SF Bay Nutrient Assessment Framework Development

Nutrient Technical Workgroup Meetin

February 4, 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)

Specific Feedback from SAG:

- Opportunity to provide technical input in real time, not just comment on outcome

Progress Since Last Meeting

- Completed preliminary analysis of existing data
- Held 2nd conference call of expert team to discuss:
  - Proposed segmentation
  - Get consensus on indicators
  - Present analysis of existing data
- First workshop is scheduled for February 11-12, 2014
  - Tech team is working on the charge

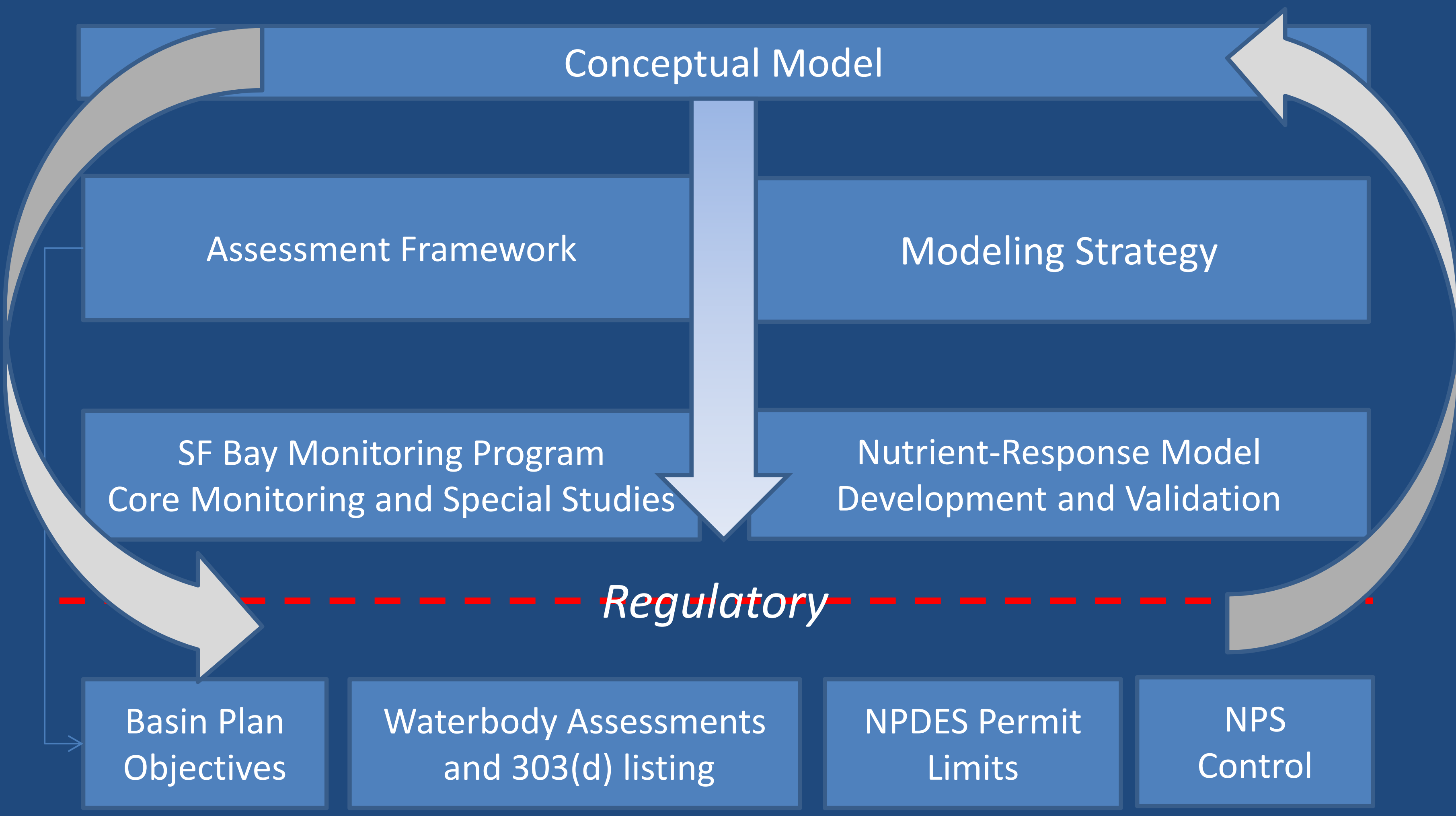
Goal and Roadmap for This Agenda Item

Goal: Provide opportunity for SAG technical input on approach prior to for technical team workshop

Road map:

- Overview of process, approach and timeframe
- Geographic scope, focal habitats, and proposed segmentation
- Informing the process: analysis of existing data
- Charge for February 11-12, 2014 workshop
- Discussion (all)

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

Fall 2012

Spring 2013

Fall 2013

Spring 2014

Summer 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 -- Wim Kimmerer
  - Anke Mueller-Solger
  - Dick Dugdale
  - Raphael Kudela

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 geographic scope, 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
- **Workshop 3 (May-June 2014)**
  – Develop classification scheme by Bay segment
  – Discuss uncertainty associated with classification scheme
- **Conference calls (June – July 2014)**
  – Comment on assessment framework document

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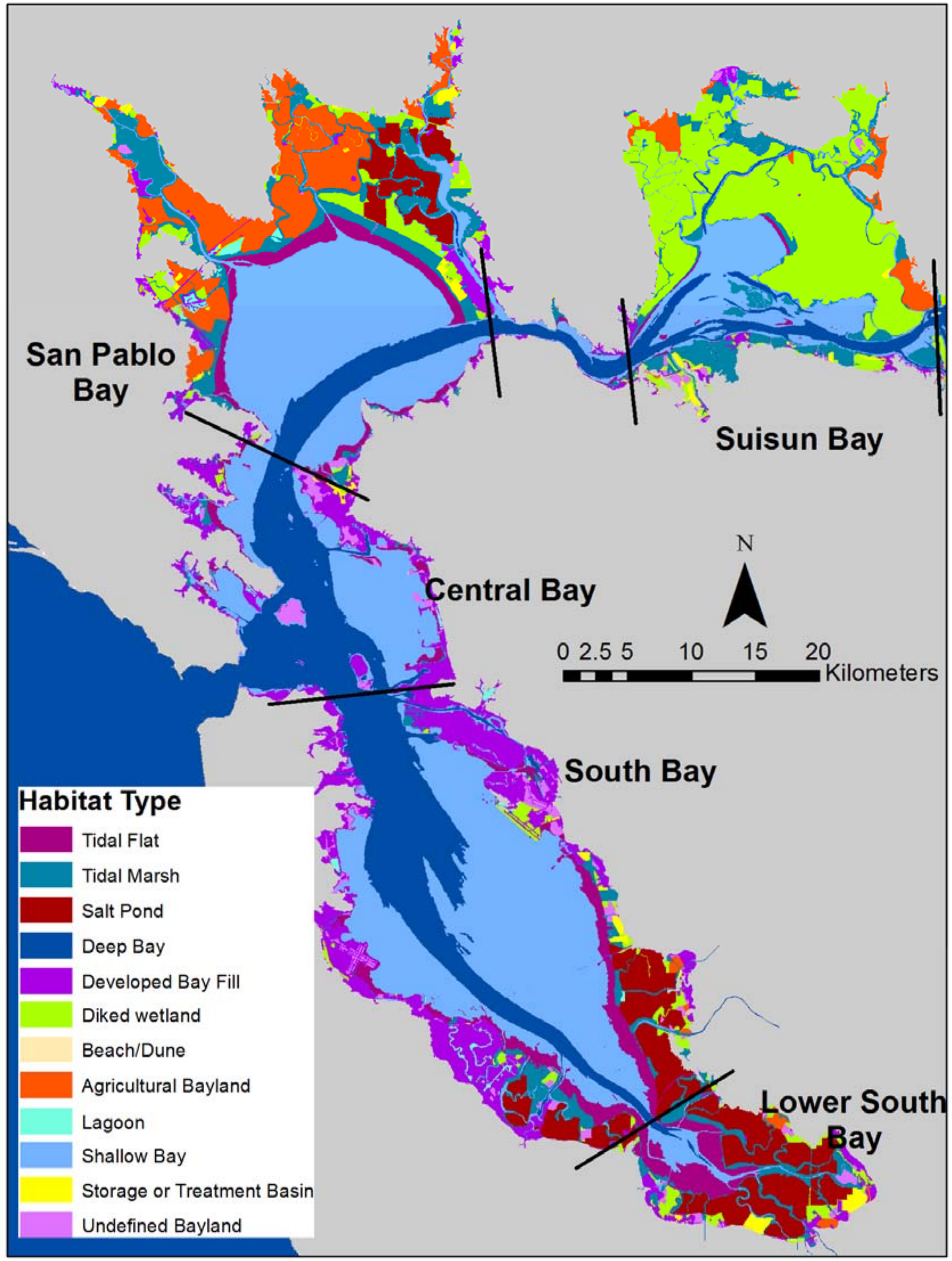
Geographic Scope and Applicable Habitats?

