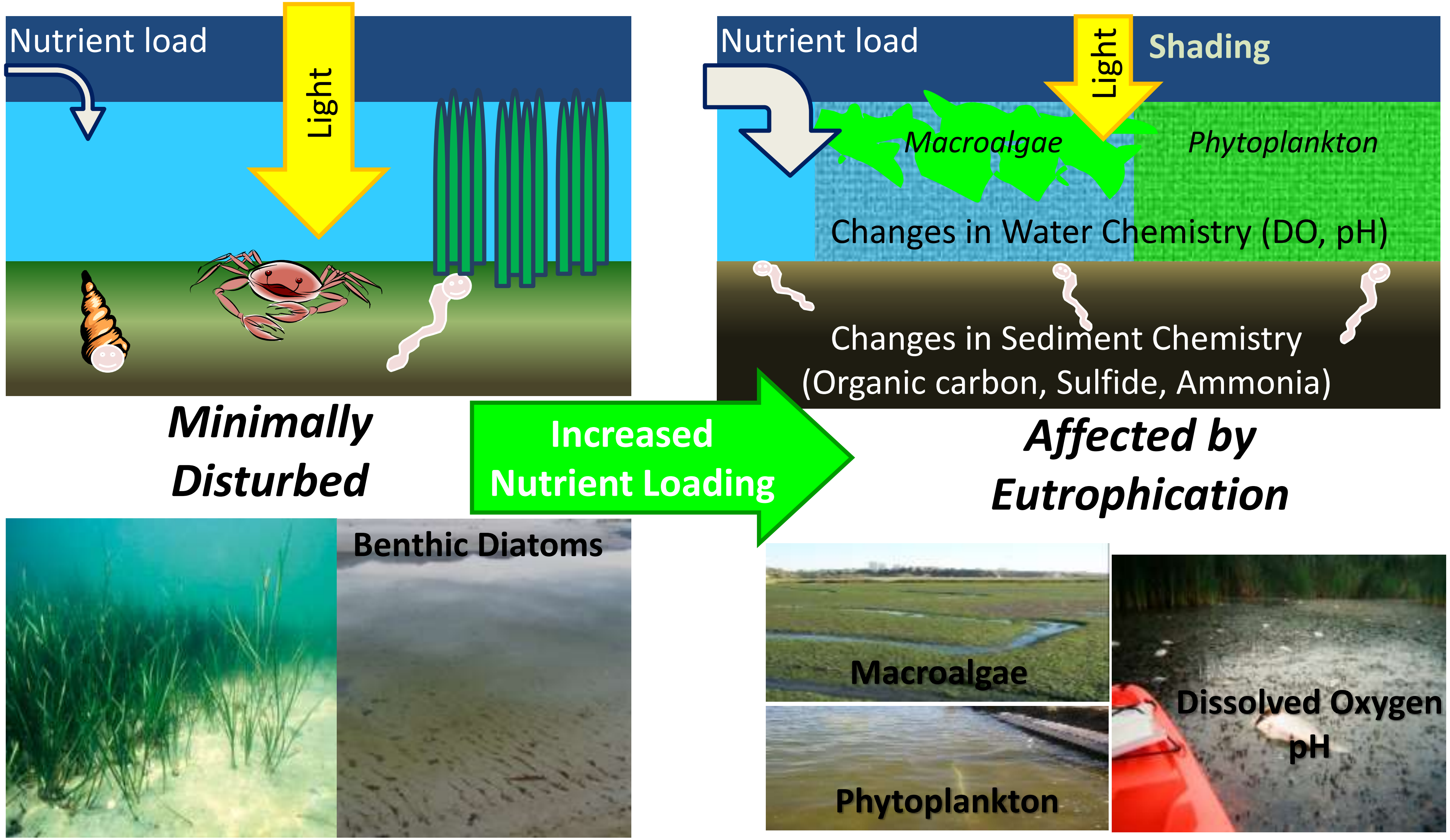
Low Impact Development

Watershed Restoration

Environmental Flows

Consider eutrophication indicators that integrate both nutrient loads and other biostimulatory conditions

Conceptual Model of Eutrophication Symptoms in California's Mediterranean Estuaries

