San Francisco Bay Nutrient Management Strategy

FY2021 Program Plan

June 2020

SFEI Contribution #1322

SFEI San Francisco Estuary Institute

This document contains a description of Core Program and Projects for the FY2021 Program Plan. Please see Program_Plan_FY2021_SC_materials_1 for background and context, including the interactive_version of the program plan and science plan.

The set of projects, while consistent with what's included in the SciencePlan2.0, exceeds what is realistically possible to pursue in parallel in FY2021. We will be presenting a pared-down recommended plan for consideration at the June 12 meeting, drawn from this suite of projects.

The overall content below is essentially the same as in the interactive (spreadsheet) version, but with additional project information included in this document.

FY2021 “Max Plan” -- assuming all priority work in Science Plan 2.0 moving forward, no slowdowns

interactive_program plan

	Project / Activity	TOTAL Cost ($1000s)	FY2021 NMS funds ($1000s)	Target: A AF	Target: B Cond	Target: C Link	Target: D Mgmt	Focus Area: Nuts	Focus Area: phyto DO open	Focus Area: phyto DO marg	Focus Area: HABs	Focus Area: Coast	Focus Area: Risk	Program Area: monit	Program Area: model	Program Area: spec study	Program Area: Synth	Program Area: AF	Program Area: Prog Mgmt Coord
C1	Monitor: ship-based sampling	150	150																
C2	Monitor: moored sensors	370	370																
C3	Modeling	500	500																
C4a&b	a. Program Mngmnt; b. Science Program Coord.	500	400																
P1a	Biogeochem Field study (South Bay)	225	175																
P1b	LSB field study (sloughs,ponds)	100	75																
P1c	Biogeochem field study (Suisun, west Delta)	265	40																
P2	Lateral variability (phyto,zoop,nuts,HAB)	75	25																
P3	Sediment/light (field, RS, model)	200	100																
P4	LSB model development	100	50																
P5	HAB special studies: a. mussels (SFB, Tomales); b. Pseudo-nitzschia growth (cont'd)	130	130																
P6	Phyto-HAB monitor (seq, molec)	100	0																
P7	LSB DO-synthesis	100	100																
P8	Synthesis projects	250	150																
P9	Monitoring workgroup	50	25																
P10a	HAB synthesis	150	150																
P10b	HAB expert workgroup	25	25																
P11a	Trends: Continuation of FY20 project	50	50																
P11b	AF - priority analyses	200	150																
P12a	LSB-DO data analysis / habitat	150	75																
P12b	LSB-DO fish/benthos surveys	50	0																
P13	Coastal nutrient fluxes	200	150																
P14	Risk / Scenario	200	100																
	sum	4140	2990																

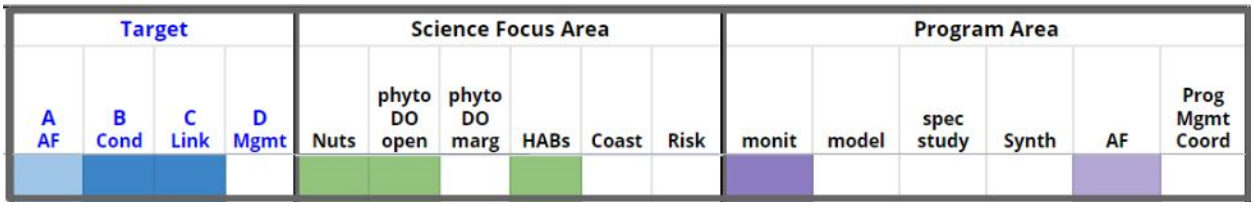
C1 Monitor: ship-based sampling	Total Cost	NMS FY21 Funds
Collaborators: USGS-Menlo, UCSC, Bend Genetics, SFEI	$350,000	$150,000

Ship-based samples from channel cruises will be collected and analyzed for multiple nutrient-related parameters. This description assumes work will go forward in collaboration with the USGS SFB water quality program, continuing the USGS' long-term research program in San Francisco Bay. The overall program is jointly funded by USGS, the RMP, and the NMS, with the NMS funds supporting several nutrient-specific measurements and additional field tech support.

Discrete samples and in-situ sensor-based measurements will be collected during USGS cruises aboard the R/V Peterson on ~12 full-bay cruises and ~12 South Bay cruises, with SFEI staff participating as a field technician(s) during cruises. Measurements include inorganic and organic nutrients; phytoplankton taxonomy by microscopy; dissolved harmful algae (HA) toxins using SPATT; targeted use of molecular techniques for quantifying phytoplankton taxa including HAs (18s, 16s sequencing; qPCR); and measurement of particulate HA toxins when warranted (LC-MS or ELISA).