- Geographic scope coincident with RB 2 boundaries
- Shallow & deepwater subtidal

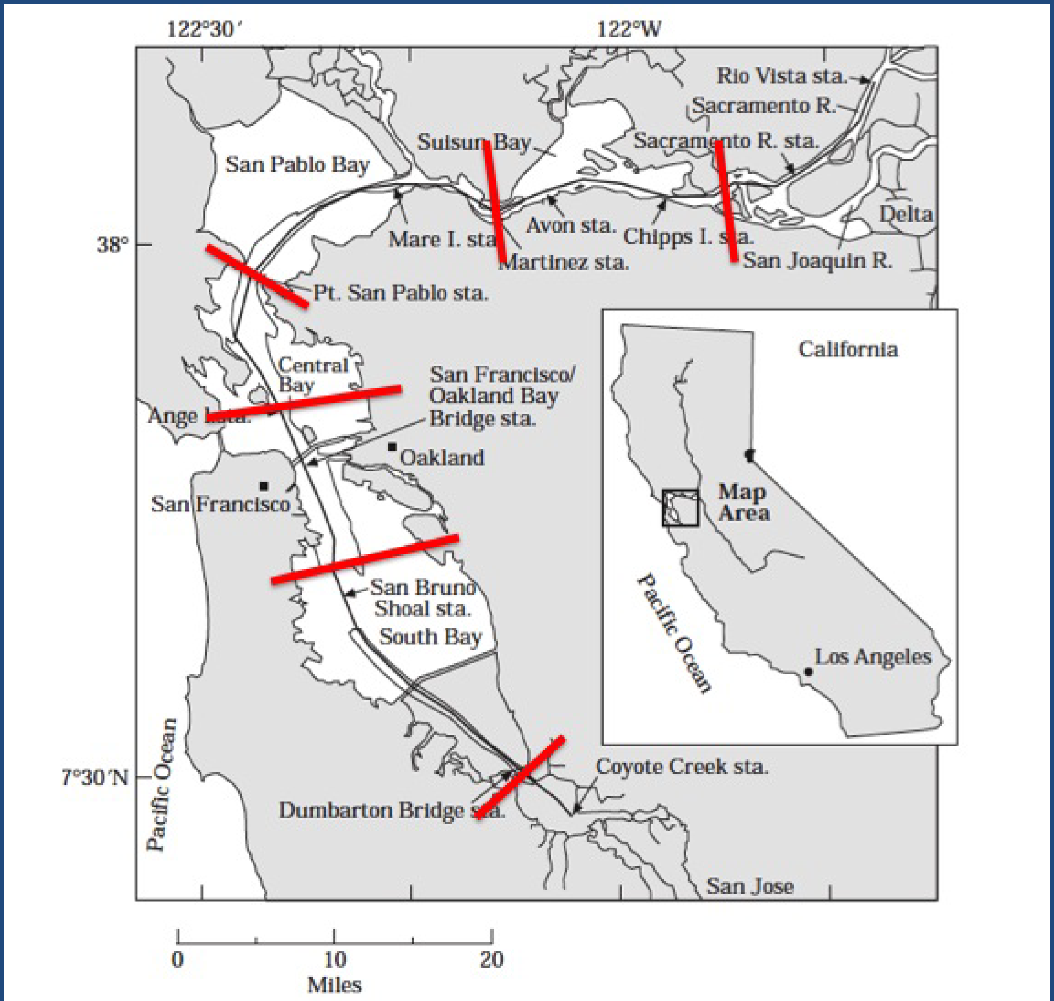
Excludes:

- Diked baylands, restored salt ponds



Proposed Preliminary Segmentation of SF Bay, Based on Jassby et al. 1997

- Boundaries coincident with natural physical boundaries
- Starting point for discussions now
- Possibility to refine with new data



Analysis of Existing Monitoring Data: A Preview

From January 16, 2014 Tech Team Conference Call

Introduction

- Many frameworks exist to assess effects of nutrient over-enrichment and/or eutrophication
- Use of different assessment frameworks on same system can yield very different results
- Different frameworks apply similar indicators, but small differences affect outcome
  - Data integration (seasonal, annual average, annual median, percentile)
  - Characteristics included in indicator metrics (concentration, spatial coverage, frequency of occurrence)
  - Combination of indicators into multiple lines of evidence

Purpose of Analysis of Existing Data

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

- Test out existing indicators and assessment frameworks using real data
- Show you how the details of indicators, thresholds, and data integration affect the result
- Generate discussion of what you like/don’t like about the frameworks
- Solicit additional analysis that could be done to better inform this process

This is a jumping off point for discussion, so looking for a visceral reaction! Does not imply we are suggesting to use these approaches for SF Bay

Frameworks, Frameworks, Frameworks…

Method Name	Biological Indicators	Physico-Chemical Indicators	Load related to WQ	Integrated final rating
TRIX	CHL	DO, DIN, TP	No	Yes
EPA NCA Water Quality Index	CHL	DO, Water clarity, DIN, DIP	No	Yes
ASSETS	CHL, macroalgae, seagrass, HAB	DO	Yes	Yes
LWQI/TWQI	CHL, macroalgae, seagrass	DO, DIN, DIP	No	Yes
OSPAR COMPP	CHL, macroalgae, seagrass, PP indicator spp.	DO, DIN, DIP, TP, TN	Yes	Yes
WFD guidance	CHL, PP, macroalgae, benthic invertebrates, seagrass,	DO, Water clarity, DIN, DIP, TN, TP	No	Yes
HEAT	CHL, macroalgae, benthic invertebrates, seagrass, HAB	DO, Water clarity, DIN, DIP, TN, TP, C	No	Yes
IFREMER	CHL, seagrass, macrobenthos, HAB	DO, Water clarity, DIN, SRP, TN, TP, sediment organic matter, sediment TN, TP	No	Yes
Statistical Trophic Index	CHL, Primary Production	DIN, DIP	No	No
AMBI	Soft bottom macrobenthic community		No	Yes
BENTIX	Soft bottom macrobenthic community		No	Yes
ISD (lagoons)	Benthic community biomass size classes		No	Yes
B-IBI	Benthic community species diversity, productivity, indicator spp., trophic composition		No	Yes

Data Sets– Quarterly Sampling

- 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)

Data Limits the Framework We Can Apply

Method Name	Biological Indicators	Physico-Chemical Indicators	Load related to WQ	Integrated final rating
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Conceptual Basis for Frameworks-Linkage to Management Endpoints