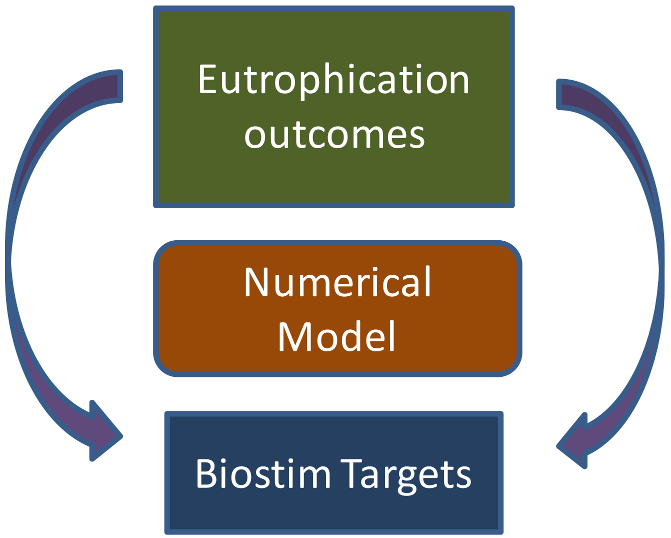


Options for Establishment of Numeric Targets in Elkhorn Slough

Existing RB Basin Plan Biostimulatory Objectives?

TN? TP?

Dissolved oxygen objectives?



Alternative Targets

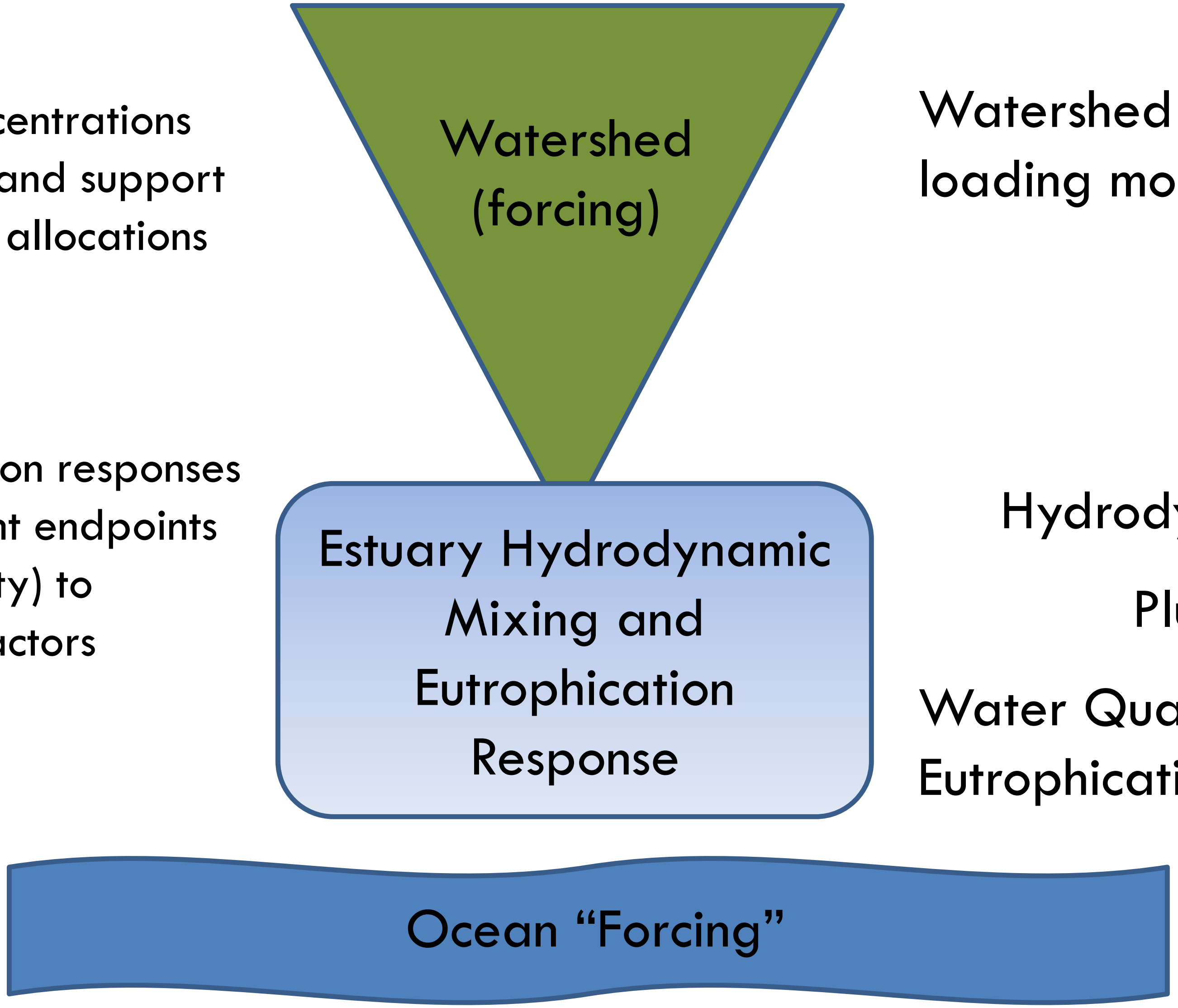
- Acidification (low pH) on native oysters
- Macroalgal blooms effects on mudflats
- Light limitation of seagrass (phytoplankton or macroalgal biomass)
- Poor benthic habitat quality
  - Elevated sediment organic matter
- Degraded wetland habitat