In FY2021 we will explore the possibility of conducting routine measurements at one or more shoal station sites. Planning would include discussions with USGS staff to assess logistical feasibility, and evaluate whether adding shoal sites would require decreasing effort elsewhere (e.g., bypassing some deep channel stations), and what the implications of any changes would be on the long-term observational data.

Project Relevance



Datasets resulting from ship-based monitoring address multiple management issues or Targets and multiple Science Focus Areas.

Targets: Condition measurement; exploring quantitative links between nutrients and response variables through data analysis and model calibration; and Assessment Framework development.

Focus Areas: important data source for Nutrients, Phytoplankton-DO in open-Bay habitats; and HABs.

Products/Deliverables

- Nutrient and chl-a dataset, made publicly available through the USGS website.
- Results summarized in the NMS Annual Report.
- Data will be used in other NMS program areas (model calibration, condition assessment, Assessment Framework development).

Budget Justification: The overall program is supported by multiple funding sources. Approximately $200k from the RMP (included in the above total) goes directly to USGS to support 1-1.5 FTE USGS technicians who carry out the field work, analyze a subset of samples (chl-a, SPM, etc.), and manage most of the data. Funds from the NMS ($150k) support the following: nutrient

measurements (~300 station-date samples: ammonium, nitrate + nitrite, reactive phosphorus, dissolved silicate; total N and total P measured in ~half the samples; $40k); phytoplankton taxonomy by microscopy (~200 samples, $45k); dissolved toxin measurements (SPATT, $25k); molecular techniques for detecting and quantifying HA abundance and further characterizing phytoplankton assemblage (18s,16s amplicon sequencing; qPCR) and particulate toxins (ELISA or LC-MS); and additional staff support for field work ($25k). In-kind programmatic funds from the USGS cover the following: ship captain and direct costs (fuel, ship maintenance, transportation), etc.; program management; remaining support (0.5-1.0 FTE) for the program's field/lab/data-management.

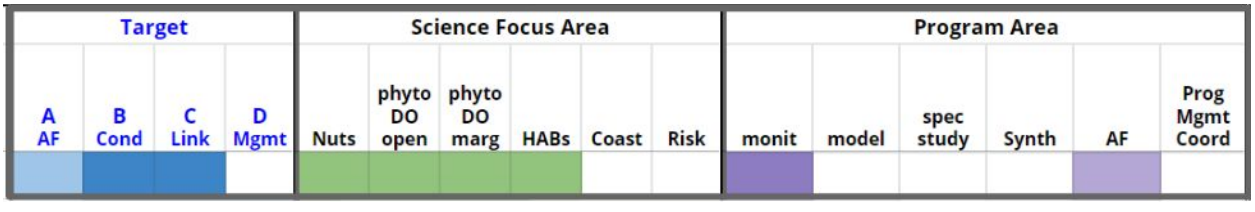
C2 Monitoring: Moored Sensor Program	Total Cost	NMS FY21 Funds
Collaborators: USGS-BGC, USGS-MarFac, SFEI	$370,000	$370,000

Funds will support field work (maintenance) and data management for nine sensor moorings in South Bay and Lower South Bay. An overview of the mooring program can be found here. Work will include:

- 12-15 maintenance trips per year.
- Program management, data QA/QC, including updates and refinement to data management protocols and software.
- Addition of two new shoal monitoring sites; the cost of these sites is partially offset by cost savings from retiring two current LSB sites and reallocating resources (instruments, maintenance effort) to the new shoal sites.
- Installation and operation of new sensors (e.g., NO_3^-, velocity) at a subset of locations (2-3 existing monitoring sites). Costs of the new instrumentation covered by FY2020 projects.
- Coordination and cost-sharing with the RMP sediment workgroup on suspended sediment sampling and potentially wave sensor deployment at four NMS moorings.

Trade-off: The current budget is based on the assumption that 2 slough/margin stations will be retired and those resources reallocated to the shoal. Field maintenance represents one of the most expensive elements of continuous monitoring. By relocating hardware and maintenance efforts from two LSB stations, we can collect high-priority data from the shoal without adding to our typical two trips-per-month servicing schedule. Selection of stations to retire will be a function of a basic analysis of relevance and trade-offs.

Project Relevance



Data collection through the moored sensor program addresses the following:

Targets: Measurement of Condition; enables the development of quantitative Links between nutrients and response variables through data analysis and model calibration; and Assessment

Framework development.

