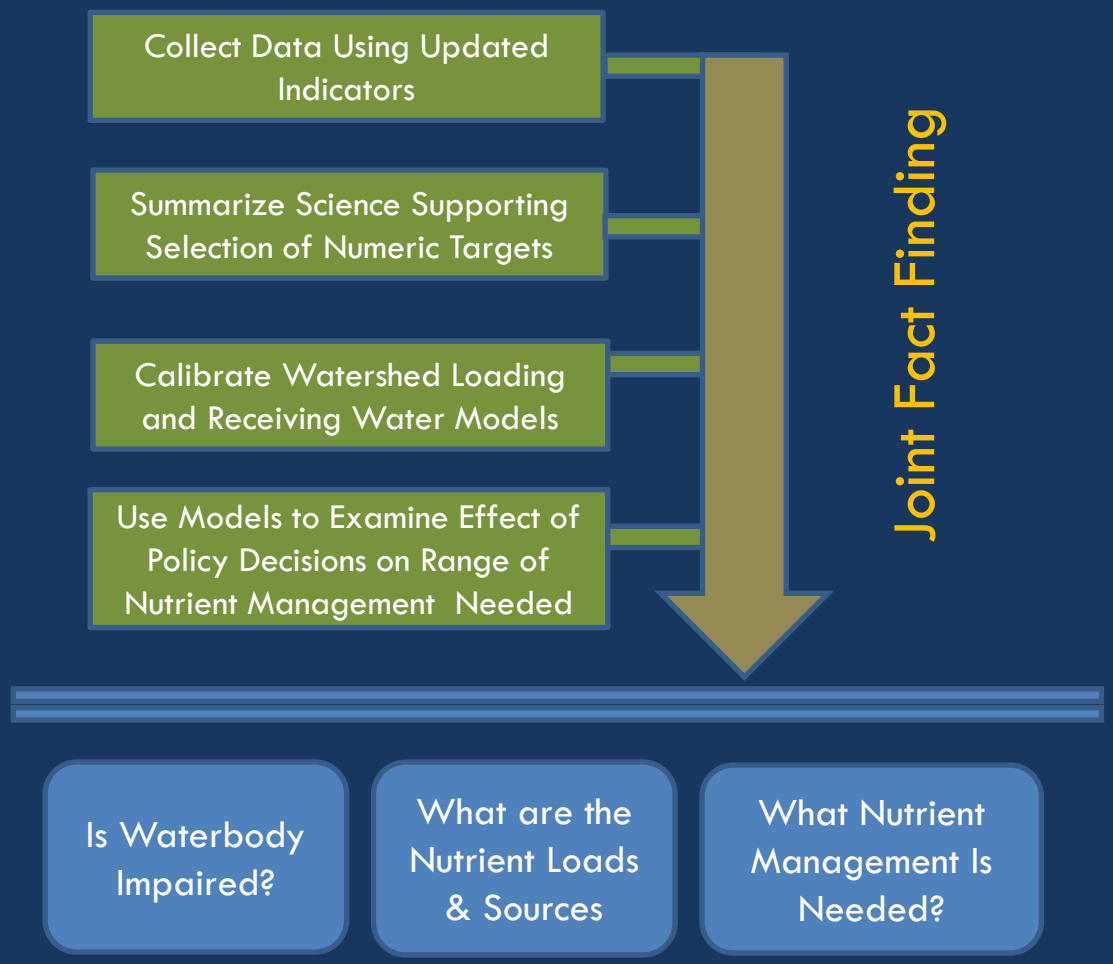
Overview of Science Supporting Selection of Indicators & Numeric Targets for SMR Estuary

SMR NMI Stakeholder Meeting

Martha Sutula, SCCWRP

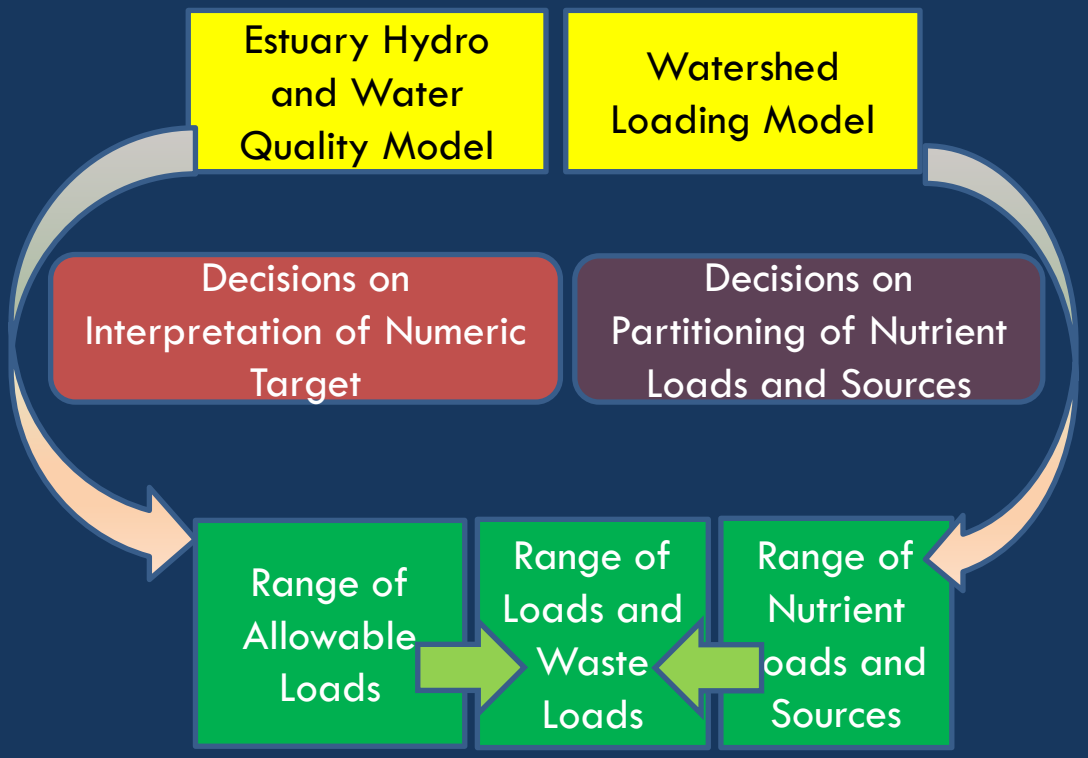
December 7, 2015

Conceptual Approach for Technical Activities in River and Estuary



Management Questions and Policy Applications

Model Application Components and Decisions



Model Application: Decisions Involving Interpretation of Numeric Target

Key Decisions That Factor into Calculation of Allowable Load:

- What are the indicators used for the numeric targets
  - What is the numeric target?
- Critical period?
- Assessment based on..

—Average value of whole estuary, or by segment?

—Average of vertical profile, top only, bottom only?

—Seasonal maximum or average (temporal aggregation)?

- Allowable frequency of non-compliance?