We can consider basin plan or alternative targets representing ***eutrophication outcomes*** *via numerical modeling, but we are limited by what model can reliably predict*

Discussion of Eutrophication Indicators Will Drive Choice in Estuarine Water Quality model (and Limited by our Ability to model Them)

estimate nutrient concentrations and loads to Slough and support conversation on load allocations

Simulate eutrophication responses linked to management endpoints (e.g. DO, algal density) to nutrients and other factors



Watershed loading model

Hydrodynamics

Plus

Water Quality or Eutrophication Model

Process to Select Eutrophication Targets

Synthesis of Eutrophication Targets ⟷ Estuary WQ Model Selection & Calibration

Step 1: Agree on conceptual model of eutrophication in Slough (problem statement)

- Management endpoints to protect? (e.g. seagrass, estuarine birds, fish)
- Eutrophication indicators that relate to those endpoints?

Step 2: Determine which approach can best model desired indicators of eutrophication

Limited by available data to calibrate model

Step 3: Calibrate model & conduct sensitivity analyses

- Refine choice of indicators based on model performance
- Use model to derive range of eutrophication targets protective of management endpoints

Step 4: Use output of numerical modeling (and literature sources) to facilitate conversations on numeric eutrophication targets

Initial Thoughts on Management Endpoints– What Do You Want to Protect? What Do you Have Data For?

Potential Management Endpoints	Potential Eutrophication Indicators
Seagrass?	Phytoplankton biomass (chl-a) Macroalgal biomass
Fish? Benthic invertebrates Native oysters?	Dissolved oxygen Sediment organic matter Water column pH
Aesthetics (lack of floating algae, visual scums or cloudy water)	Macroalgal biomass
Toxic harmful algal blooms?	Phytoplankton or macroalgal biomass

Next Steps on Eutrophication Targets

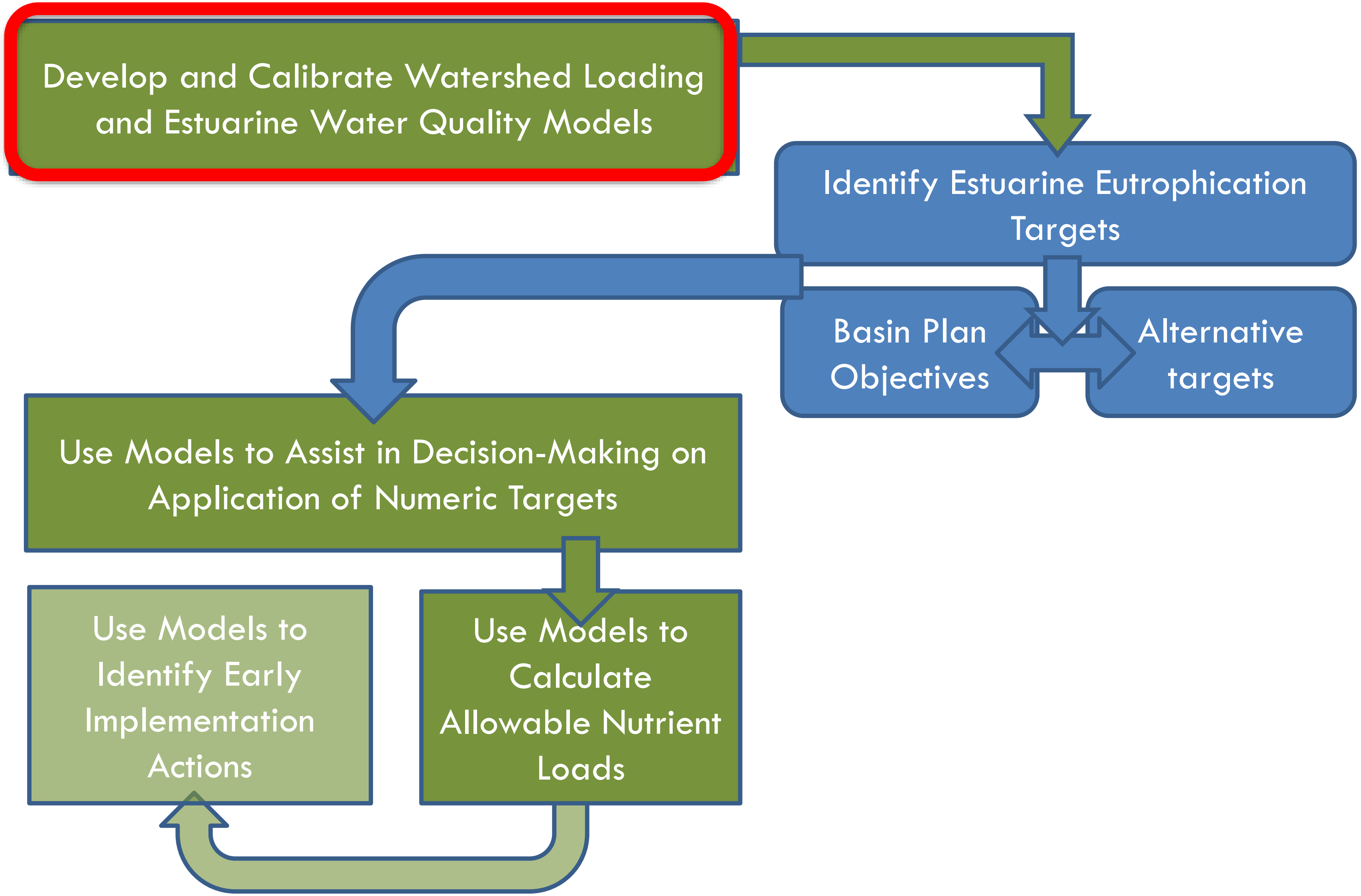
Give me your thoughts on management endpoints and/or eutrophication indicators relevant for Elkhorn

