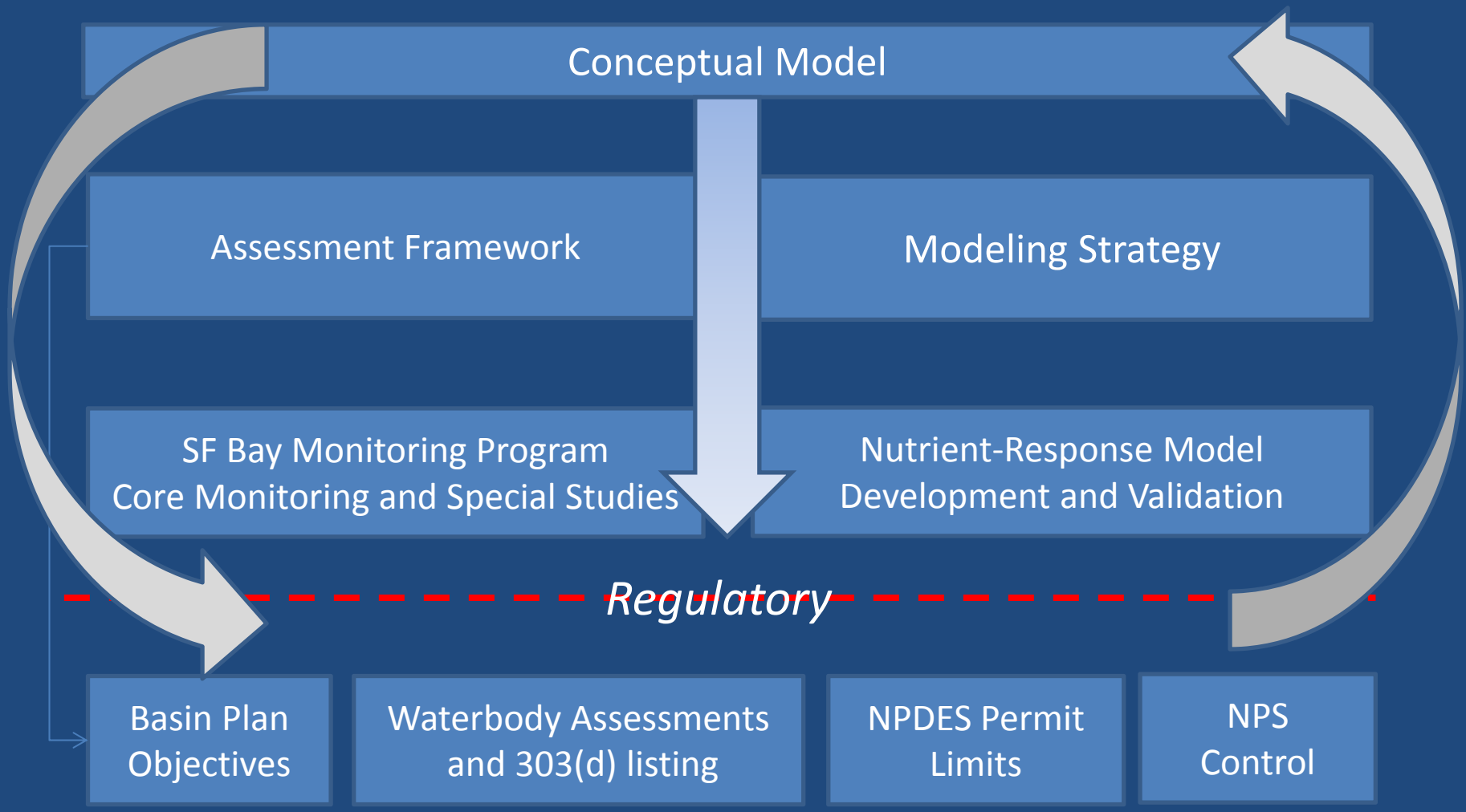
Update on SF Bay Nutrient Assessment Framework Development

Stakeholder Advisory Group Meeting
December 6, 2013

Context for Assessment Framework



What is An Assessment Framework?

- **Decision support**
  - Transparent
  - Peer-reviewed
  - Capacity to evolve framework as science advances
  - Indicators, metrics & endpoints may differ by Bay segment or season
- **Key components**
  - Supported by SF Bay conceptual models
  - Specifies what to measure, temporal and spatial frequency in which those indicators/metrics should be measured
  - Specifies how to use data to classify the Bay (or segments of the Bay) in “risk categories”
- **Assessment frameworks do not:**
  - Specify regulatory thresholds – that is a policy decision

Process and Schedule to Develop Assessment Framework

- **Begin with conceptual models** — Fall 2012
  - Identify indicators, linkages to beneficial uses at relevant spatial and temporal scales
- **Review available assessment frameworks** — Spring 2013
  - White paper that synthesizes approaches, data required
- **Utilize those frameworks with existing SF Bay data (if available) to demonstrate applicability** — Fall 2013
  - Inform decision-making
- **Utilize demo results, in tandem with conceptual models, to craft strawman framework with experts** — Spring 2014
  - Demonstrate with existing data
- **Vete and refine assessment framework (…repeat)** — Summer 2014

At Previous Stakeholder Meetings….