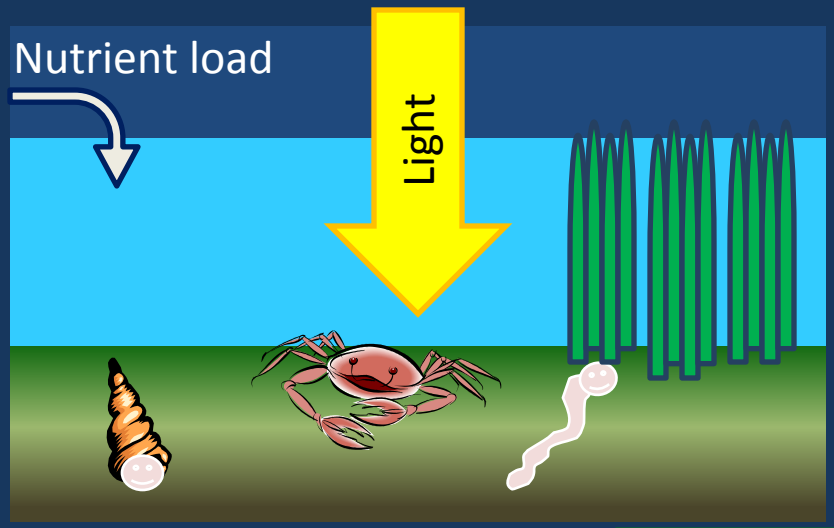
Goal of Discussion

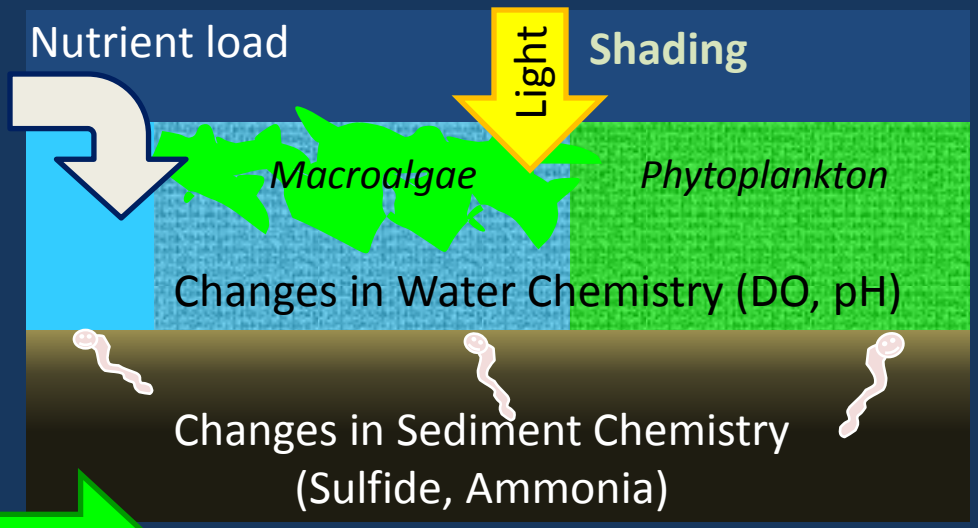
- Give you a broad overview in science supporting decisions on numeric targets
  - TAC has already received a more detailed version of this presentation (August 14, 2014)
- Starting point to discuss key decisions on applications of numeric targets to Santa Margarita River Estuary
  - Focus of next three stakeholders meetings
  - Heads up on key issues!

Overview of Presentation

- Context: Conceptual model of nutrient enrichment in Santa Margarita River Estuary
- What is available to consider
  - Existing basin plan objectives
  - Alternative numeric targets: nutrient numeric endpoint framework
- Science supporting decisions on numeric targets
  - Give you the punchline
- Key decisions for interpreting basin plan objectives and NNE to Santa Margarita River Estuary

Conceptual Model of Eutrophication Symptoms in Mediterranean Estuaries





Minimally Disturbed

Increased Nutrient Loading

Affected by Eutrophication

Eutrophication Symptoms Most Evident During Dry Weather

- Impairment may be present year around, during wet or dry weather conditions, but….
  - Critical condition will always be during dry weather
  - Most often during dry season, but this will be tied to timing of nutrient loads and site-specific factors

Options for Numeric Targets

Given: Basin plan objectives

- Dissolved oxygen
- Biostimulatory objectives (TN and TP)

Alternative: Nutrient numeric endpoint (NNE)

- Macroalgae biomass and percent cover
- Phytoplankton biomass, HAB abundance, toxins

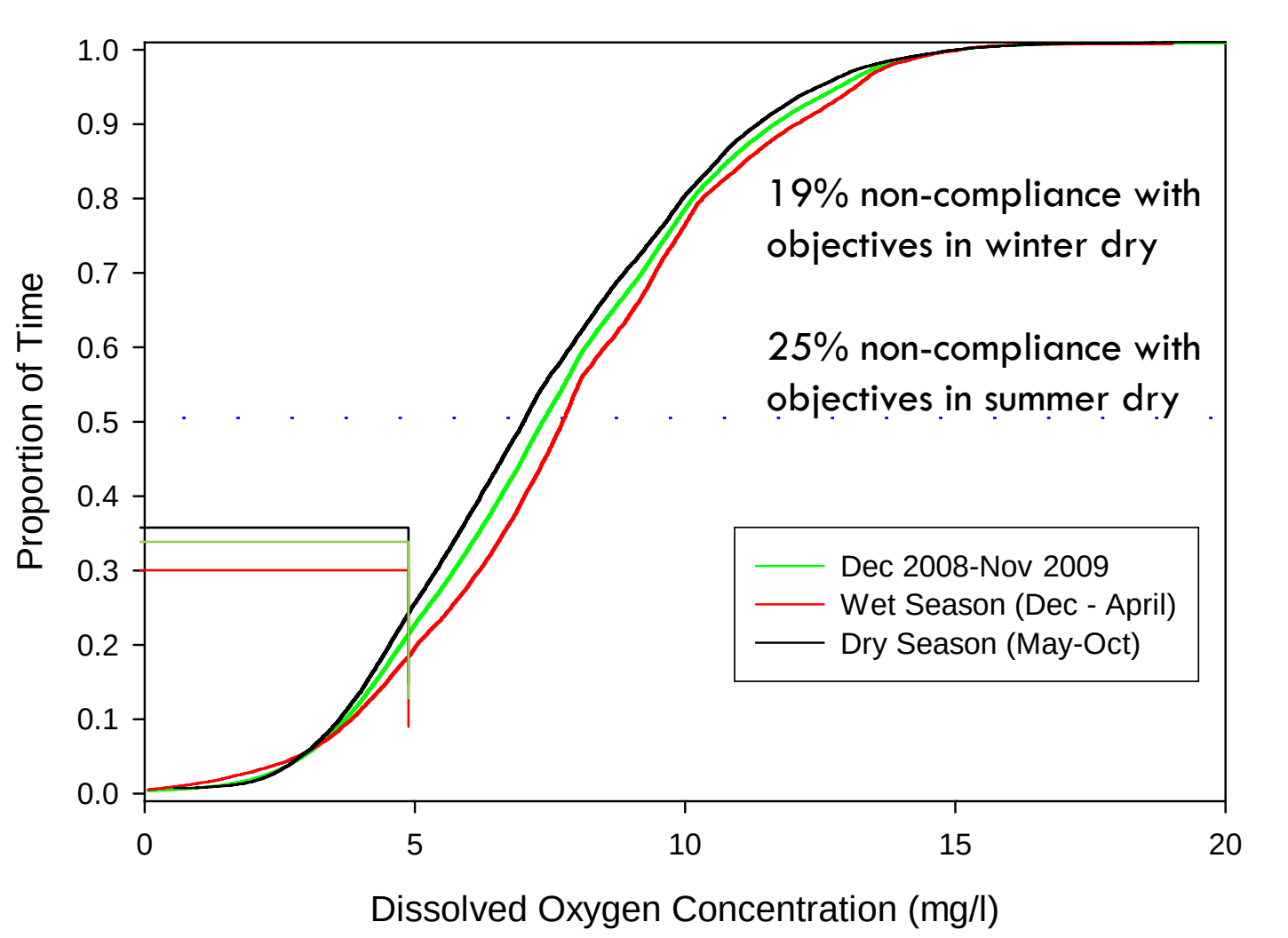
Basin Plan Objectives for Dissolved Oxygen