Focus Areas: Builds data resources related to Phytoplankton-DO in open-Bay habitats; Phytoplankton-DO in margin (slough, creek) habitats; and Nutrient cycling. The connection to HABs is indirect, via overall phytoplankton production.

The addition of shoal moorings is addressing an important monitoring gap, because of the substantial differences in nutrient concentrations and phytoplankton biomass observed along the shoals relative to the deep channel.

Deliverables or Products

- Curated dataset of 15-minute measurements of water quality parameters at 9 sites.
- Basic reporting. The data are used in other projects and program areas (e.g., modeling, synthesis), and associated cost are covered within those projects.
- Updated QA scripts and documentation, maintained and versioned on GitHub.

Budget Justification: 12-15 servicing trips per year, preparation/breakdown, data QA and data management, program management. SFEI staff ($190k/yr: mooring maintenance, data QA / data management, mooring program management); USGS staff ($150k: boat captains, field technicians, sensor and logistic support, science oversight/collaboration); direct costs ($30k: supplies, repairs).

C3 Core Modeling	Total Cost	NMS FY21 Funds
Collaborators: Four Peaks, RMA, USGS-BGC, SFEI	$500,000	$500,000

Modeling work for FY2020 and FY2021 are aligned with the NMS 5yr Modeling Workplan.

Focus and Progress in FY2020

- Major advancements to biogeochemical model implementation. Improved multiple parameterizations, rates, and model input fields: e.g., sediment diagenesis; water column nutrient transformation rates; organic N, P; temperature; light attenuation.
- Simulated/validated hydrodynamics for new water years (2017, 2014, 2003, 2006).
- Refined/improved a fast-running aggregated model. Using this model allowed for conducting extensive sensitivity analyses.
- Updated biogeochemical simulations for wy2013 and wy2017.
- Model applications: interpreting model output using mass balance approaches; and identifying source contribution zones.
- Interim Progress Report (Dec 2019) and overall modeling program update (June 2020).

FY2021 Focus

Model Development

- Incorporate time-space varying light attenuation coefficient predictions from sediment transport models for wy2013 and wy2017, and refine calibrations accordingly.
- Extend biogeochemical model runs to 2-3 more years, depending on availability of suitable light

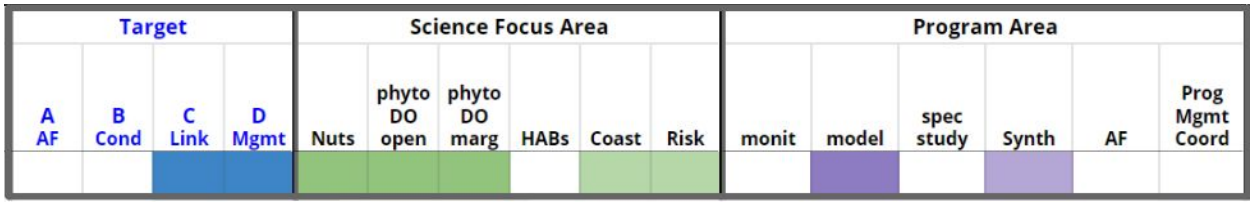
attenuation data.

- Continued biogeochem sensitivity analysis, aiming for multi-year optimized calibration.
- Hydrodynamics: evaluate the need for improving vertical stratification, and if necessary make improvements and re-run current simulations; time and budget permitting, simulate wy2018 and wy2019, to allow calibration/validation work to take advantage of years having increasingly high-frequency biogeochemical data.

Model Application

- Continue the work on nutrient cycling and ecosystem response in SFB, extending to 3+ years; mass balance interpretations;
- Other applications: responses under changing nutrient loads; responses under other altered forcings (SSC, rainfall)

Project Relevance



Linkages: quantifying dominant nutrient cycling pathways and relative importance of nutrient sources; developing quantitative dose:response relationships between nutrients and important response variables (indicators).

Management: examining a range of management scenarios, e.g., how nutrient load reductions would influence ecosystem response.

Focus Areas: Nutrient cycling, Phytoplankton/DO response (openBay, margins/sloughs/creeks). Models also serve as essential tools or generate needed input data for Coastal investigations and Risk/Scenario evaluation.