- Discussed work plan to create assessment framework
- Presented white paper summarizing existing approaches to creating assessment frameworks
  - Site-specific (Chesapeake Bay chlorophyll a criteria)
  - Regional (Florida, European Water Framework Directive)

Progress Since Last Meeting

- Completed preliminary analysis of existing data
- Held first conference call of expert team to lay groundwork
- First workshop is scheduled for February 2014

Who Are The Experts

- **International experts in assessment frameworks, criteria:**
  - Suzanne Bricker (NOAA)
  - Larry Harding (University of Maryland/UCLA)
  - James Hagy (EPA ORD)

- **Local experts in SF Bay nutrient biogeochemistry and eutrophication, but not limited to:**
  - Jim Cloern
  - Dick Dugdale
  - Raphael Kudela
  - Anke Mueller-Solger

What's Ahead: Three 2-Day Experts Workshops To Develop Draft Framework

- **Workshop 1 (January-February 2014)**
  - Confirm indicators (and metrics) of interest
  - Agree on SF Bay "segments" and targeted habitats
  - Identify temporal elements of assessment framework
  - Identify spatial elements of assessment framework
- **Workshop 2 (March- April 2014)**
  - Develop proto-monitoring program
  - Discussion of thresholds for classification scheme
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  - Comment on assessment framework document

Conceptual Model Development Lays Groundwork for Assessment Framework

Problem statement: Management endpoints of concern (primary indicators)

- Elevated chlorophyll a biomass and/or primary productivity
  - Increased frequency and duration of phytoplankton blooms
- Reduced chlorophyll a biomass and/or primary productivity
- Imbalanced phytoplankton community composition
  - Harmful algal species and toxin concentrations
- Low dissolved oxygen concentrations

Conceptual Model Discussions Confirm Preliminary Assessment of Indicator Suitability

Primary

- Dissolved oxygen
- Chlorophyll a (biomass) and/or primary productivity
- HAB species and toxin concentration
  - Cyanobacteria

Supporting

- Phytoplankton assemblages or taxonomic composition
- Nutrient concentrations and/or ratios

White Paper Outline

- Context for assessment framework
  - — Conceptual approach to nutrient objectives in SF Bay
  - — Previous work
- Review of existing approaches
  - — Regulatory (Chesapeake Bay, Florida) and non-regulatory
  - — How is the approach used to assess waterbody condition
    - What is the basis of the ranking
    - Indicators, categories, thresholds
    - Method used to measure indicator
    - Data requirements for the assessment
    - How are the data used to calculate the score/category

Overview of Regional Approaches

Table 3.4. Summary of approaches used for assessment of eutrophication applicable to shallow and deepwater unvegetated subtidal habitat. Adapted from Devlin et al. 2011.

		UK WFD	OSPAR	TRIX	ASSETS	EPA NCA	TWQI/LWQF	HEAT
Grouping of Variables	Causative Factors	Nutrient Load	DIN and DIP concentration, ratios, and loads	DIN and TP concentration	DIN and DIP loads	DIN, DIP conc	TN, TP, DIN and DIP conc.	DIN and DIP
	1^{ary} effects	Chl-a, PP indicator species, seasonal changes in cell abundance of diatoms/dinoflagellates, SAV, macroalgae	Chl-a, PP indicator species, macroalgae, microphytobenthos, SAV	Chl-A	Chl-a macroalgae	water clarity, chl-a	Chl a, SAV, macroalgae	Chl a, water clarity, SAV,
	2^{ary} effects	DO	DO, zoobenthos and/or fish kills, organic carbon	DO	Nuisance/toxic blooms	DO	DO	Benthic invertebrates
	Other effects		Algal toxins					
Temporal sampling framework		Annual chla and DO, winter DIN, monthly PP groups	Growing season chl-a (Mar-Sept), Winter DIN, summer DO	Annual	Annual	One sample per year (per station) within summer index period	Results can be derived based on one time period, multiple periods recommended	Growing season chl-a (Mar-Sept), Winter DIN, summer DO
Spatial sampling framework		Sampling in estuaries and nearshore defined by salinity, reported by waterbody	Sampling defined by salinity in estuaries, nearshore	Sampling mostly in larger offshore systems; results reported by region	Sampling in salinity zones, synthesized to waterbody, region, then national, with reporting at all levels	Sampling is regional, synthesized to national level, reported at regional and national level	For shallow, benthic PP dominated. Can be applied to single stations or groups of stations.	Sampling defined by salinity in Baltic Sea
Assessment of indicators		Deviation from reference conditions	Deviation from reference conditions	Placement on scale from 1-10 TRIX units	Deviation from reference conditions	Deviation from reference conditions	Deviation from reference condition	Deviation from reference condition
Comb-ination Method		Indicator scores are averaged within in indicator group. Final score gives classification status	One out, all out for individual categories and overall classification	Linear combo of logarithm of variables modified by scaling coeff.	Scores of ave. primary and secondary indicators combined in a matrix	Indicators assessed individually. WQI based on % of samples in 4 categories.	TWQI scores combined as the sum of weighted quality values for individual indicators.	One out, all out for individual categories and overall classification