- MAR and WARM – 5.0 mg/l

  Applied instantaneously (no averaging)

  10% of samples below WQO allowed

SMR Estuary Bottom Water Dissolved Oxygen vis-à-vis Basin Plan Objectives



Basin Plan Objectives for Biostimulatory Substances

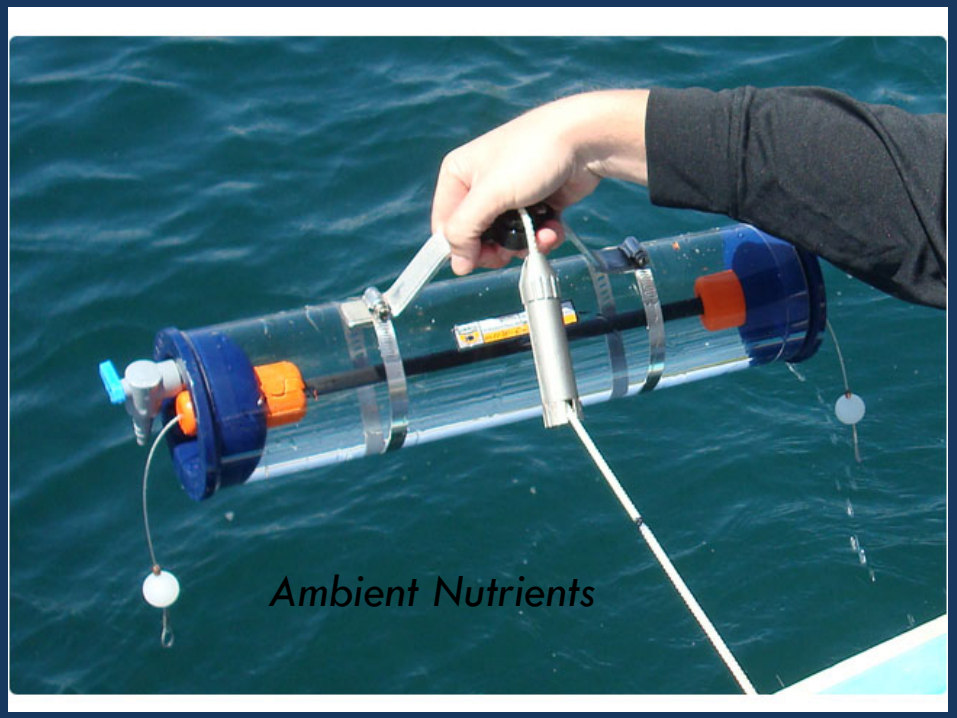
"Concentrations of nitrogen and phosphorus, by themselves or in combination with other nutrients, shall be maintained at levels below those which stimulate algae and emergent plant growth. Threshold total phosphorus concentrations shall not exceed **0.05 mg/l** in any stream at the point where it enters a standing body of water, nor **0.025 mg/l** in any standing body of water. A desired goal in order to prevent plant nuisance in streams and other flowing waters appears to be **0.1 mg/l total phosphorus**."
"Natural ratios of nitrogen to phosphorus are to be determined by surveillance and monitoring and upheld. If data are lacking, a **ratio of Nitrogen: Phosphorus – 10:1**, on a weight of weight basis shall be used."

Estuary TN and TP Concentrations Exceed Biostimulatory Objectives (2008-2009 Data)

TN (mg l^{-1})	Jan'08	Apr '08	Jul '08	Oct '08	% Exceedance (TN> 1 mg L-1)
ME	3.1	1.1	0.3	ND	60%
Seg2	2.9	0.8	0.9	0.8	25%
Seg 1	13.6	7.9	2.3	2.3	100%
Ave Seg 1-2	8.2	4.4	1.6	1.5	

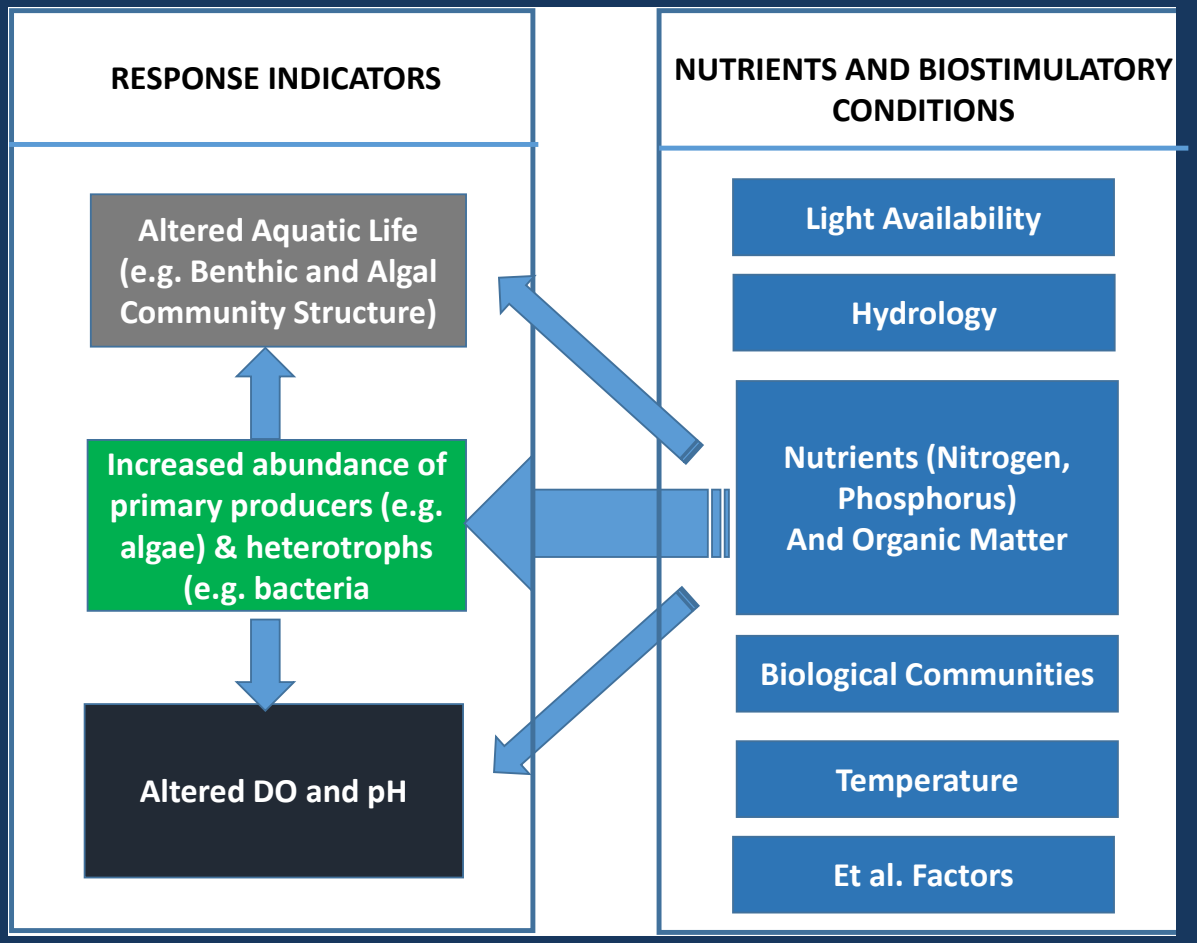
TP (mg l^{-}1)	Jan'08	Apr '08	Jul '08	Oct '08	% Exceedance (TP> 0.1 mg L-1)
ME	0.1	0.1	0.2	ND	100%
Seg2	0.3	0.3	0.2	0.1	100%
Seg 1	0.1	0.1	0.3	0.6	100%
Ave Seg 1-2	0.2	0.2	0.2	0.37	100%