Work Products / Deliverables

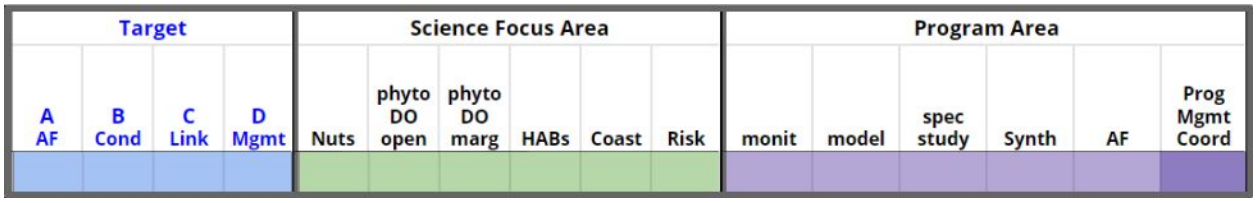
- Updated/improved biogeochemical model calibration (3-4 years).
- Hydrodynamic model runs for additional years.
- Model documentation, code for pre-/post-processing.
- Technical Report(s): Updated Technical Report on model application(s), including potential manuscript

Budget Justification: ~2.25 FTE modeling team (distributed across 3 SFEI staff, 1 external consultant).

C4 a. NMS Science Program Coordination **C4 b. NMS Program Management**	Total Cost	NMS FY21 Funds
	$500,000	$400,000

This funding covers the costs associated with overall program management and science program coordination. Work includes the following: managing science projects and providing scientific oversight for all aspects of the program; program management including stakeholder engagement through the NMS (NMS Steering Committee, Planning Subcommittee, other subcommittees, Nutrient Technical Workgroup) and other stakeholders; fundraising; and financial management and contracting.

Project Relevance



Products/Deliverables

- PS meetings, SC meetings, stakeholder engagement, subcommittees and expert workgroups.
- Science contributions to projects, and overall program science oversight
- Contracts
- Financial management and quarterly financial reports
- Project/Program management

Budget Justification:

Funds cover NMS lead scientist's effort across all scientific activities of the NMS and for overall program coordination, stakeholder engagement, and NMS management ($240k; work distribution: 60% hands-on science and/or directing projects; 40% program coordination (fundraising, stakeholder engagement, NMS and PS process)). With recent program growth, there is need for additional program and project management support, and funding is included for a program manager (0.5 FTE), and science oversight and program/project management management by other staff (0.5 FTE, distributed across several staff). Funding is also included for financial management/contracting (0.25 FTE) and for regional travel ($5k).

Approximately ~$100k in remaining funds from FY2020 will be rolled over to FY2021, so the FY2021 request is $400k.

P1a South Bay Biogeochemical Field Study	Total Cost	NMS FY21 Funds
Collaborators: Stanford, USGS-BGC, UMCES, SFEI	$225,000	$175,000

Goals:

- Address important data gaps related to nutrient-related biogeochemical transformation rates in South Bay needed for model calibration including: sediment oxygen demand, sediment:water-column nutrient fluxes, and water column transformation rates.
- Through ancillary measurements and data analysis, identify factors that influence higher/lower rates, both for improved system-level understanding and so that those factors can be taken into account when selecting rates or parameterizing processes within the model.

This project is a continuation of a multi-year project that began in earnest in FY2020. Field studies were designed with input from expert advisors (Workplan #1 Draft, Oct 2019; Revised Workplan, Jan 2020), and regional collaborations were set up to carry out the work. Field work was originally slated to begin in May 2020, but was postponed due to public health issues. The current plan is to conduct the first field sampling work in August-September. Field work will include: water column rate measurements (nitrification and respiration/oxygen demand), sediment transformations (nitrification, denitrification, N and P fluxes to/from the sediments, and sediment oxygen demand). Sediment characteristics will also be measured to establish relationships between benthic conditions and process rates which are important for mechanistic understanding and for model calibration.

Project Relevance

Target: field and lab measurements to yield improved quantification of Linkages between Nutrients and Phytoplankton-DO in open Bay habitats; and Nutrient transformation rates and mechanisms / factors regulating those rates. Data will be important inputs for calibrating biogeochemical models for exploring phytoplankton and nutrient dynamics, and for evaluating management options.

Products/Deliverables:

- QA/QC'd dataset for water column and sediment processes for use in model calibration
- Results will be summarized in a technical report
- Postdoc will lead a peer-reviewed paper

Budget Justification: The full project cost is estimated to be $750k over 3 years. Approximately 80% of overall project funding will support external collaborators on fieldwork, analysis, interpretation; 20% of funds support SFEI staff to participate in and coordinate project(s). The FY2021 funds ($175k) will be combined with ~$115k remaining from FY2020 to support work from Aug 2020 - Jun 2021. Costs include postdoc at Stanford ($140k, including support for faculty advisor); equipment construction ($20k); fieldwork including training, personnel and boat time ($95k); water column sample analysis ($10k); sediment sample analysis ($50k); staff support for project

management and reporting ($30k). Depending on what amount of fieldwork is feasible, the additional $50k may be needed in the third quarter of FY2021.