Will also be consulting with Central Coast Water Board staff

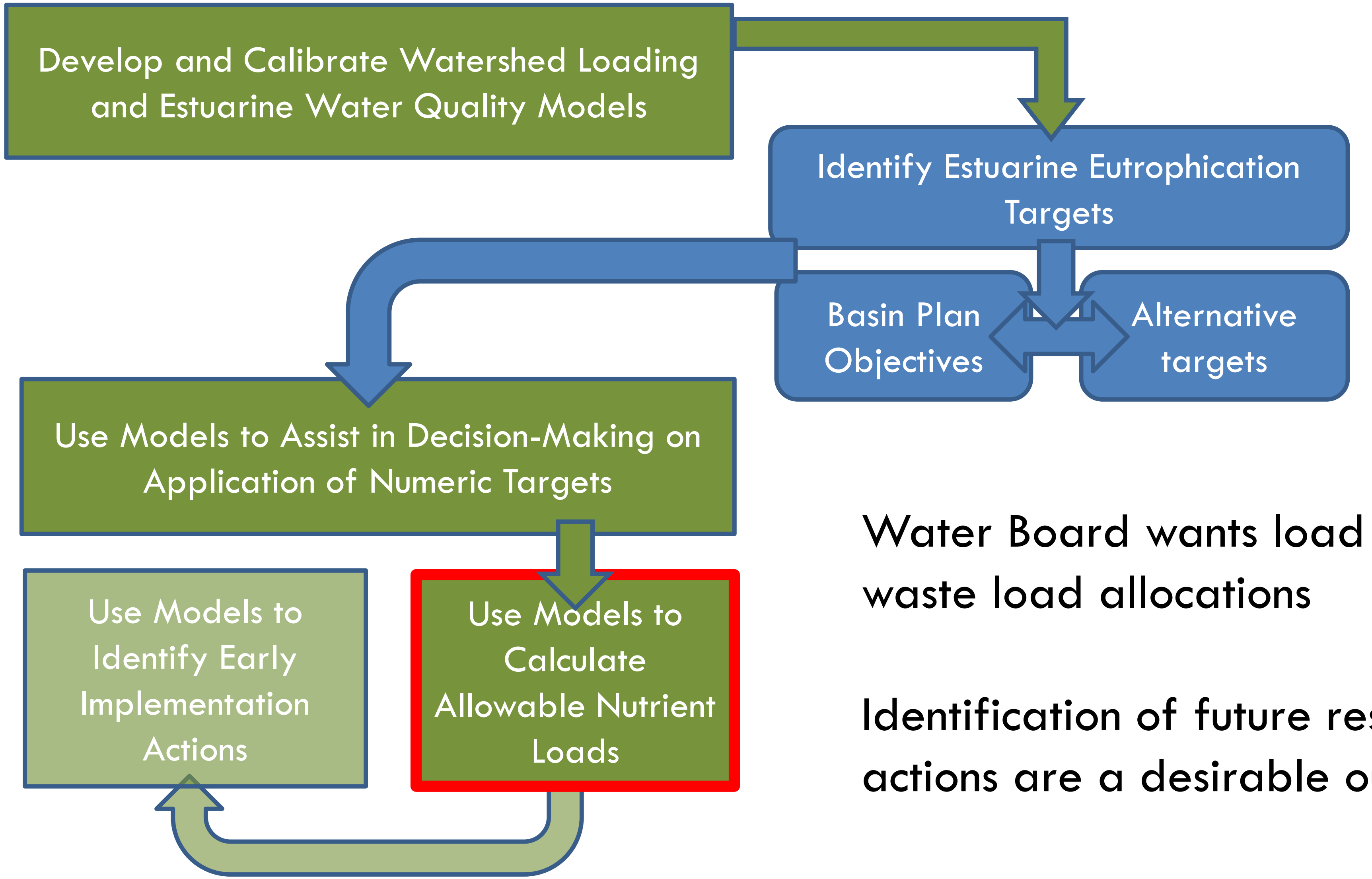
Next meeting

- Detail discussion of eutrophication conceptual model in Elkhorn Slough