Objective of Analysis of Existing Data

Inform the process of developing an appropriate assessment framework and monitoring program

- Test out existing indicators and assessment frameworks using real data
- Understand how categorization of condition varies as function of magnitude, frequency and duration (thresholds, space and time)
- Provoke a visceral reaction from local experts to "bring home" options that we are considering

First phase of analysis pending feedback from group– application of existing frameworks to SF Bay does not imply that we are going to use them!!!

Just a jumping off point for discussion!!

Frameworks Supported By Existing Data

- Water Framework Directive (United Kingdom)
  - Phytoplankton index based on chlorophyll a
  - Taxa index
- Assessment of Estuarine Trophic Status (ASSETS)
  - Chlorophyll a
- The French Research Institute for the Exploration of the Sea (IFREMER) Classification for Mediterranean Lagoons

Indicators:
UK-WFD Phytoplankton

Each statistic is given a point value of 1 if it does not exceed the threshold, the sum of points accumulated yields the final classification.

Statistic	Low Salinity Threshold (0-25 ppt)	High Salinity Threshold (> 25 ppt)
Average Annual CHL-a	≤ 15 µg L^{-1}	≤ 10 µg L^{-1}
Median Annual CHL-a	≤ 12 µg L^{-1}	≤ 8 µg L^{-1}
% CHL-a less than 10 µg L^{-1}	> 70 %	> 75 %
% CHL-a less than 20 µg L^{-1}	> 80 %	> 85 %
% CHL-a less than 50 µg L^{-1}	< 5 %	< 5 %

Points	Classification
5	High
4	Good
3	Moderate
2	Low
0-1	Very Low

Classification presented with respect to ecological condition

Indicators:
UK-WFD Taxa

Classification is assessed as the sum of a series of exceedences

Index	Statistic	Threshold
CHL	Chlorophyll (CHL)	> 10 µg L^{-1}
S	Any phytoplankton taxa (S)	> 10^6 cells L^{-1}
P	*Phaeocystis sp.** (P) *used Cyanobacteria	> 10^6 cells L^{-1}
T	Total taxa counts (T)	> 10^7 cells L^{-1}

Sum of % Exceedences Σ(CHL + S + P + T)	Classification
0-10	High
10-20	Good
20-40	Moderate
40-60	Low
60-100	Very Low

Classification presented with respect to ecological condition

Indicators: IFREMER

Classification is assessed using a series of indicators and thresholds—focus on chlorophyll a

Indicator	Unit	Ecological Condition				
		High	Good	Moderate	Low	Very Low
%O2 Saturation	% SAT	<20	20-30	30-40	40-50	>50
Turbidity	NTU	<10	10-20	20-30	30-40	>40
phosphate	µM	<0.3	0.3-1	1-1.5	1.5-4	>4
Dissolved inorganic nitrogen	µM	<15	15-20	20-40	40-60	>60
Nitrite	µM	<0.5	0.5-1	1-5	5-10	>10
Nitrate	µM	<7	7-10	10-20	20-30	>30
Ammonia	µM	<7	7-10	10-20	20-30	>30
CHL-a	µg L^{-1}	<5	5-7	7-10	10-30	>30
CHL-a + phaeopigments	µg L^{-1}	<7	7-10	10-15	15-40	>40
Total nitrogen	µM	<50	50-75	75-100	100-120	>120
Total phosphorus	µM	<1	1-2	2-5	5-8	>8

Classification presented with respect ecological condition

Indicators: ASSETS

Classification is assessed using a multi metric approach

For this analysis, chlorophyll a assessed independently

Classification	90th Percentile Annual CHL a
Low	< 5 mg L^{-1}
Medium	5 – 20 mg L^{-1}
High	20 -60 mg L^{-1}
Hypereutrophic	≥ 60 mg L^{-1}