Ambient Nutrient Concentrations or Response Indicators?



Alternative Targets: SWRCB Staff has developed a Workplan to move forward on Nutrient objectives

The policy will address nutrient pollution and biostimulatory substances and/or conditions.

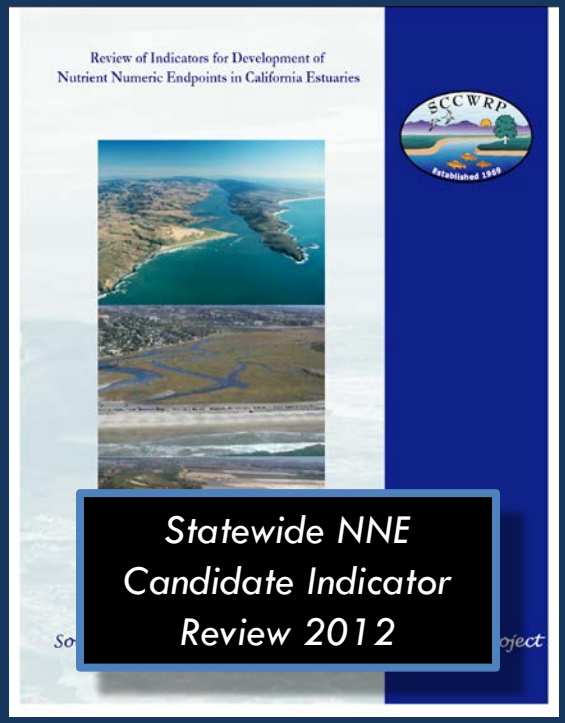


SWRCB Staff Approach to Developing Nutrient Objectives Based On Mechanistic Approach

- Narrative objective, with numeric guidance
  - Guidance coined as " Nutrient Numeric Endpoint or NNE"
- Diagnosis based on <u>response indicators</u> = <u>NNE assessment framework</u>
  - Assessing eutrophication et al. adverse effects of nutrients
- Models to link response indicators to nutrients et al. factors (e.g. hydrology,, etc.)= NNE load-response models
  - Can account for mechanisms, rather than correlations

Evaluation of Candidate Response Indicators

- **Evaluated candidate indicators vis-à-vis review criteria**
  - Clear link to beneficial uses
  - Can build model to link to nutrients
  - Scientifically sound & practical measure
  - Reliably use to diagnose eutrophication (signal: noise acceptable)
- **Reviewed studies to establish thresholds**
  - Identifies data gaps and next steps

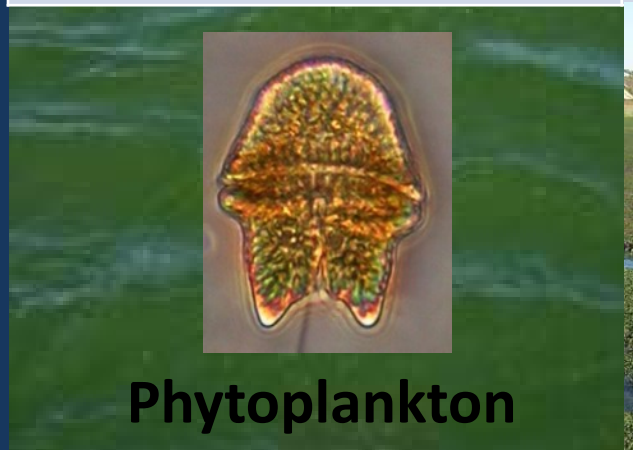


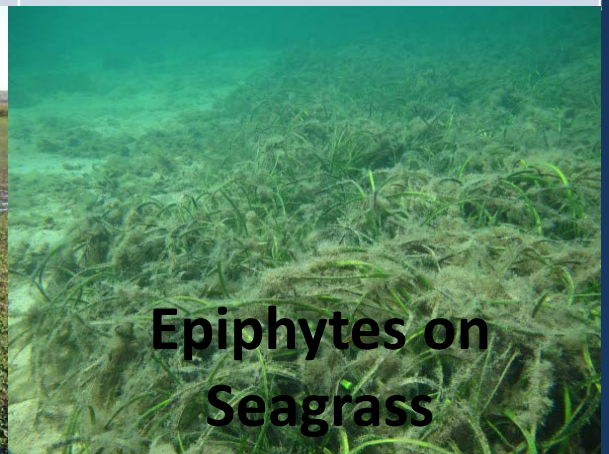
Statewide NNE Candidate Indicator Review 2012

Sutula M. 2011. Review of Indicators for Development of Nutrient Numeric Endpoints in California Estuaries. SCCWRP Technical Report 646. www.sccwrp.org

Recommended Indicators

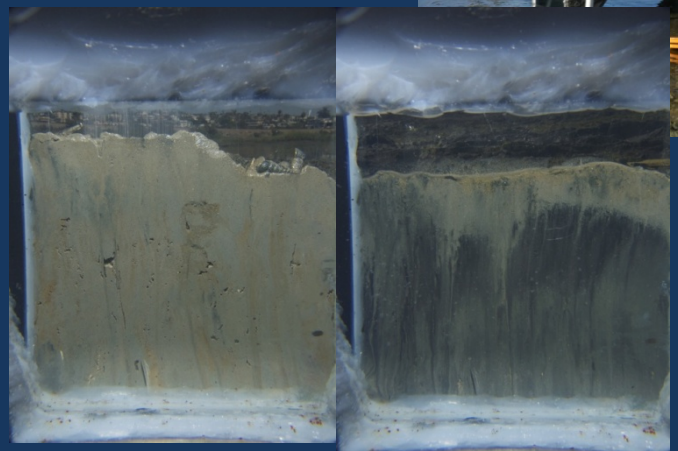
All Subtidal	Tidal Flats & Shallow Subtidal	Seagrass
Dissolved oxygen Phytoplankton Biomass, HAB cell counts & toxin conc. Macrobenthos taxonomy /Sediment OM	Macroalgal biomass/cover Sediment OM	Phytoplankton Biomass Macroalgal Biomass and Cover Light attenuation Epiphyte load