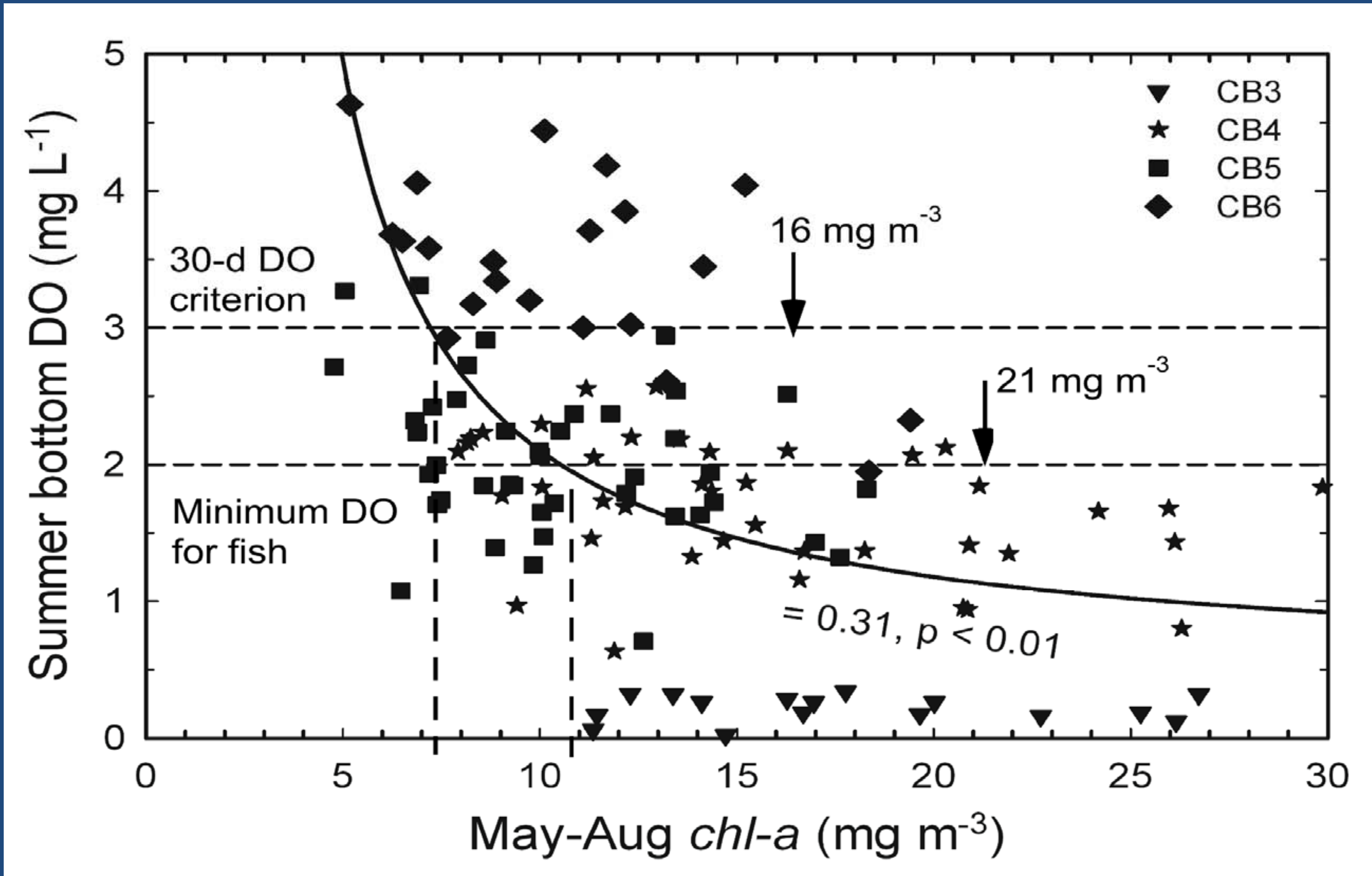
- Light limitation on seagrass
- Unbalanced algal community composition/structure and potential foodweb effects
- Over-production of organic matter (implications for hypoxia, benthic habitat quality, altered nutrient cycling)

What Would the Bay Look Like if It Had A Problem From Nutrient Overenrichment- From Senn et al. (2013)

Table 3.2 What would a problem look like in SFB? Potential impaired states

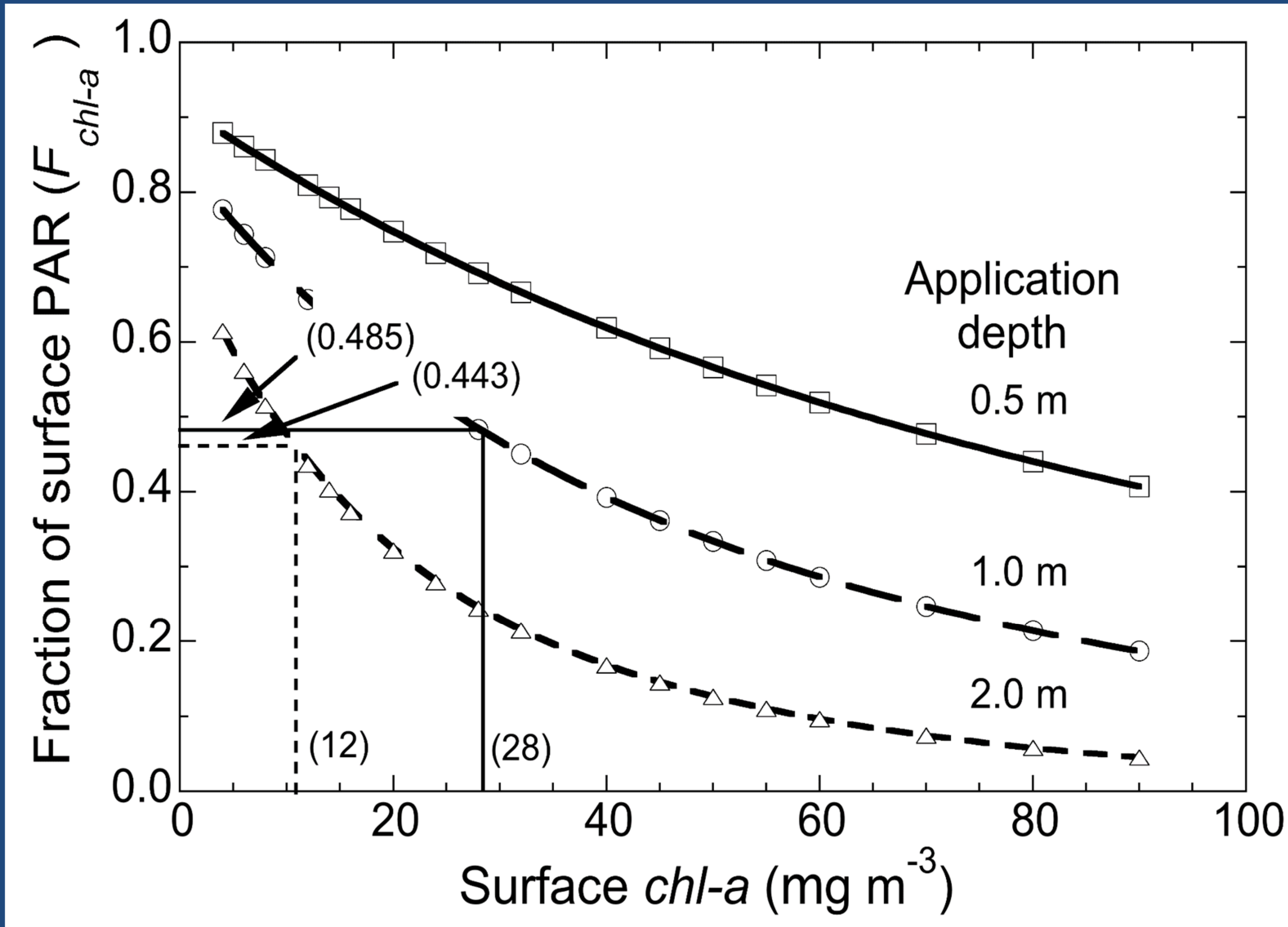
	Impaired State	Indicators
IS.1	**High Phytoplankton Biomass** High phytoplankton biomass of sufficient magnitude (concentration), duration, and spatial extent that it impairs beneficial uses due to direct or indirect effects (A0.2). This could occur in deep subtidal or in shallow subtidal areas.	**Chlorophyll a, Productivity**
IS.7	**Low Phytoplankton Biomass** Low phytoplankton biomass in Suisun Bay or other habitats due to elevated NH_4 which exacerbates food supply issues.	
IS.4	**NABs, HABs and algal toxins** Occurrence of HABs and related toxins at sufficient frequency or magnitude of events that habitats reach an impaired state, either in the source areas or in areas to which toxins are transported.	**HAB or NAB abundance, toxin concentrations**
IS.6	**Suboptimal phytoplankton assemblages** Nutrient-related shifts in phytoplankton community composition, or changes in the composition of individual cells (N:P), that result in decreased food quality, and have cascading effects up the food web.	**Phytoplankton assemblage**
IS.2	**Low Dissolved Oxygen in Deep Water**– Deep subtidal Low DO in deep subtidal areas of the Bay, below some threshold for a period of time that beneficial uses are impaired.	**Dissolved oxygen**
IS.3	**Low DO in Shallow Habitat**– Shallow/margin habitats: DO in shallow/margin habitats below some threshold, and beyond what would be considered "natural" for that habitat, for a period of time that it impairs beneficial uses, by reducing habitat area for fish or benthos at various life stages.	
IS.8	**Other nutrient-related impacts.** Other direct or indirect nutrient-related effects that alter habitat or food web structure at higher trophic levels by other pathways. (e.g., creating conditions that favor the establishment of invasive benthos and copepods; NH_4 direct toxicity to copepods; spreading of macrophytes related to high nutrient concentrations)	**Nutrient concentrations (Ammonium), nutrient ratios,**