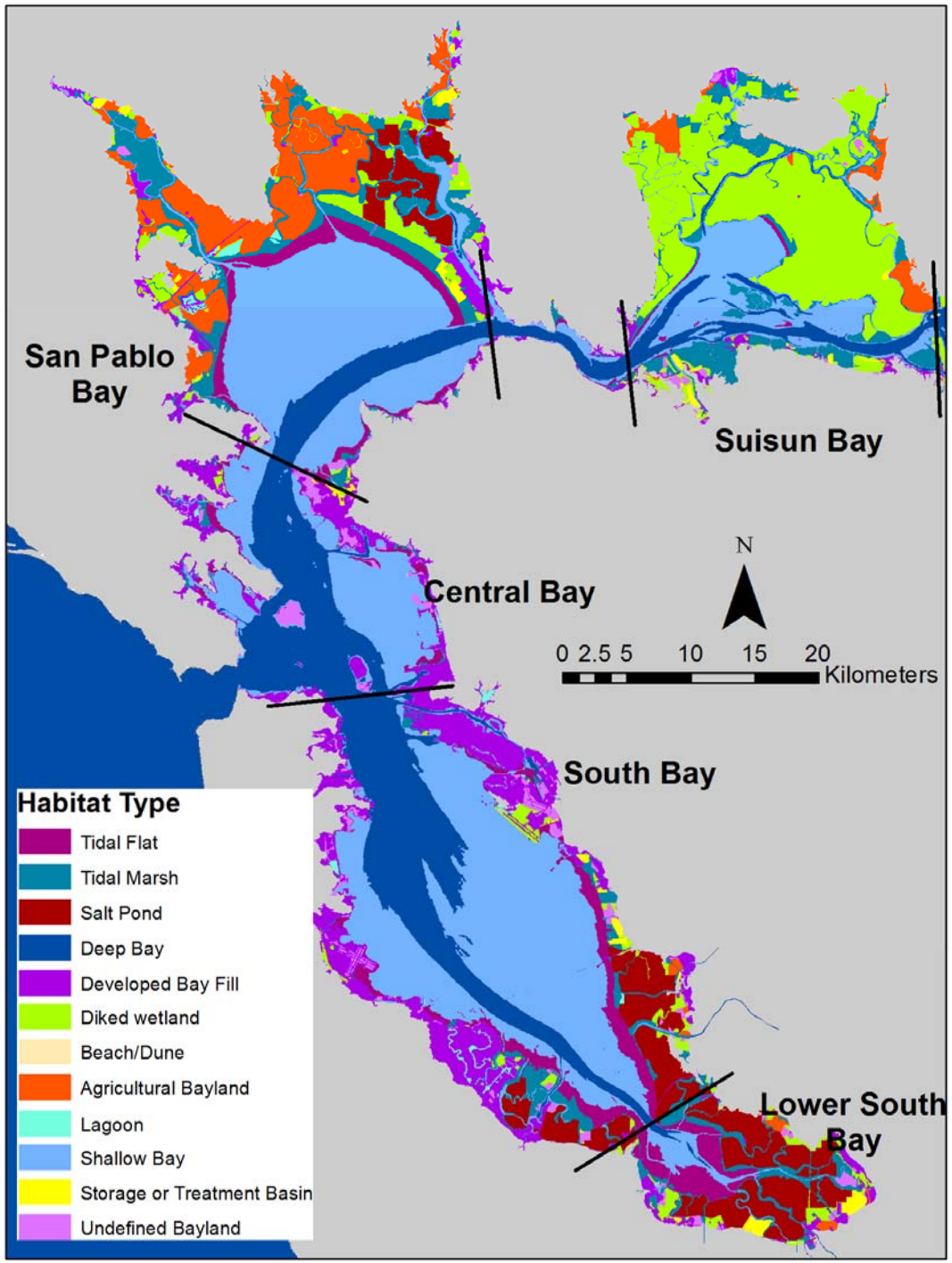
Classification presented with respect to status of eutrophication

Data Sets Used for Analysis of Existing Data

- USGS Water Quality Monitoring Surveys
  - Chlorophyll (1975-present)
  - Dissolved oxygen (1971-present)
  - Inorganic nutrients (1971-present)

- Interagency Ecological Program (IEP) Bay –Delta monitoring program (CA Department of Water Resources)
  - Chlorophyll (1975-present)
  - Taxa (1975-present)
  - Dissolved oxygen (1971-present)
  - Inorganic nutrients (1971-present)
  - Total nutrients (1971-present)
  - Turbidity (1975-present)