Review Provided Impetus for Studies Synthesis Supporting Decisions on Thresholds

- Manipulative Studies
- Empirical surveys to relate stress-response
- Studies to characterize natural background at “reference sites”
- Expert best professional judgment to address data gaps



Ongoing Studies, Reports and Publications Supporting Decisions on Estuarine NNEs

- Candidate Indicator Review
  - *Sutula M. 2011. Review of Indicators for Development of Nutrient Numeric Endpoints in California Estuaries. SCCWRP Technical Report 646. www.sccwrp.org*
- Dissolved oxygen
  - M Sutula, H Bailey, S. Poucher. 2013. Science Supporting Dissolved Oxygen Objectives in California Estuaries. Technical Report 684. www.sccwrp.org
- Macroalgae
  - Experiments: L Green, M Sutula. P Fong, 2013. Ecological Applications DOI 10.1890/13-0524.1.
  - Field Survey: Sutula M., L. Green, G. Cicchetti, N. Detenbeck, P. Fong. 2014. Estuaries and Coasts DOI: 10.1007/s12237-014-9796-3
  - Draft Assessment framework- Spring 2014
- Phytoplankton and macroalgae – closed estuaries
  - Study of natural background in reference estuaries- to be completed Spring 2016

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  - Dissolved oxygen
  - Macroalgae
- Key decisions for interpreting basin plan objectives and NNE to Santa Margarita River Estuary

Scope of Review of Science Supporting Dissolved Oxygen Objectives

- Evaluate the scientific basis for deriving DO criteria for California bays and estuaries
- If possible, derive criteria that reflect regional differences and estuary types

Used Virginia Province Approach, similar to what was done in Chesapeake Bay

What We Found
(and Relevance to SMR Estuary)

- Work supports existing DO objectives of 5 mg L^{-1}
- Natural hypoxia exists in Mediterranean estuaries
  - How to interpret objective vertically?
  - Ongoing Reference study will help to quantify levels of natural hypoxia, results available in late spring 2016

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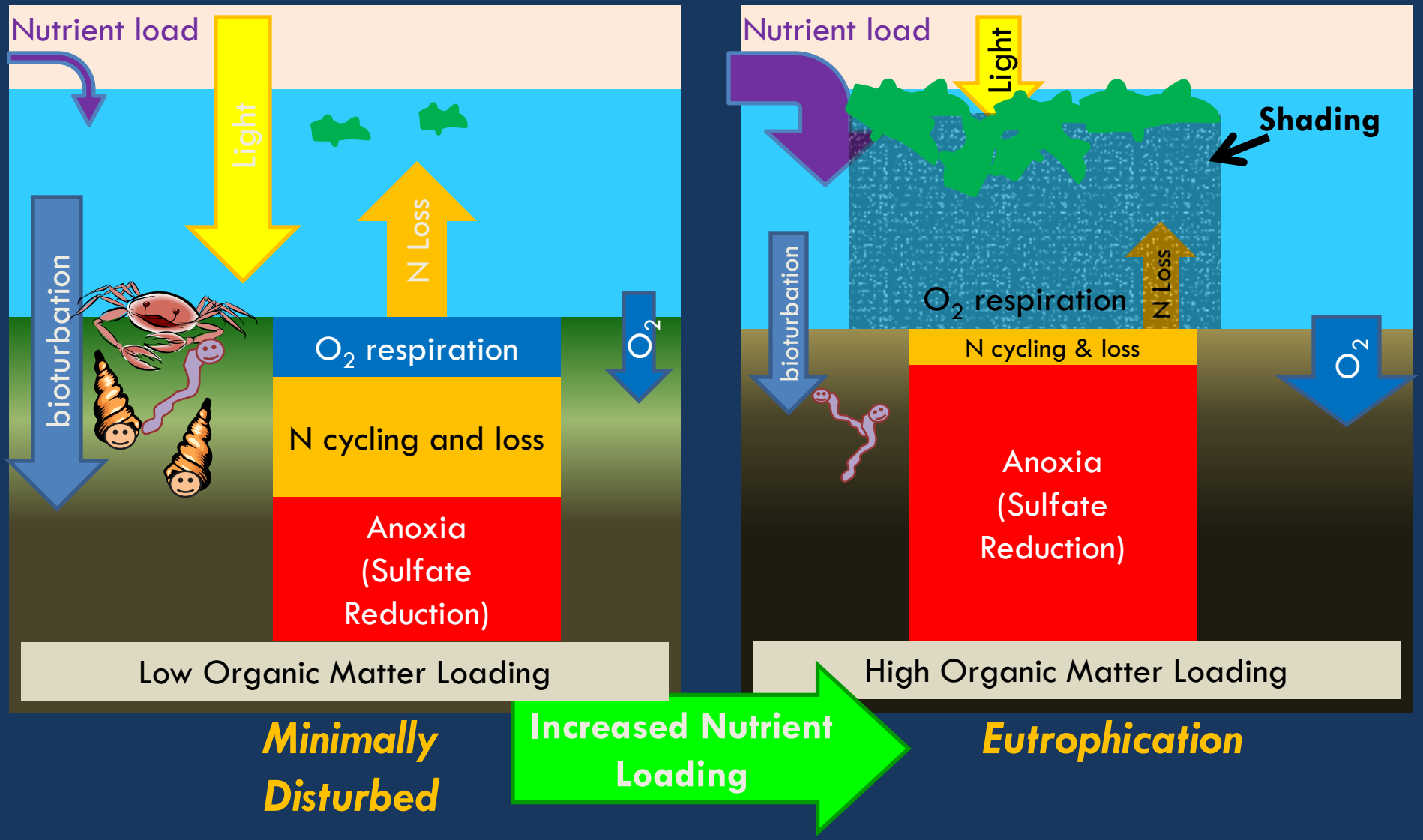
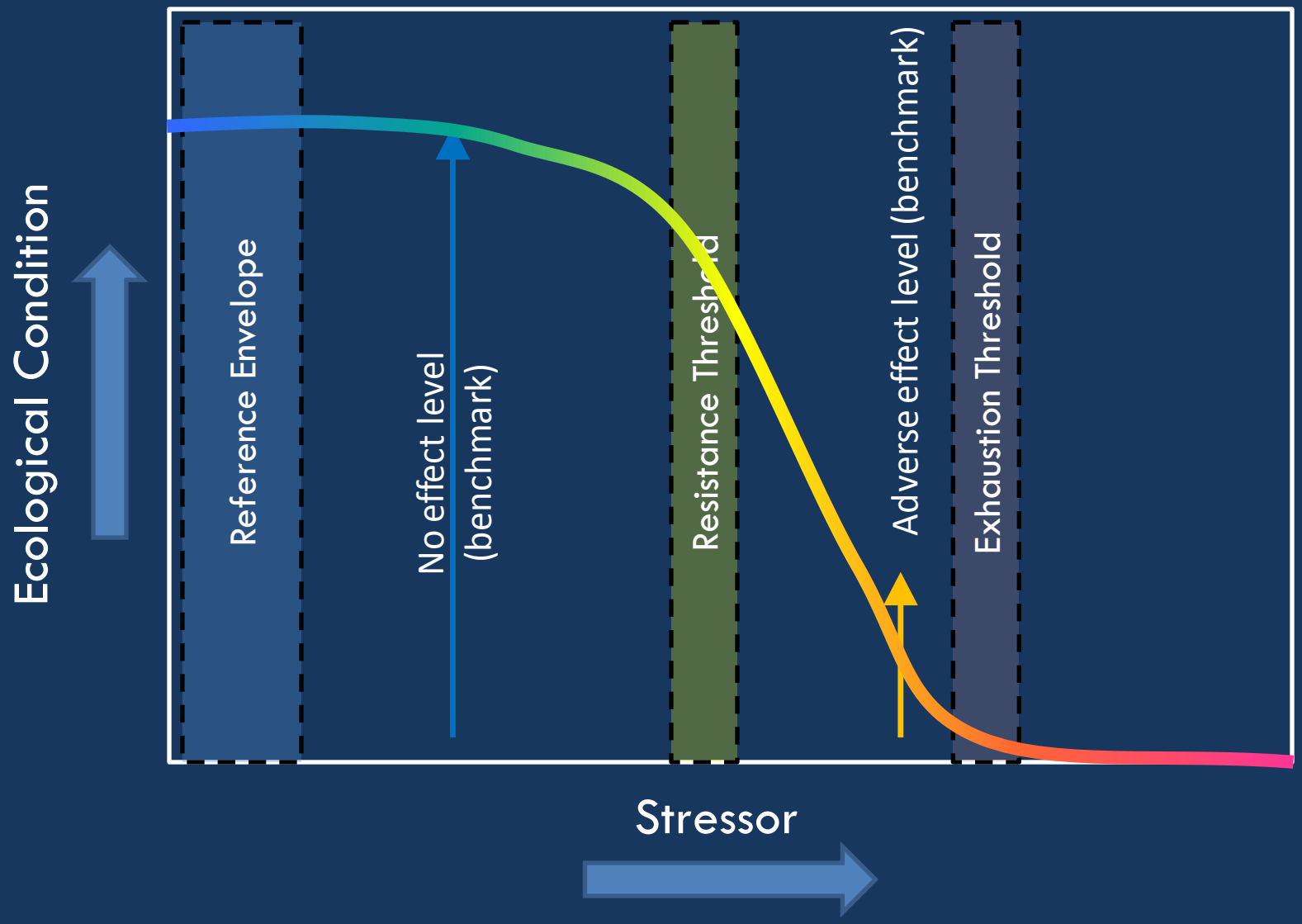
Effects of Macroalgae: Conceptual Model