  - Facilitate TAC recommendations on indicators to consider in modeling exercise

Technical Approach Elkhorn Slough Nutrient TMDL Science



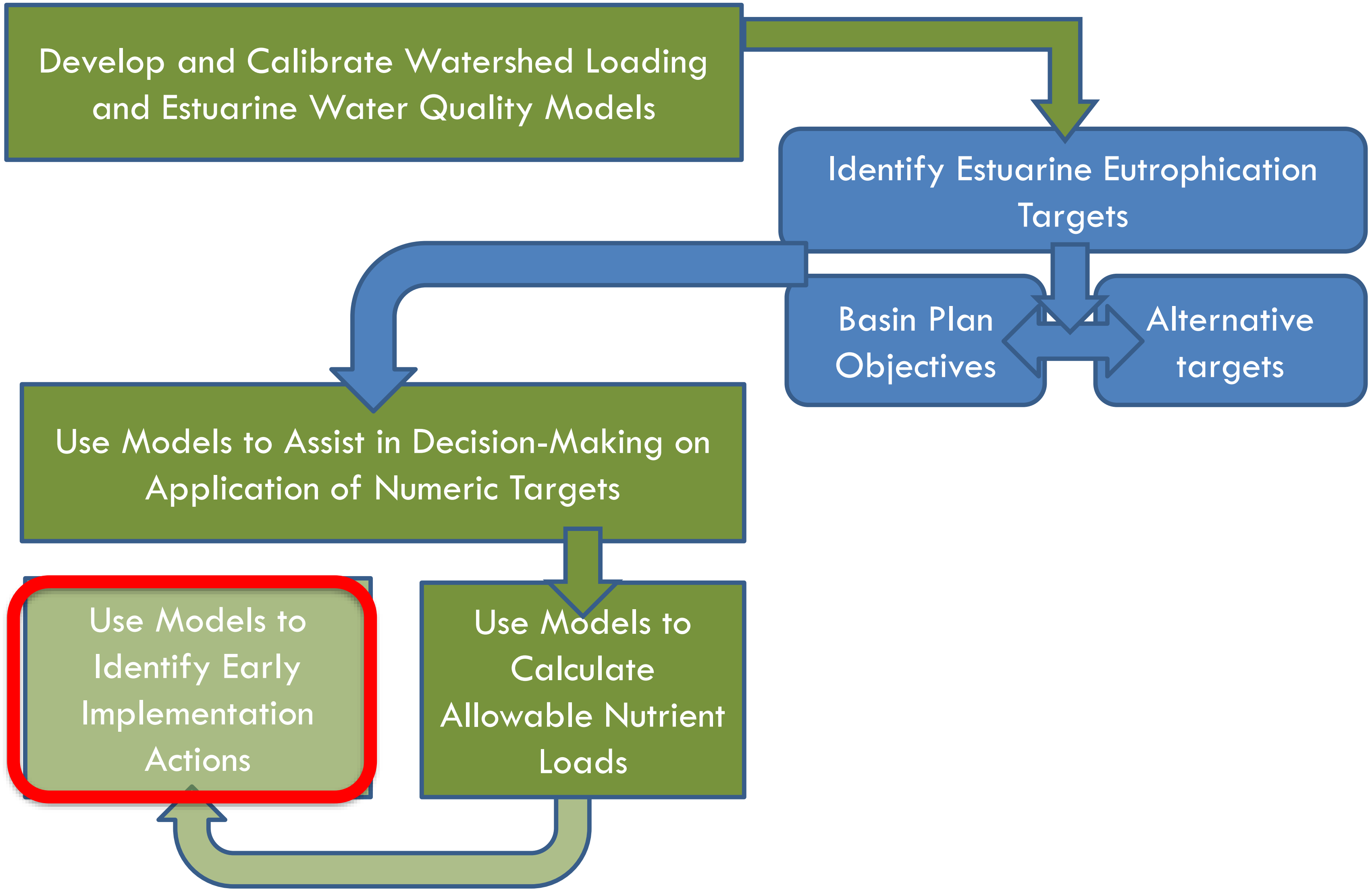
Conceptual Approach Elkhorn Slough Nutrient TMDL