Dissolved Oxygen (DO)



From L. W. Harding et al. 2013. Scientific bases for numerical chlorophyll criteria in Chesapeake Bay. *Estuaries and Coasts* doi:10.1007/s12237-013-9656-6

Submerged Aquatic Vegetation (SAV)



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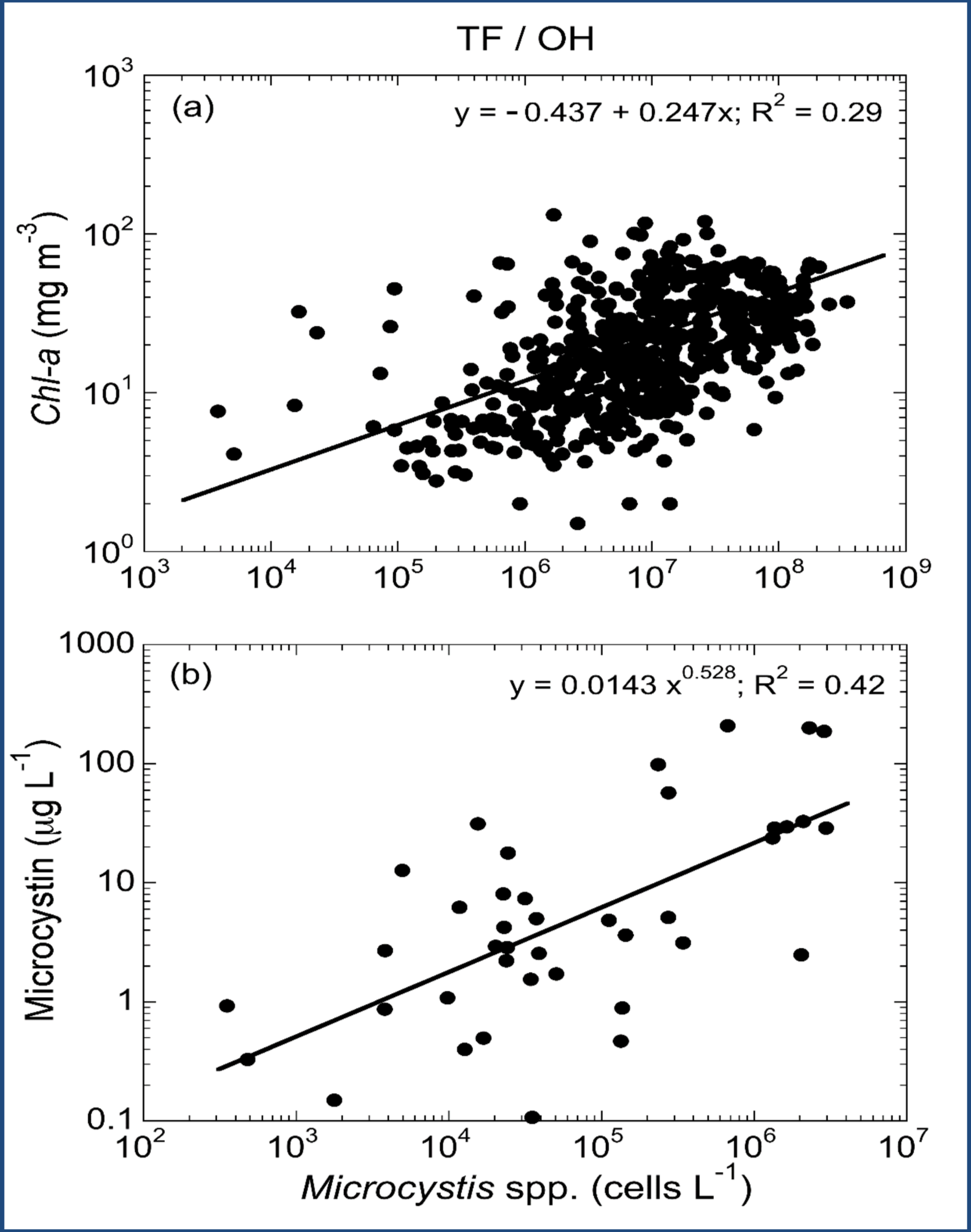
***HABs – Microcystis* spp.**



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Evaluated Frameworks

- Water Framework Directive (developed in United Kingdom)
  - Water quality index
  - Phytoplankton index
  - Taxa index
- Assessment of Estuarine Trophic Status (ASSETS)
  - Chlorophyll
  - Dissolved oxygen
- The French Research Institute for the Exploration of the Sea (IFREMER) Classification for Mediterranean Lagoons

Why These Three?

These three frameworks differ sufficiently in approach, results demonstrate how organizing principles affect outcome.

Method	Application	Indicator Use		
		Light limitation on seagrass	Unbalanced algal assemblage	Organic matter over-production
ASSETS	Broad in scope; designed to be used in all estuaries	X	X	X
UK-WFD	Designed for estuaries in the UK (strong seasonality)	X	X	X
IFREMER	Limited to shallow, Mediterranean Lagoons	X	X	

Indicators:
ASSETS

Classification is assessed using a multi metric approach

For this analysis; indicators for chlorophyll a and dissolved oxygen were assessed independently

Classification	90^{th} Percentile Annual CHL a
Low	≤ 5 µg L^{-1}
Medium	5 – 20 µg L^{-1}
High	20 – 60 µg L^{-1}
Hypereurophic	> 60 µg L^{-1}

Classification	10^{th} Percentiles Annual Dissolved Oxygen
High	> 5 mg L^{-1}
Biologically Stressful	2 - 5 mg L^{-1}
Hypoxia	0 - 2 mg L^{-1}
Anoxia	0 mg L^{-1}

Indicators: IFREMER

Classification is assessed using a series of indicators and thresholds

Indicator	Unit	Eutrophic Status				
		Blue	Green	Yellow	Orange	Red
%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	$\mu g\ L^{-1}$	<5	5-7	7-10	10-30	>30
CHL-a + phaeopigments	$\mu g\ L^{-1}$	<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

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

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	Poor
0-1	Bad

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	Poor
60-100	Bad

Indicators:
UK-WFD Water Quality Index

Classification is assessed via progression through three indices

Statistic for Index		Index 1: I_{DIN} Nutrient Concentration	Index 2: I_{PP} Production*	Index 3: I_{DO} Undesirable Disturbance
		Mean Winter Dissolved Inorganic Nitrogen (µM)	Growing Season Potential Primary Productivity (g C m^{-2} y^{-1})	Growing Season Mean Dissolved Oxygen Concentration (mg L^{-1})
Eutrophic Status	High	$I_{DIN} \leq 12$	n/a	n/a
	Good	$I_{DIN} < 30$	n/a	n/a
	Good		$I_{DIN} \geq 30$ µM $I_{PP} < 300$	$I_{DO} > 5$
	Moderate		$I_{DIN} \geq 30$ µM $I_{PP} \geq 300$	$I_{DO} > 5$
	Poor		$I_{DIN} \geq 30$ µM $I_{PP} \geq 300$	$I_{DO} \leq 5$
	Bad		$I_{DIN} \geq 30$ µM $I_{PP} \geq 300$	$I_{DO} \leq 2$

* For this exercise, potential primary production was calculated using DIN rather than loads, because loads are unavailable

Comparison

UK-WFD Sum of Multiple Statistics		
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 < 10 µg L^{-1}	> 70 %	> 75 %
% CHL-a < 20 µg L^{-1}	> 80 %	> 85 %
% CHL-a > 50 µg L^{-1}	< 5 %	< 5 %