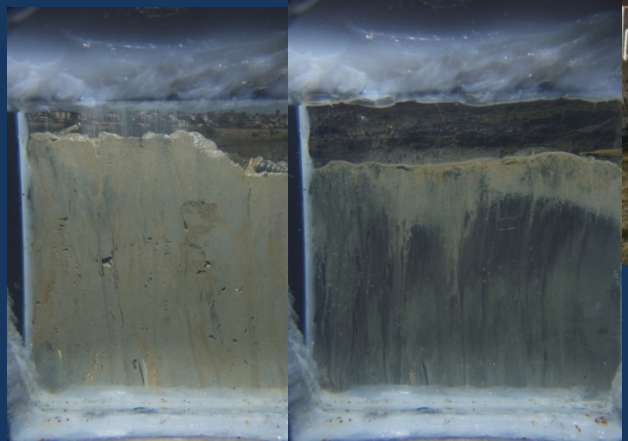
Defining Terms: Thresholds vs. Benchmarks



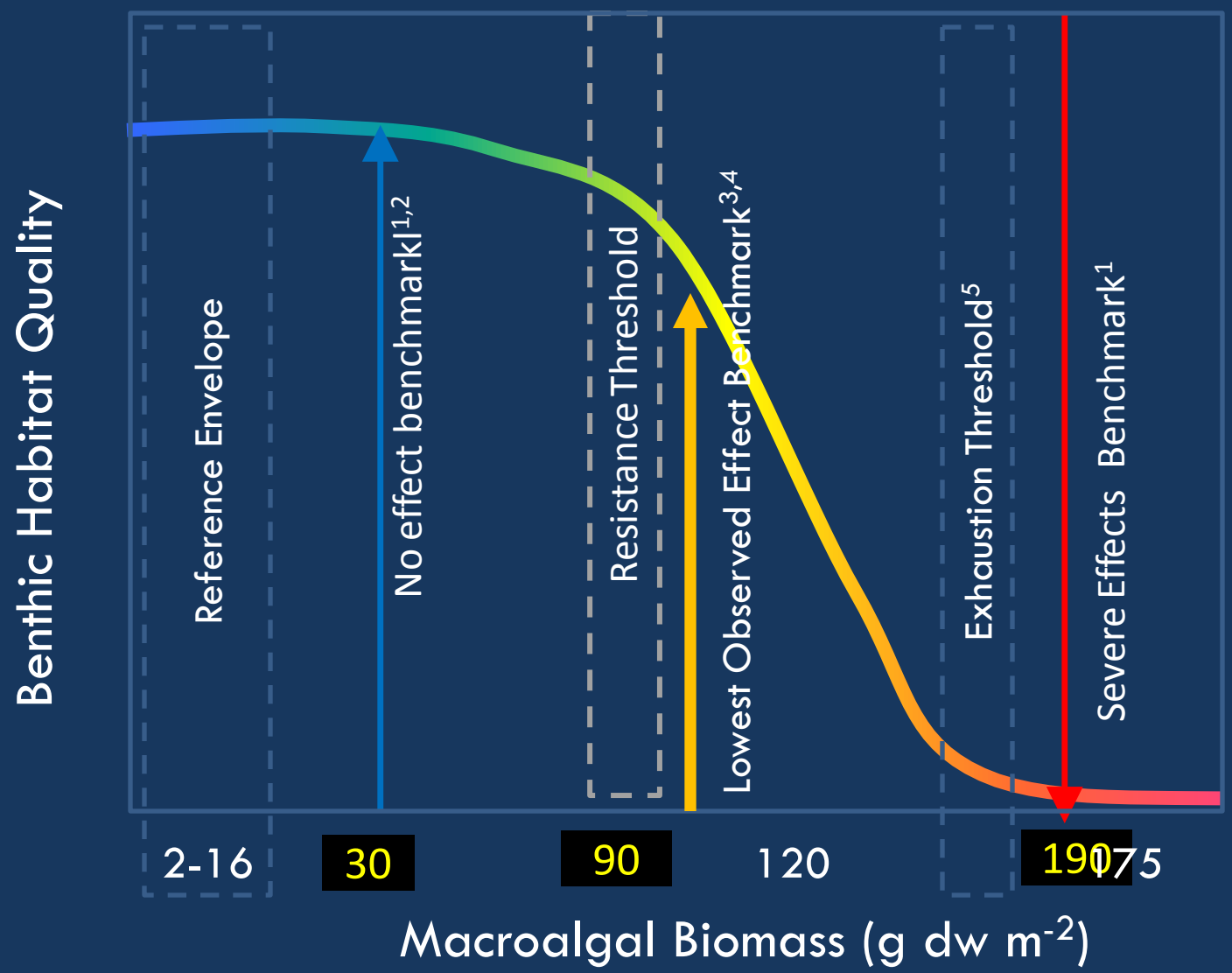
Effects of Macroalgal Blooms on Intertidal Flats: Study Components