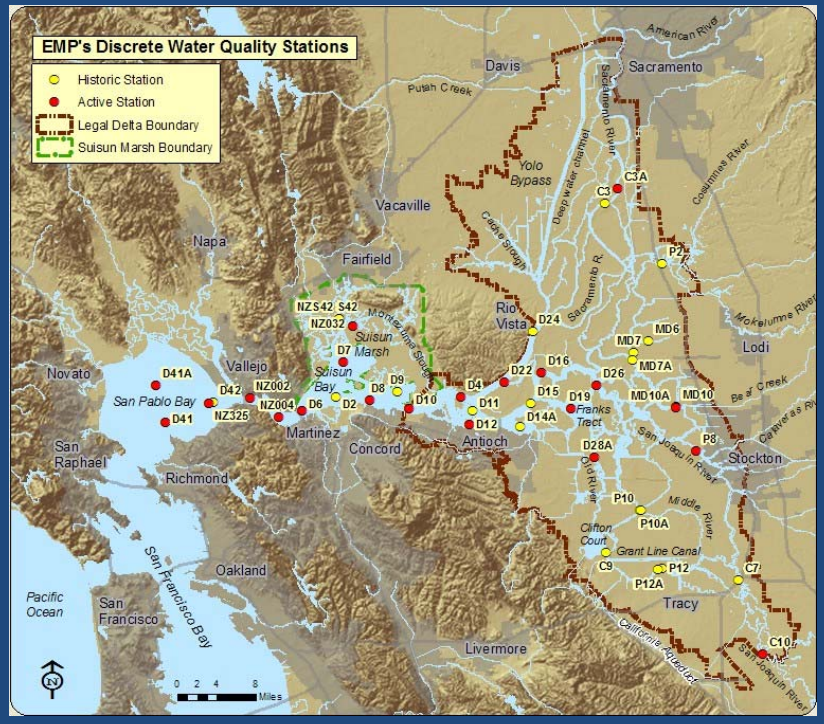
Preliminary Segmentation of the Bay



Habitat types of SFB and surrounding Baylands. Water Board subembayments boundaries are shown in black. Habitat data from CA State Lands Commission, USGS, UFWS, US NASA and local experts were compiled by SFEI.

Preliminary Bay Segments Used to Aggregate USGS and IEP Data Into Sub-basins

- Suisun, San Pablo, Upper South Bay, Lower South Bay



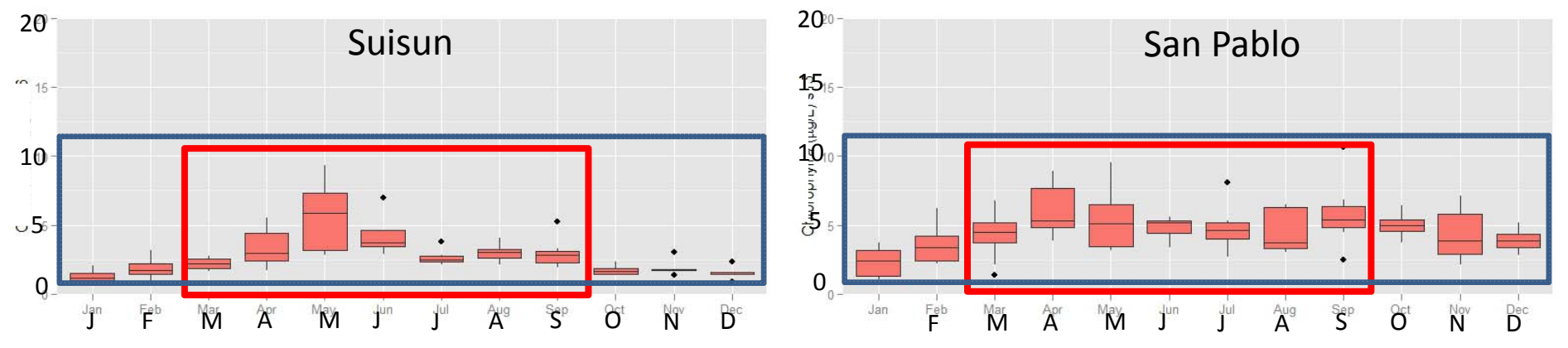
Approach

- Classify sub-basins using existing approaches
- Compare outcomes based on varying data integration methods
  - Inter-annual variability (yearly, six year running average)
  - Temporal integration of annual data (seasonal, annual average, annual median, percentile)
  - Spatial integration
- Use as a jumping off point to consider options for what to develop specifically for SF Bay

Defining How to Use Data to Make An Assessment—Critical Period?

- Annual Average? Median Value? Percentile? "Growing Season"?