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

Classification	High	Good	Mod	Poor	Bad
Points	5	4	3	2	0-1

Classification	ASSETS: 90th Percentile Annual CHL a	IFREMER: Annual Average CHLa
Low	0 - 5 µg L^{-1}	<5 µg L^{-1}
Medium-Low		5-7 µg L^{-1}
Medium	5 - 20 µg L^{-1}	7-10 µg L^{-1}
High	20 - 60 µg L^{-1}	10 - 30 µg L^{-1}
Hypereurophic	> 60 µg L^{-1}	> 30 µg L^{-1}

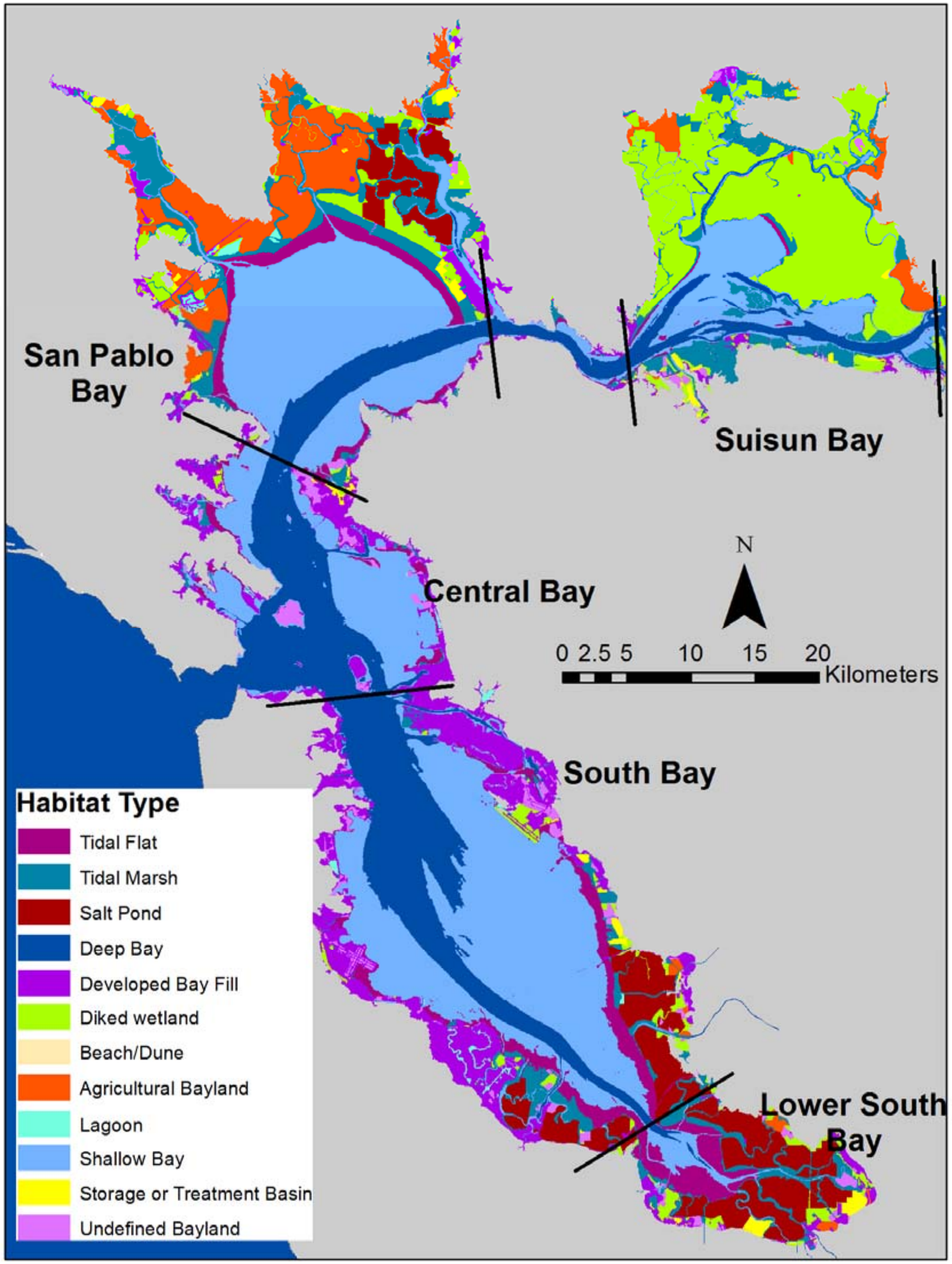
Analysis of Existing Data Approach

- Assess eutrophic condition for SF Bay and its segments

- Compare results between indicators

- Compare outcomes based on data integration
  - Inter-annual variability (yearly, six year running average)
  - Temporal integration of annual data (seasonal, annual average, annual median, percentile)
  - Spatial integration

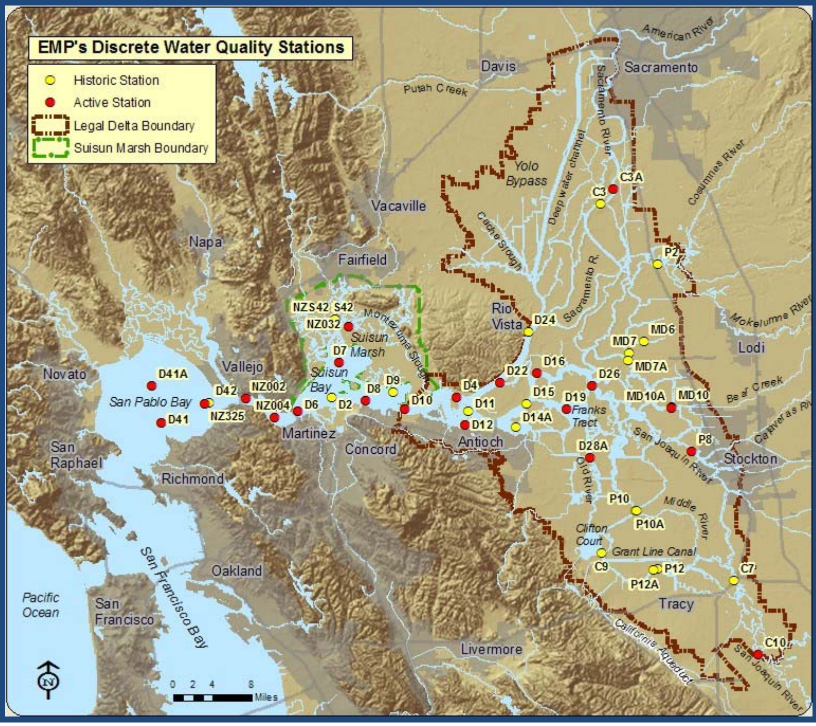
Preliminary Segmentation of the Bay



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

- Sub-estuaries: North Bay, South Bay, Delta
- Sub-basins: Suisun, San Pablo, Upper South Bay, Lower South Bay



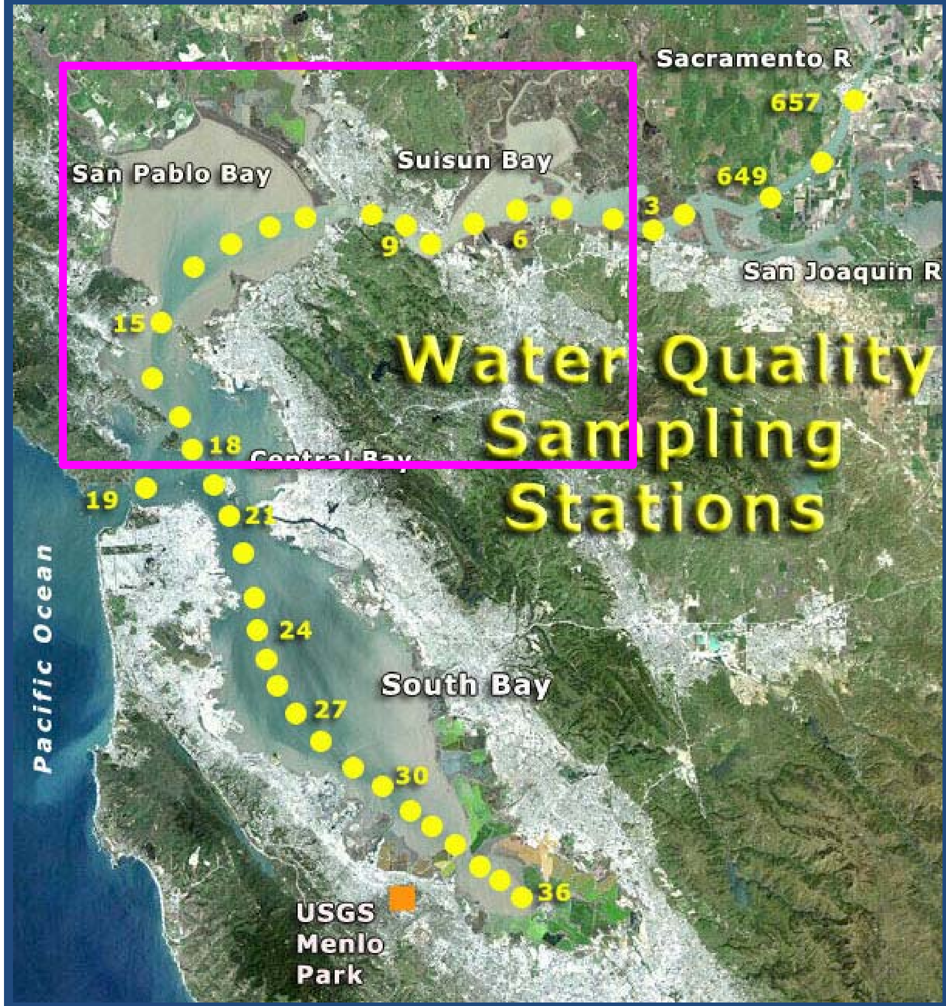
Understanding the Effects of Data Integration on Outcome