- Cage experiments with variable "dose" of macroalgal biomass
  - Tight control on "duration"
  - Effect on macrobenthos community structure

- Field survey with sediment profile imagery
  - Many estuaries
  - Effect on benthic habitat quality



Synthesis of Threshold Information



1 Green 2011
2 Cardoso et al. 2004
3. Green, Fong and Sutula 2013
4. Bona (2006)
5. Sutula et al. 2014

Macroalgal Assessment Framework For Estuarine Tidal Flats and Shallow Subtidal Habitat

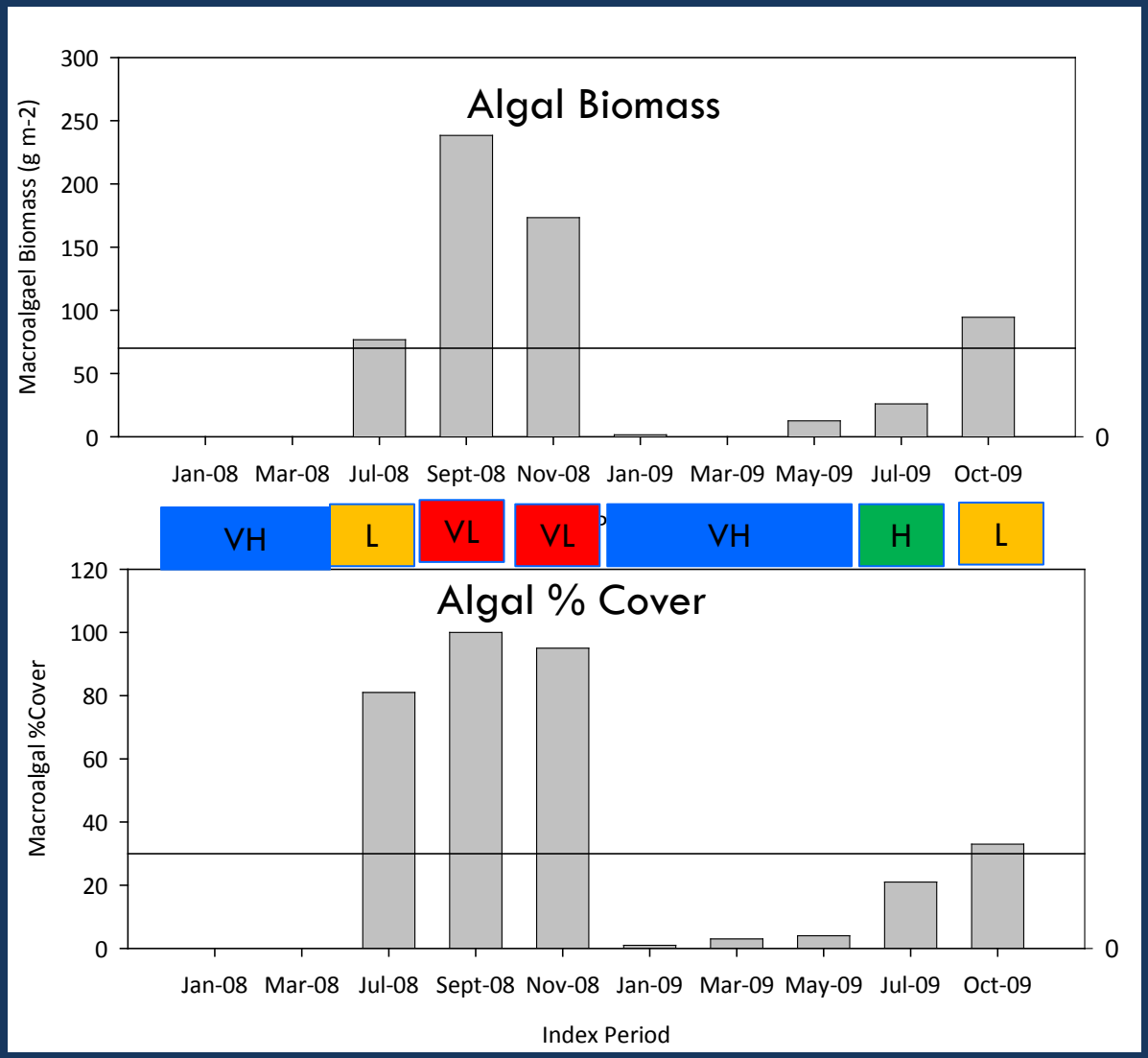
Categories Represent Ecological Condition

	(g dw m^{-2})	%Percent Cover				
		< 10 %	10 - 25 %	25 - 40 %	40 - 70 %	> 70 %
Biomass	>175	Moderate	Low	Low	Very Low	Very Low
	100 - 175	Moderate	Moderate	Low	Very low	Very Low
	70-100	Moderate	Moderate	Low	Low	Low
	50 - 70	High	High	Moderate**	Moderate**	Low
	15 - 50	Very High	High	High	Moderate	Moderate
	< 15	Very High	Very High	High	High	Moderate

** downgrade if moderate for 2 consecutive sampling periods

from Sutula (2013); Draft Framework for Assessment of Macroalgae in California Estuaries

Mean Macroalgal Biomass and %Cover By Sampling Period In Lower Estuary



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  - Dissolved oxygen
  - Macroalgae
- Key decisions for interpreting basin plan objectives and NNE to Santa Margarita River Estuary

Key Decisions Interpreting Macroalgal, DO, TN and TP Indicators As Numeric Targets

- What is the appropriate numeric target?
- How will duration taken into account?
  - What kind of temporal averaging?
- How is extent taken into account?
- How are vertical gradients taken into account (e.g. dissolved oxygen)?

Key Questions: TN and TP

- What interpretation of numeric target?
  - Standing: 0.05 mg l^{-1} TP + 0.5 mg L^{-1} TN
  - Flowing: 0.1 mg l^{-1} TP + 1 mg L^{-1} TN
- Vertical aggregation: Surface and bottom or surface only?
- Spatial aggregation: Aggregate model information by segment or whole estuary? If by segment, how many segments?
- Temporal aggregation, e.g. percent of monthly average of "samples"?
- Critical period?
  - Wet versus dry weather
  - Summer dry versus winter dry weather