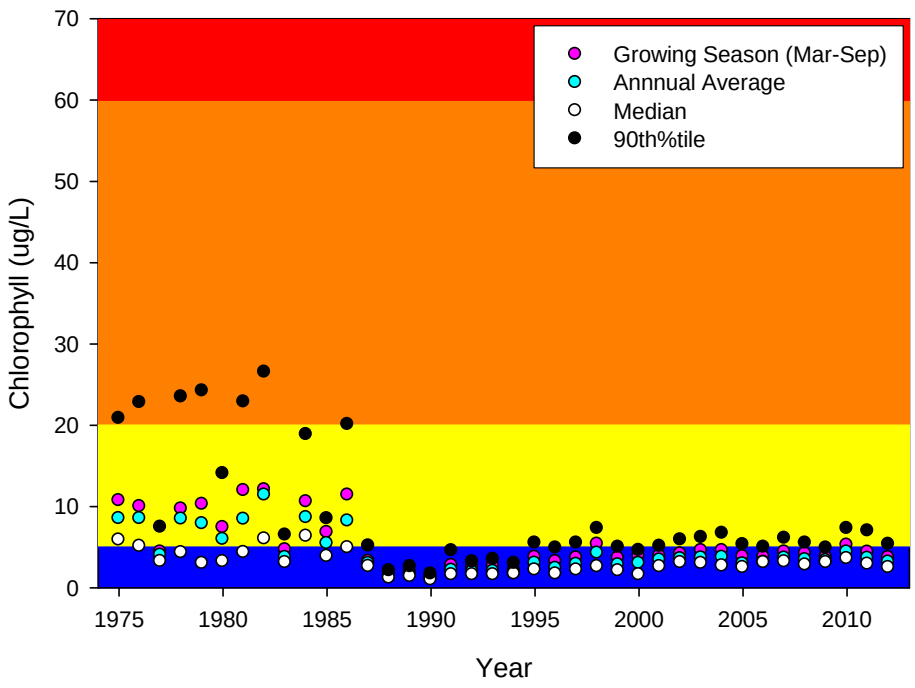
Monthly average chl-a (mg m^{-3}) – 2006-2011



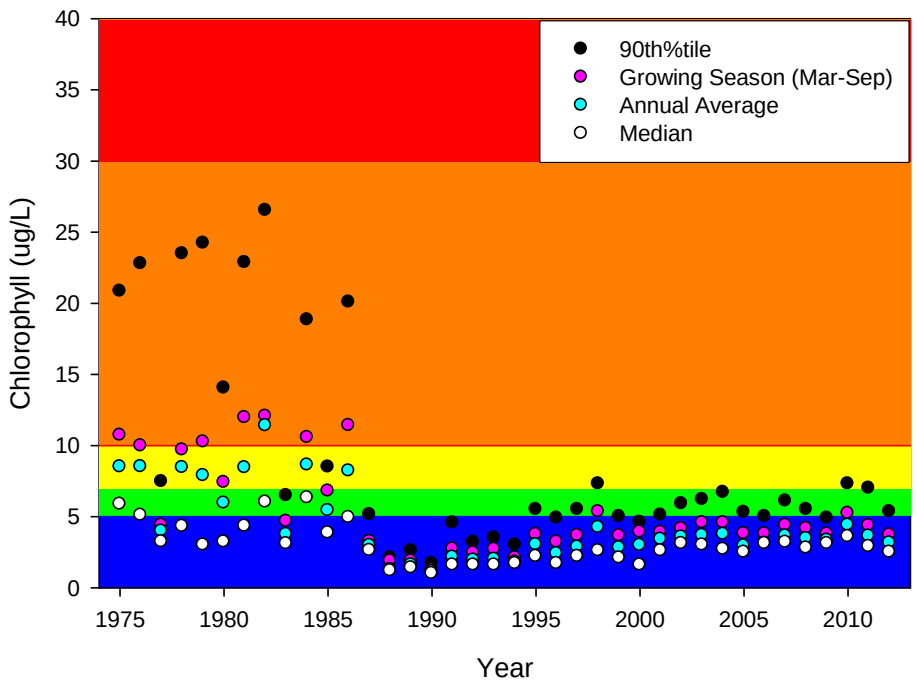
Data source: http://sfbay.wr.usgs.gov/access/wqdata/