- Use North Bay as a test case
  - Two different datasets allow

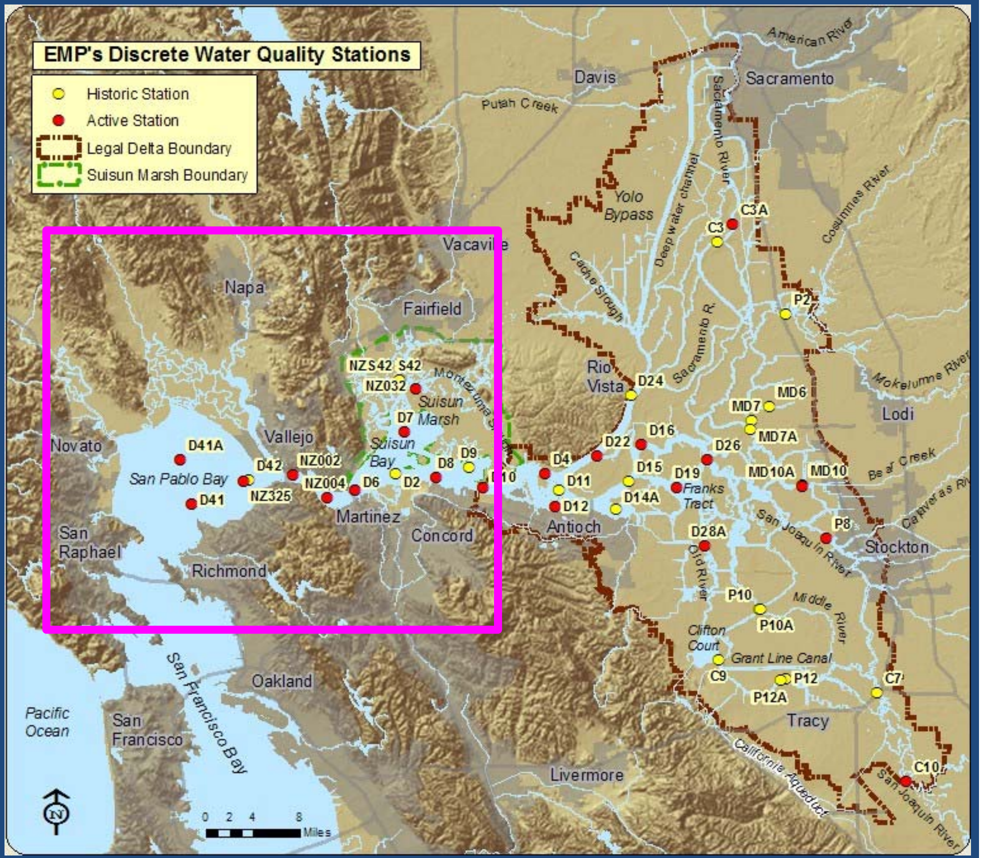
- Compare results between indicators
  - Focus primarily on chlorophyll

- 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

North Bay

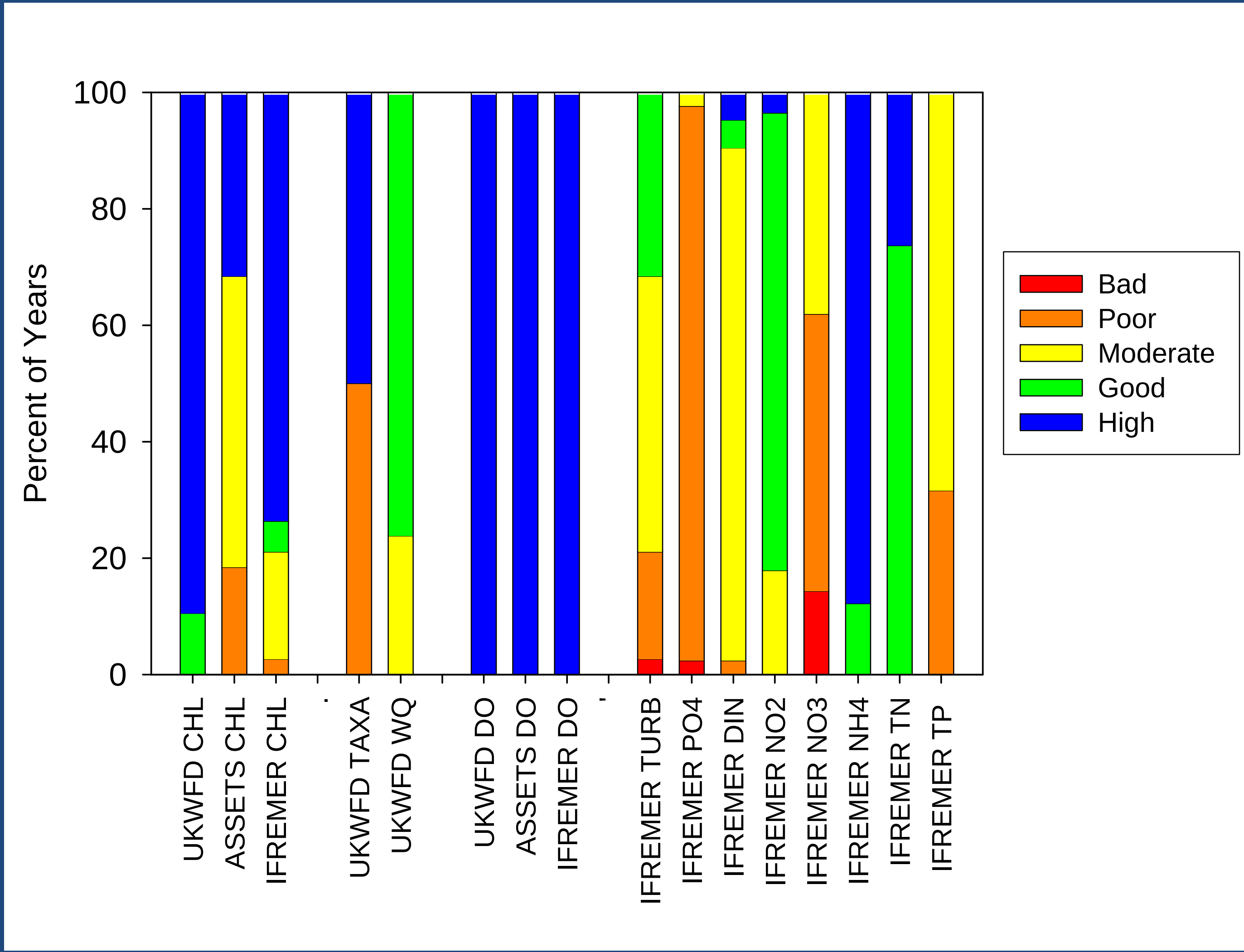


Sacramento R
657
649
San Pablo Bay
Suisun Bay
9
6
3
San Joaquin R
15
Water Quality Sampling Stations
18
Central Bay
19
21
24
27
30
36
South Bay
Pacific Ocean
USGS Menlo Park