Water Board wants load and waste load allocations

Identification of future restoration actions are a desirable outcome

Technical Approach Elkhorn Slough Nutrient TMDL Science



Two Types of Scenarios That We Could Run to Inform Implementation Actions

Environmental Management

- Nutrient load reduction
  - BMPs
- Slough restoration options
  - Hydrodynamic
  - Removal of sediments with heavy organic matter accumulation

Alternative Future, e.g.

- Climate change
  - Sea level rise
  - Nearshore deoxygenation and hypoxia

If you want to do these, incorporate into conceptual models and assure available resources

Products

1. **Technical workplan**

October 2019

2. **Model development and calibration report**

October 2020

3. **Model application report**

- Conceptual model of "problem" of eutrophication and Linkage to key indicators
- Application of model to derive eutrophication numeric targets
- Application of model to derive TMDL
- Derivation of model to derive load and waste load allocations

Oct 2020 – April 2021

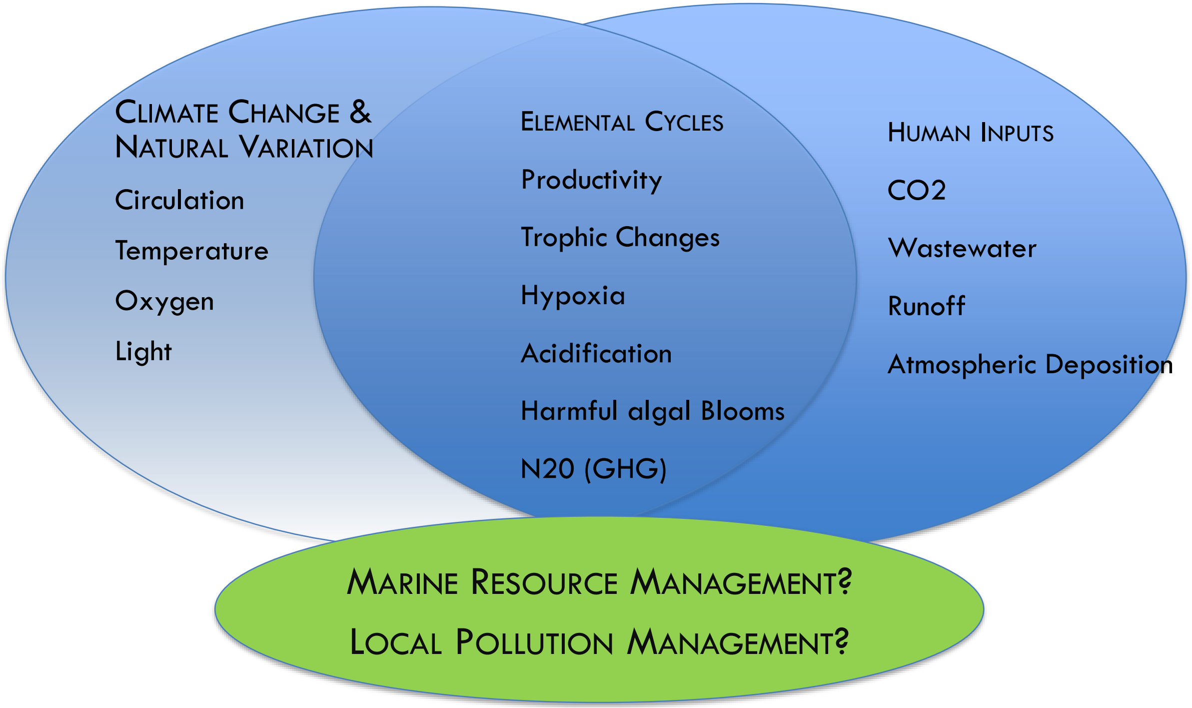
Questions? Comments?