Effect of Threshold and Temporal Aggregation on Categorization: North Bay

ASSETS Thresholds

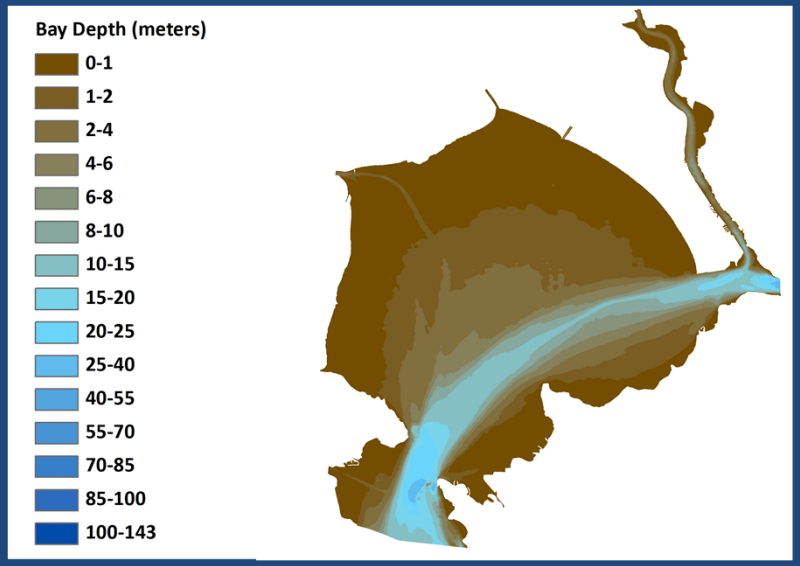


IFREMER Thresholds

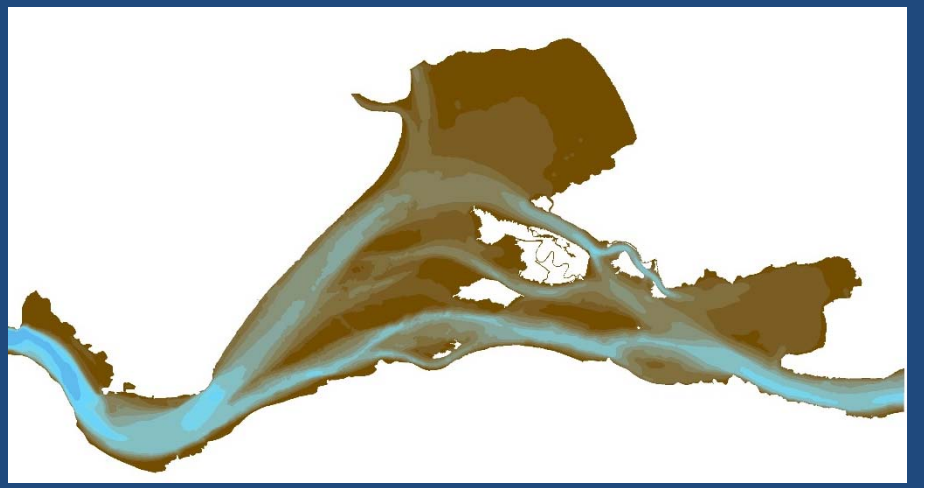


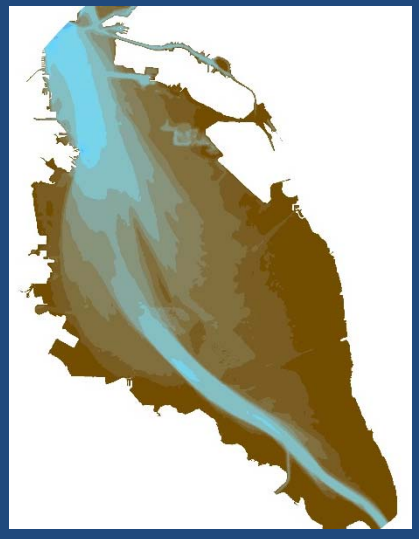
Targeted Habitats and Effect of Spatial Aggregation on Categorization