EMP's Discrete Water Quality Stations
Historic Station
Active Station
Legal Delta Boundary
Suisun Marsh Boundary
Davis
Sacramento
American River
Putah Creek
Yolo Bypass
Vacaville
Napa
Fairfield
Rio Vista
Lodi
Novato
Vallejo
San Pablo Bay
Suisun Marsh
Suisun Bay
Martinez
Concord
Antioch
Franks Tract
San Rafael
Richmond
Stockton
Clifton Court
Grant Line Canal
Tracy
Oakland
Pacific Ocean
San Francisco
San Francisco Bay
Livermore
California Aqueduct
San Joaquin River
Miles

North Bay:
Comparison of Results Among Indicators



North Bay:

Incorporation of Inter-Annual Variability

Yearly Data

Year	WFD CHL	ASSETS CHL	IFREMER CHL	WFD TAXA	WFD WQ
1975	GOOD	HIGH	YELLOW		GOOD
1976	HIGH	HIGH	YELLOW		GOOD
1977	HIGH	MEDIUM	BLUE		MODERATE
1978	HIGH	HIGH	YELLOW		MODERATE
1979	HIGH	HIGH	YELLOW		MODERATE
1980	HIGH	MEDIUM	GREEN		GOOD
1981	HIGH	HIGH	YELLOW		GOOD
1982	GOOD	HIGH	ORANGE		GOOD
1983	HIGH	MEDIUM	BLUE		GOOD
1984	GOOD	MEDIUM	YELLOW		GOOD
1985	HIGH	MEDIUM	GREEN		GOOD
1986	GOOD	HIGH	YELLOW		GOOD
1987	HIGH	MEDIUM	BLUE		GOOD
1988	HIGH	LOW	BLUE		GOOD
1989	HIGH	LOW	BLUE		GOOD
1990	HIGH	LOW	BLUE		MODERATE
1991	HIGH	LOW	BLUE		MODERATE
1992	HIGH	LOW	BLUE		MODERATE
1993	HIGH	LOW	BLUE		GOOD
1994	HIGH	LOW	BLUE		MODERATE
1995	HIGH	MEDIUM	BLUE		GOOD
1996	HIGH	LOW	BLUE		GOOD
1997	HIGH	MEDIUM	BLUE		GOOD
1998	HIGH	MEDIUM	BLUE		GOOD
1999	HIGH	LOW	BLUE		GOOD
2000	HIGH	LOW	BLUE		GOOD
2001	HIGH	MEDIUM	BLUE		GOOD
2002	HIGH	MEDIUM	BLUE		GOOD
2003	HIGH	MEDIUM	BLUE		GOOD
2004	HIGH	MEDIUM	BLUE		GOOD
2005	HIGH	MEDIUM	BLUE		GOOD
2006	HIGH	LOW	BLUE		GOOD
2007	HIGH	MEDIUM	BLUE		MODERATE
2008	HIGH	MEDIUM	BLUE		MODERATE
2009	HIGH	LOW	BLUE		MODERATE
2010	HIGH	MEDIUM	BLUE		GOOD
2011	HIGH	MEDIUM	BLUE	HIGH	GOOD
2012	HIGH	MEDIUM	BLUE	POOR	GOOD

Six Year Running Average

Year	WFD CHL	ASSETS CHL	IFREMER CHL	WFD TAXA	WFD WQ
1975					
1976					GOOD
1977					GOOD
1978					GOOD
1979					GOOD
1980	HIGH	MEDIUM	GREEN		GOOD
1981	HIGH	MEDIUM	GREEN		GOOD
1982	HIGH	MEDIUM	YELLOW		GOOD
1983	HIGH	MEDIUM	YELLOW		GOOD
1984	HIGH	MEDIUM	YELLOW		GOOD
1985	HIGH	MEDIUM	GREEN		GOOD
1986	HIGH	MEDIUM	YELLOW		GOOD
1987	HIGH	MEDIUM	GREEN		GOOD
1988	HIGH	LOW	BLUE		GOOD
1989	HIGH	LOW	BLUE		GOOD
1990	HIGH	LOW	BLUE		GOOD
1991	HIGH	LOW	BLUE		MODERATE
1992	HIGH	LOW	BLUE		MODERATE
1993	HIGH	LOW	BLUE		MODERATE
1994	HIGH	LOW	BLUE		MODERATE
1995	HIGH	LOW	BLUE		MODERATE
1996	HIGH	LOW	BLUE		MODERATE
1997	HIGH	LOW	BLUE		GOOD
1998	HIGH	LOW	BLUE		GOOD
1999	HIGH	MEDIUM	BLUE		GOOD
2000	HIGH	MEDIUM	BLUE		GOOD
2001	HIGH	MEDIUM	BLUE		GOOD
2002	HIGH	MEDIUM	BLUE		GOOD
2003	HIGH	MEDIUM	BLUE		GOOD
2004	HIGH	MEDIUM	BLUE		GOOD
2005	HIGH	MEDIUM	BLUE		GOOD
2006	HIGH	MEDIUM	BLUE		GOOD
2007	HIGH	MEDIUM	BLUE		GOOD
2008	HIGH	MEDIUM	BLUE		MODERATE
2009	HIGH	MEDIUM	BLUE		MODERATE
2010	HIGH	MEDIUM	BLUE		MODERATE
2011	HIGH	MEDIUM	BLUE	MODERATE	MODERATE
2012	HIGH	MEDIUM	BLUE	POOR	MODERATE

North Bay:
Differences in Spatial Sampling

Sampling in Main Channel Only

USGS Only

Year	WFD CHL	ASSETS CHL	IFREMER CHL
1975			
1976			
1977	HIGH	MEDIUM	BLUE
1978	HIGH	MEDIUM	GREEN
1979	HIGH	MEDIUM	GREEN
1980	HIGH	MEDIUM	BLUE
1981	HIGH	LOW	BLUE
1982			
1983			
1984	HIGH	LOW	BLUE
1985			
1986			
1987			
1988	HIGH	LOW	BLUE
1989	HIGH	LOW	BLUE
1990	HIGH	LOW	BLUE
1991	HIGH	LOW	BLUE
1992	HIGH	LOW	BLUE
1993	HIGH	LOW	BLUE
1994	HIGH	LOW	BLUE
1995	HIGH	MEDIUM	BLUE
1996	HIGH	LOW	BLUE
1997	HIGH	MEDIUM	BLUE
1998	HIGH	MEDIUM	BLUE
1999	HIGH	LOW	BLUE
2000	HIGH	LOW	BLUE
2001	HIGH	MEDIUM	BLUE
2002	HIGH	MEDIUM	BLUE
2003	HIGH	MEDIUM	BLUE
2004	HIGH	MEDIUM	BLUE
2005	HIGH	MEDIUM	BLUE
2006	HIGH	LOW	BLUE
2007	HIGH	MEDIUM	BLUE
2008	HIGH	MEDIUM	BLUE
2009	HIGH	LOW	BLUE
2010	HIGH	MEDIUM	BLUE
2011	HIGH	MEDIUM	BLUE
2012	HIGH	MEDIUM	BLUE