Extra Slides on UW/SCCWRP ocean modeling project

Ocean Forcing to Elkhorn Slough: Will Leverage CA OPC and NOAA Investments in Numerical Ocean Modeling to Support California's Climate Change Actions Plans

- Numerical modeling program goals
  - Disentangle the relative contributions of **climate change, natural variability** and **local pollution impacts** on **OA, hypoxia** (HABs and N20 emissions)
  - Apply model to support policy decisions

- Directly supports elements of CA OA Action Plan recommendations
  - **Manage local pollution sources**
  - Create biologically relevant OA water quality criteria
  - Sequester carbon through habitat restoration



Earth Systems Modeling Approach

Atmospheric forcing

WRF model (Weather and Research Forecast Model; Boe et al., 2011)

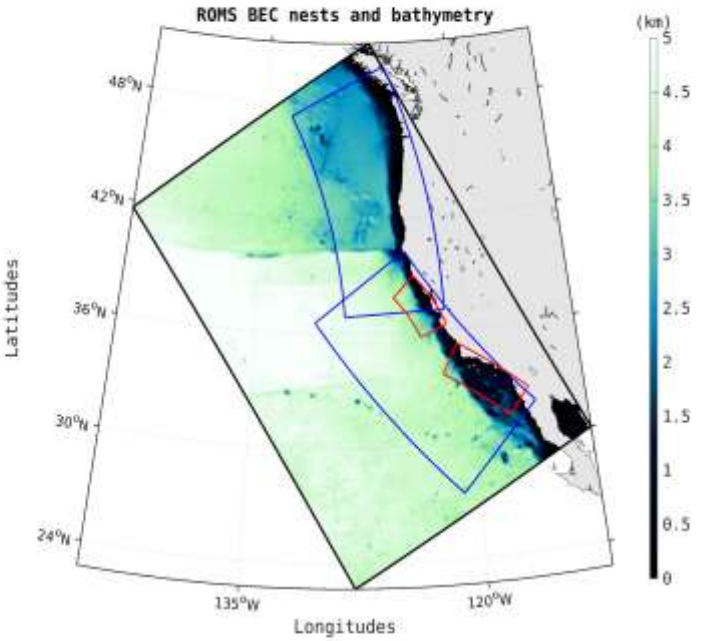
Physical model

ROMS (Regional Oceanic Model System; Shchepetkin and McWilliams, 2003, 2005, 2008, 2011)

Biogeochemistry and Lower Ecosystem

Biogeochemical Elemental Cycling (BEC; Moore et al. 2002)

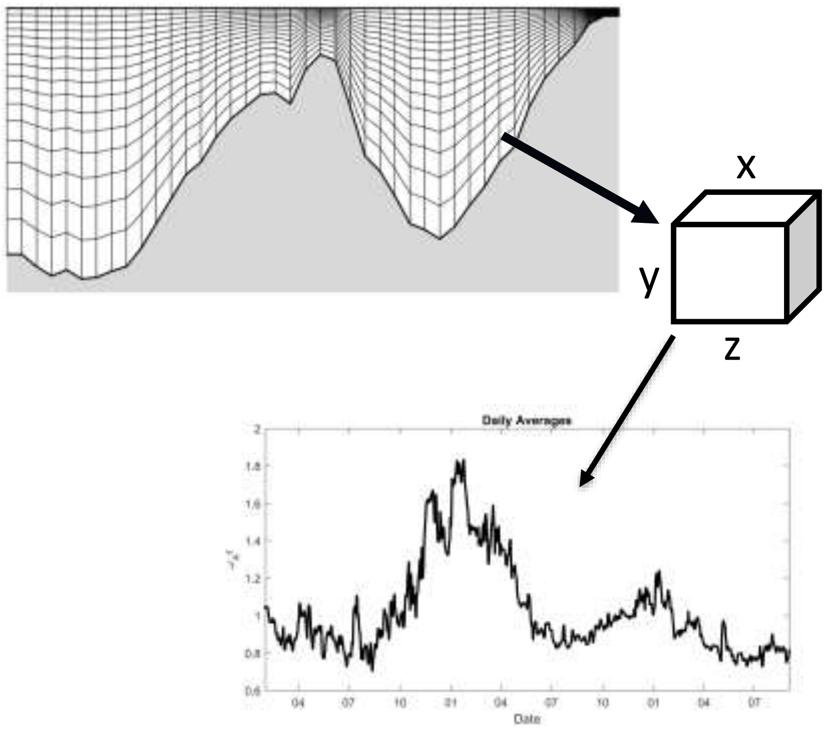
Full model domain is California Current wide at 4 km resolution, with higher resolution grids "nested" inside (1 km to 300 m)