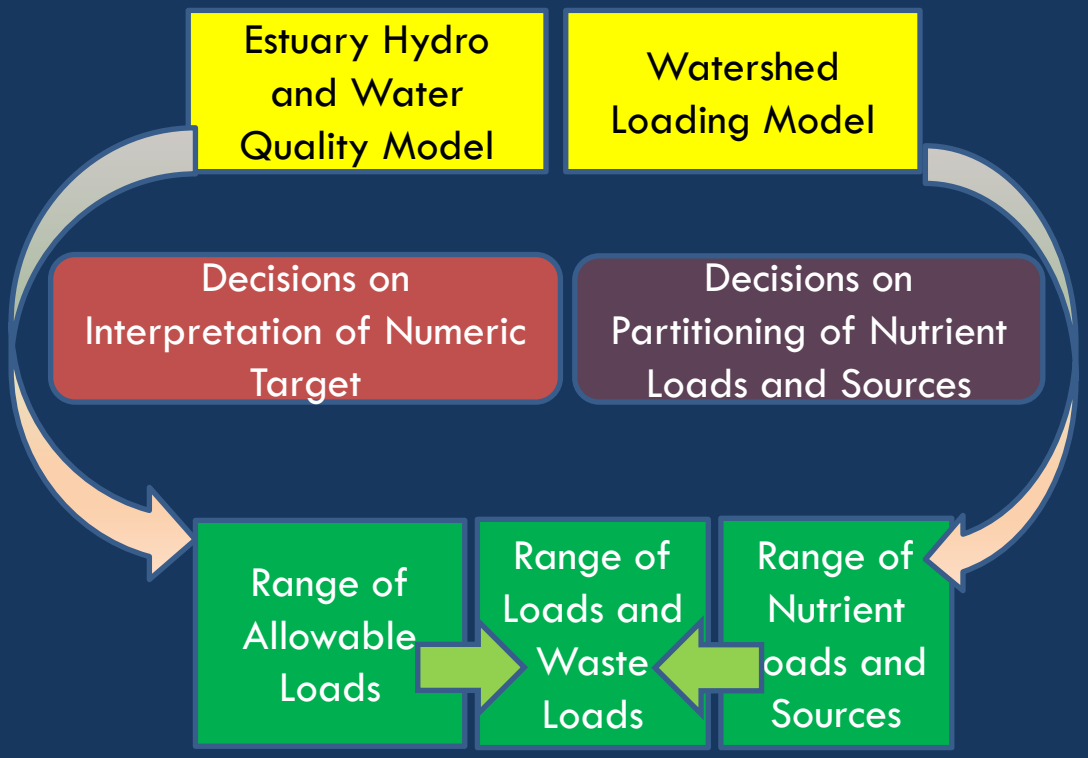
Key Questions: Macroalgal Biomass

- What is the critical period
- Spatial aggregation:
  - Aggregate model information by segment or whole estuary?
  - If by segment, how many segments?
- Temporal aggregation:
  - Assess base on critical period maximum?
  - Average of peak two months?
  - Summertime average?
- What numeric target?

Key Questions: DO

- Numeric Target
  - 5mg L^{-1}
- Critical period –
  - All year (wet and dry)
  - Dry only
  - Summer dry only
- Vertical averaging: Average across all depth gradients or just surface?
- Spatial aggregation: Aggregate model information by segment or whole estuary? If by segment, how many segments?
- Should some period of non-compliance be granted?

Model Application Components and Decisions



Load Allocations and WLA

- What are the categories of interest in order to partition loads? What level of detail
- Equal reduction in loads? Assume equal reduction in first cut, but RB staff can decide otherwise

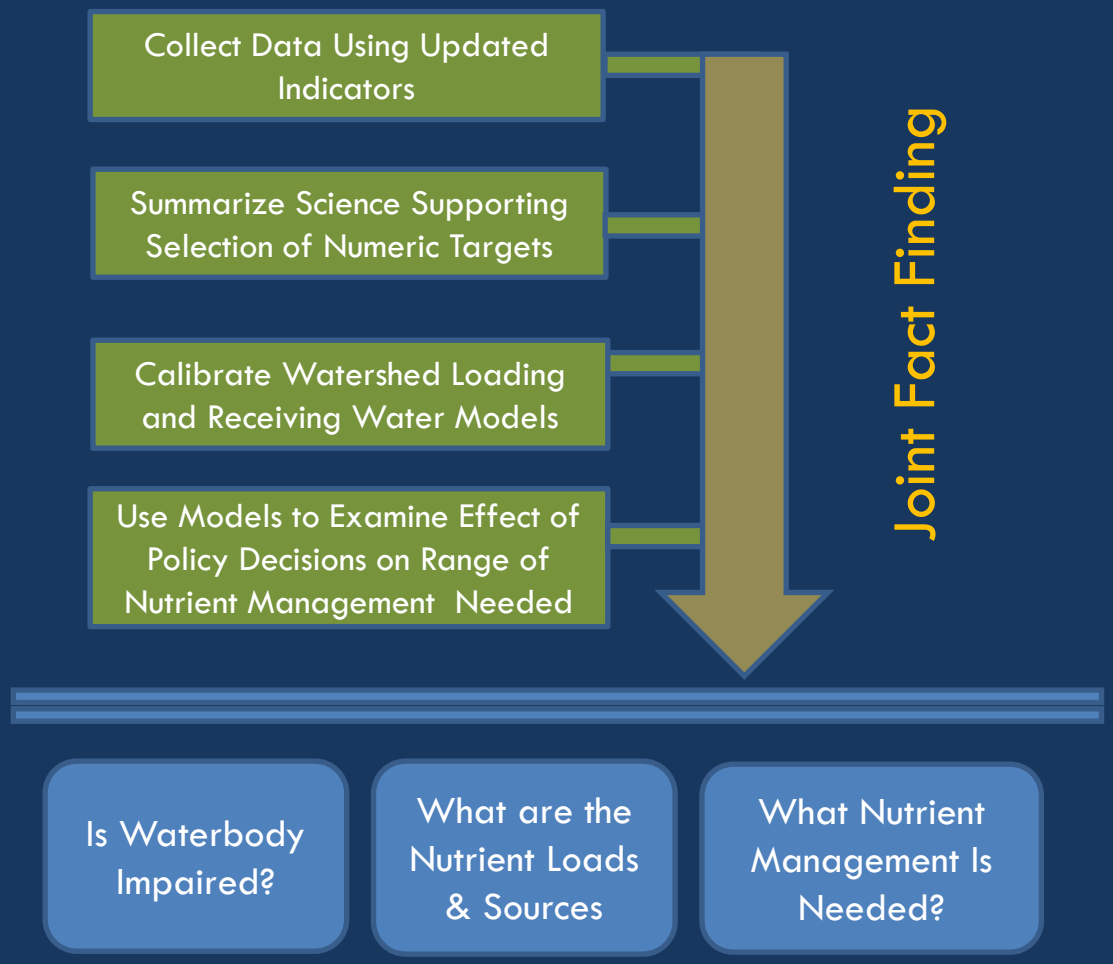
<u>Complicating factors</u>

- Uncertainty in model predictions
- Riverside rising groundwater?
- Reservoirs – CO river project water (treated as point)
- Appropriate averaging period?
- Others….

Sequence of Technical Discussions at Upcoming Meetings

- December 2015
  - Estuary water quality model calibration
  - Work plan to calculate watershed loads and sources
  - Optional approaches to establishing limits for wet weather
- January 2016
  - Effect of decisions on numeric targets on calculation of range of allowable loads
- February
  - Summary of nutrient loads and sources
  - Effect of decisions on numeric targets on range of load and waste load allocations
- March 2016
  - Draft technical reports

Conceptual Approach for Technical Activities in River and Estuary



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Questions? Comments