Sampling in Main Channel and Shallower Waters

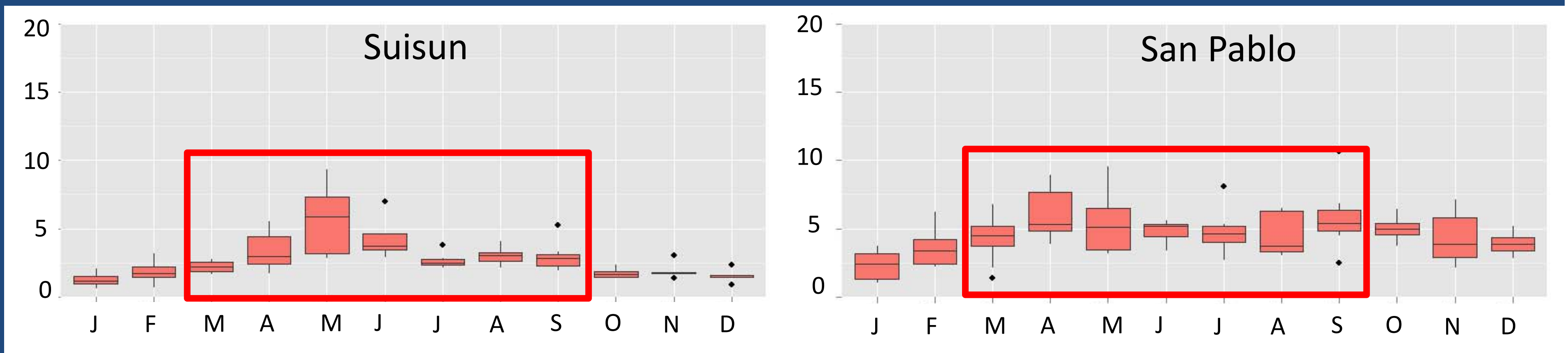
DWR Only

Year	WFD CHL	ASSETS CHL	IFREMER CHL
1975	GOOD	HIGH	YELLOW
1976	HIGH	HIGH	YELLOW
1977	HIGH	MEDIUM	BLUE
1978	GOOD	HIGH	ORANGE
1979	MODERATE	HIGH	ORANGE
1980	GOOD	HIGH	ORANGE
1981	GOOD	HIGH	ORANGE
1982	GOOD	HIGH	ORANGE
1983	HIGH	MEDIUM	BLUE
1984	GOOD	MEDIUM	YELLOW
1985	HIGH	MEDIUM	GREEN
1986	GOOD	HIGH	YELLOW
1987	HIGH	MEDIUM	BLUE
1988	HIGH	LOW	BLUE
1989	HIGH	LOW	BLUE
1990	HIGH	LOW	BLUE
1991	HIGH	LOW	BLUE
1992	HIGH	LOW	BLUE
1993	HIGH	MEDIUM	BLUE
1994	HIGH	LOW	BLUE
1995	HIGH	LOW	BLUE
1996	HIGH	LOW	BLUE
1997	HIGH	LOW	BLUE
1998	HIGH	MEDIUM	BLUE
1999	HIGH	MEDIUM	BLUE
2000	HIGH	MEDIUM	BLUE
2001	HIGH	LOW	BLUE
2002	HIGH	LOW	BLUE
2003	HIGH	LOW	BLUE
2004	HIGH	LOW	BLUE
2005	HIGH	LOW	BLUE
2006	HIGH	MEDIUM	BLUE
2007	HIGH	LOW	BLUE
2008	HIGH	MEDIUM	BLUE
2009	HIGH	LOW	BLUE
2010	HIGH	MEDIUM	BLUE
2011	HIGH	MEDIUM	BLUE
2012	HIGH	LOW	BLUE

North Bay:
Defining the Averaging Period

- Annual Average, Median Value, Percentile

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



- Growing Season?

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

North Bay:
Effect of Statistic and Threshold

- ASSETS Thresholds

IFREMER Thresholds

ASSETS Thresholds

North Bay:
Effect of Statistic and Threshold

WFD 95% < 50 ug/L = 1 point

ASSETS 90% > 60, 20, 5 ug/L

WFD 85% < 20 ug/L = 1 point

WFD 75% < 10 ug/L = 1 point

Take Home Messages- Preliminary Analysis of Existing Data

- Finite set of indictors considered
  - Phytoplankton biomass and/or productivity
  - Phytoplankton assemblage, harmful algal blooms
  - Nutrients, when employed, are secondary
- Convergence on thresholds
  - Differences in spatial and temporal statistic used for data interpretation matter!

Outcome of Discussion on Analysis of Existing Data

- Discussion on indicators and metrics
- Suggestions for additional analysis of existing data

Discussion on Indicators and Metrics

- Phytoplankton biomass and productivity
- Phytoplankton assemblage
- HAB species abundance and toxin concentration
- Affirmed that nutrient forms and ratios would be monitoring but not considered upfront
  - Minority dissent

Suggestion for Additional Analysis of Existing Data

- Refine previous analyses, using new segmentation boundaries per Jassby et al. (1997)
- New indicator for productivity
- Suggestions for additional datasets to be included in the analyses
  - 1989 Ota et al. USGS open file report has detailed spatial data of SF Bay. Rerun analysis to show comparison of shallow and deepwater stations
  - With R. Kudela, redefine metric applicable to phytoplankton assemblage or HAB species cell count (biovolume) and/or toxin concentrations.
  - Provide graphic of climate context for time series
  - Locate 1970s Ball and Arthur data set that featured large blooms in Suisun Bay associated with low DO

Prospective Indicator:
Gross Primary Production

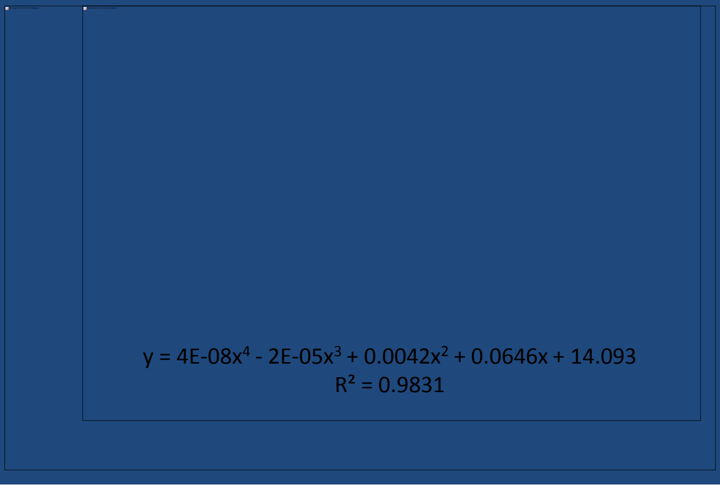
Modeled for each data point from existing dataset following Cloern et al. 2007:

$$GPP = 3.77\ (CHLa * I_0)/k$$

k estimated from suspended particulate matter (SPM)

$$k = 0.567 + 0.0586 * SPM$$

I_0 estimated by day from average irradiance profile fit to a fourth order polynomial



All points in each segment were averaged to generate an annual average GPP

Modeled GPP by Segment

Spatial Analysis

- 1980 USGS dataset with sampling along channel and across channel transects
  - South Bay, San Pablo Bay, Suisun Bay
- Compare main channel chlorophyll and GPP with same analyses in shallower sites in same basin
- Use measurements at 2m in main channel and 1m in shallows

Basin Average Chlorophyll in Deep Main Channel Vs. Shallow Water Survey

Analysis of 1980 High Spatial Coverage Dataset Using Existing Frameworks

Segment	Depth	WFD CHL	ASSETS CHL	IFREMER CHL
San Pablo Bay	Deep	HIGH	MEDIUM	BLUE
	Shallow	MODERATE	HIGH	ORANGE
Suisun Bay	Deep	GOOD	MEDIUM	YELLOW
	Shallow	POOR	HIGH	ORANGE
South Bay	Deep	HIGH	LOW	BLUE
	Shallow	HIGH	MEDIUM	YELLOW

Goal and Roadmap for This Agenda Item

Goal: Provide opportunity for SAG technical input on approach prior to for technical team workshop

Road map:

- Overview of process, approach and timeframe
- Geographic scope, focal habitats, and proposed segmentation
- Informing the process: analysis of existing data
- Charge for February 11-12, 2014 workshop
- Discussion (all)

Goals/Charge for February Workshop

- Consensus on assessment framework metrics and methods of measurement (e.g. chl a, productivity, phytoplankton assemblage, HAB abundance, toxin)
- For each metric, consensus on:
  - What is the temporal density of data need to make an assessment (e.g. CTD casts, continuous moored sensor, etc.)
  - What is the temporal statistic used to make the assessment (e.g. trends, 90th percentile of annual samples, geomean of March – Oct, etc.)
  - What is the spatial density of data needed to make an assessment, specific to habitat types, number of stations?
  - What is the spatial statistic would be used to make an assessment (combined shallow and deep?, mean or percentile of stations?

Next Steps

- Assuming goals of February workshop are met, we will have the skeleton of a “proto-monitoring” program for core assessments of SF Bay
  - Late February or early march meeting to get your feedback on workshop recommendations
  - Things that you would like Technical Team to consider
- Next workshop..(early April?)
  - Refinements to proto-monitoring program
  - Begin discussion on thresholds