2 subdomains at 1 km resolution for CA, OR and WA

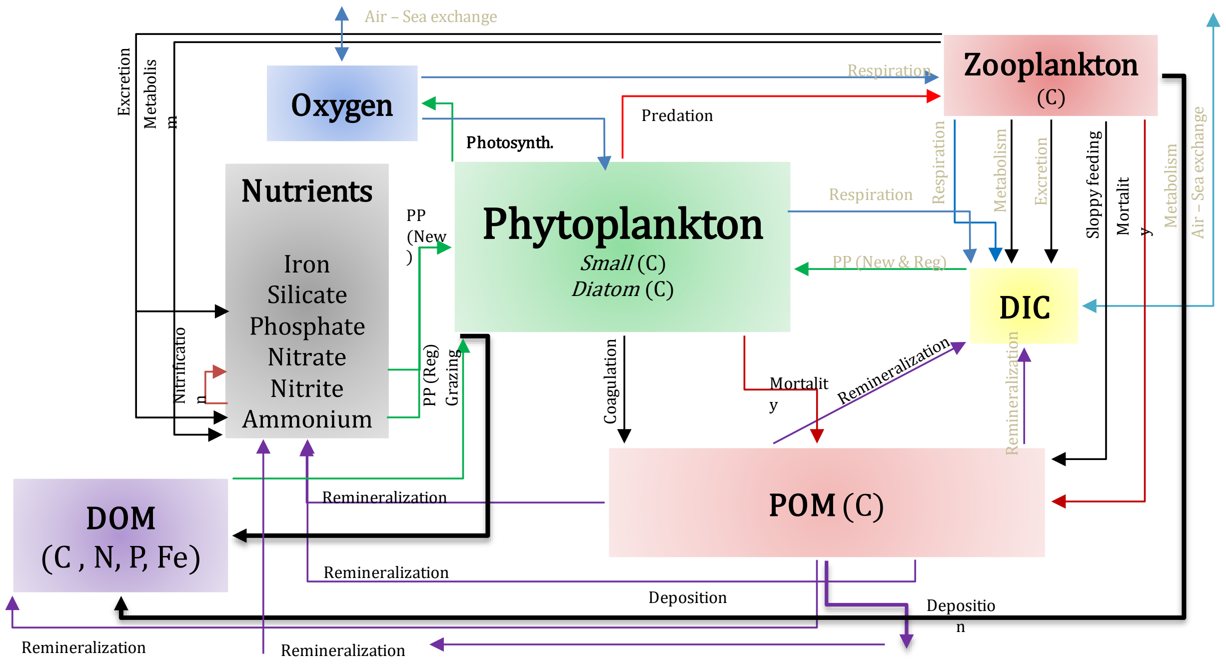
Within the 1 km CA nest, 2 smaller subdomains at 300 m within Southern California Bight and San Francisco/Monterey Coast

Grid: 60 variable depth levels



aragonite time-series from the model

Biogeochemical Elemental Cycling (Moore et al. 2002)



Developed enhanced nitrogen cycling, explicit sinking of particles and carbonate chemistry

STATE VARIABLES

Ocean physics

Nutrients
Nitrate, nitrite, ammonia
phosphate
silicate, Iron

Plankton
[2 phytoplankton groups an zooplankton biomass]

Organic matter

Oxygen

Carbonate system

Key Take Messages for Elkhorn Science Community

- Collaboration with SFEI (Senn) and UCSC (Edwards) to investigate the effects of anthropogenic nutrient and carbon inputs on OA, hypoxia and N20 on San Francisco Coast and Monterey Bay
- Model can provide ocean forcing of nutrients, carbon and oxygen to Elkhorn Slough model
- Elkhorn Slough et al. modeling efforts will provide improved terrestrial forcing to ROMS-BEC assessment of coastal impacts
- We will be running first set of 300-m resolution simulations (3 yr period) this summer

Thank You!

Questions? Comments

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4-KM AND 1-KM VALIDATION PROVIDE ASSURANCE THAT WE'VE APPROPRIATELY MODELED OCEAN FORCING

Good consistency of coast-wide 4-km and 1-km solutions for atmospheric and oceanic physical & biogeochemical outputs against available coast-wide data sets

- spatial patterns, seasonal cycles, and range of natural variability

Oxygen distribution at sigma=26.5 [~100-250m]