San Pablo Bay



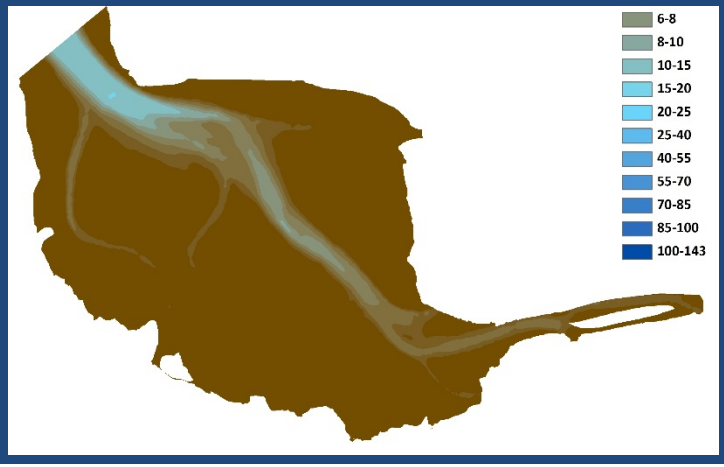
Suisun Bay





South Bay

South of Dumbarton Bridge



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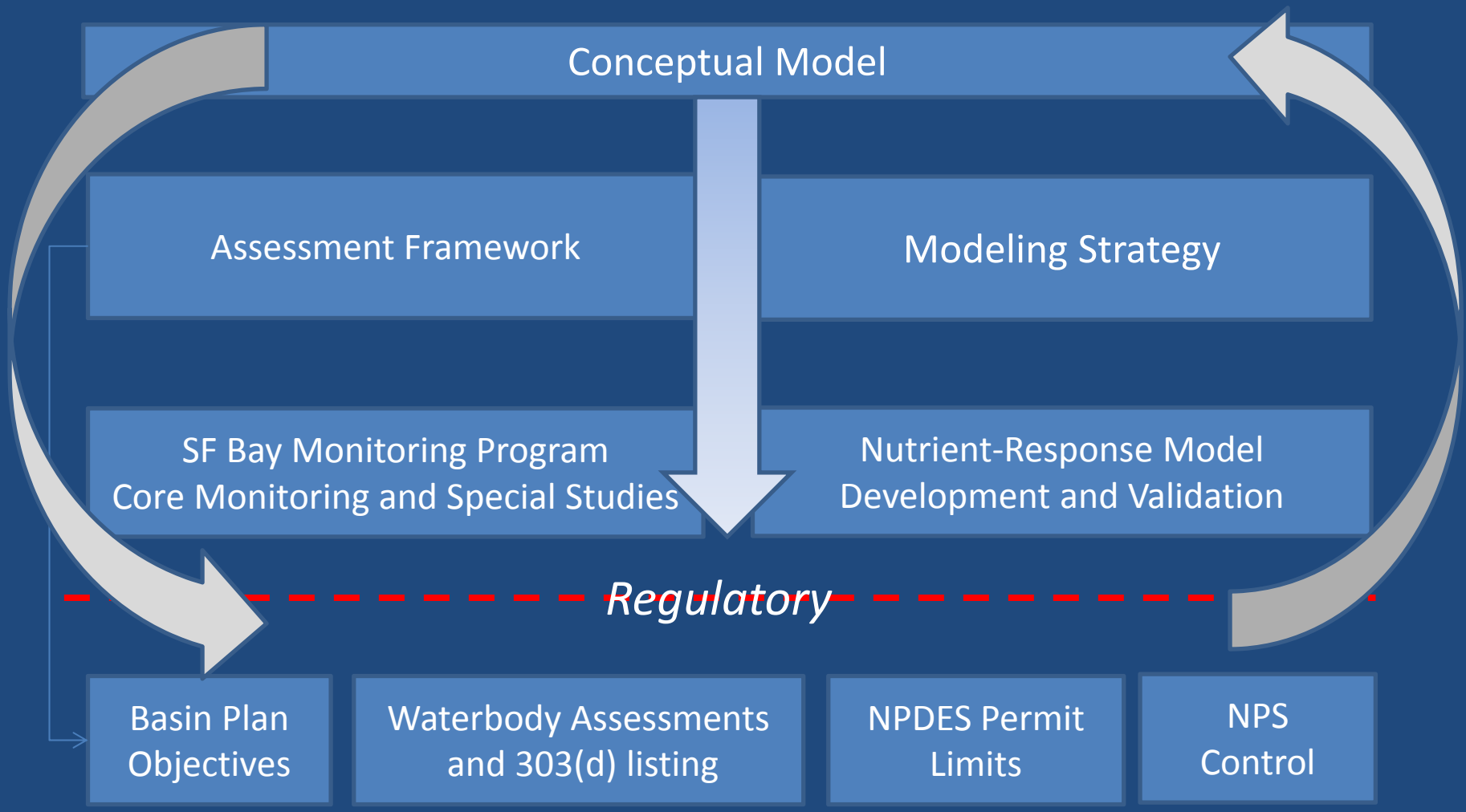

What Happens to It After That?

Technical Team Viewpoint….

- Employed as a part of a revised monitoring program for SF Bay
- Tested for a few years to see how well it jives with best professional judgment and optimize integration with monitoring and modeling
- Decision by Water Board whether to explicitly incorporate into regulatory policy, and/or use to establish nutrient limits in permits

Stakeholder Input on Process

- Discuss existing approaches and proposed analysis of existing data with technical experts (November 2013)
  - **Webinar for stakeholders (January 2014)**
- Expert workshops, proto-monitoring program (February – April 2014)
  - **Webinar or meeting with stakeholders (early March – April 2013)**
- Expert workshops, draft assessment framework (June 2014)
  - **Meeting with stakeholders (July 2014)**
- Written draft of assessment framework (July 2014)
  - **Meeting with stakeholders (September 2014)**