P1b LSB biogeochem field study (sloughs,ponds)	Total Cost	NMS FY21 Funds
Collaborators: UCSB, Stanford, USGS-BGC, SFEI	$100,000	$25,000

Goals:

- Conduct targeted field measurements to address important data gaps related to nutrient-related biogeochemical transformation rates in South Bay needed for model calibration, including: sediment oxygen demand, sediment:water-column nutrient fluxes, and water column transformation rates.
- Through ancillary measurements and data analysis, identify factors that influence higher/lower rates, both for improved system-level understanding and so that those factors can be taken into account when selecting rates or parameterizing processes within models.
- Either through this study or within the studies that use the data it generates, identify factors that contribute to low DO in LSB slough and creek habitats, including the potential role of high anthropogenic nutrient loads.

Evidence from NMS studies suggests that exchange between restored salt-ponds and sloughs has large local effects on N, C and DO in LSB slough and creek habitats, and may also substantially impact or influence conditions and cycling in open-Bay regions of LSB. Observational data are needed to inform model calibration so the magnitude of these processes can be quantified. When relevant, and to the extent possible, LSB fieldwork will be carried out in coordination with P1a and P1c to maximize efficiencies and cost-effectiveness. The details of field work are under development, including with input from an expert workgroup that was convened to provide guidance on interpretation of existing data and interpretative work completed to date (see P7).

Project Relevance

This project will help to resolve major unknowns about the impacts of salt ponds on nutrients and DO dynamics in margin habitats in the LSB. The data collected will be used to inform interpretation of empirical data (e.g., from moorings) and for LSB model calibration, and could also be used to mitigate the effects of salt pond connections through more effective management and restoration.

Products/Deliverables

- QA/QC'd dataset.
- Technical brief or memo summarizing results.

- Main application of results will be other synthesis projects, and for model calibration and applications.

Budget Justification: Funds included here are intended primarily (>75%) to cover field study costs, including costs of field work, sample analysis, and data management. The main interpretative work will be carried out in a follow-up project; limited funds (<25%) are included here for initial data analysis. The study will be designed with input from collaborators with expertise in biogeochemistry and estuarine physics, building off of results of an upcoming synthesis report (June 2020). It is anticipated that most of the field work would begin in or after summer 2021; only $25k is requested in FY2021 for early equipment or supply purchases or to begin contracting.

P1c Biogeochem field study (Suisun, west Delta)	Total Cost	NMS FY21 Funds
Collaborators: Stanford, USGS-BGC, SFEI	$300,000	$22,000

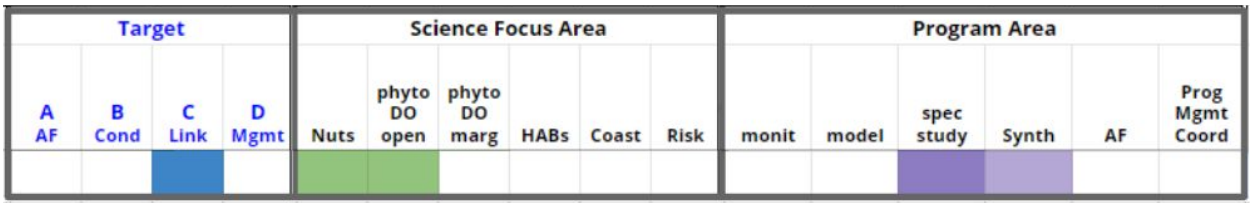
Goals:

- Quantify nutrient-related biogeochemical transformation rates in Suisun Bay and western Delta regions through a combination of field experiments and analysis of existing data.
- Test a set of field measurement techniques for in situ quantification of biogeochemical rates that occur in sediments.

SFEI-NMS staff collaborated with a postdoc to develop a Delta Science Fellowship proposal to quantify nutrient transformation rates in the Suisun-Delta region. The postdoc was awarded the fellowship and will begin a 2-yr position in July 2020, based at Stanford. One component of the field work will involve the use of aquatic eddy covariance (AEC) techniques for in situ quantification of sediment oxygen demand. This approach can overcome some important limitations of other techniques (core incubations; flux chambers), and has been applied extensively in other estuarine and freshwater systems (e.g., Volaric et al., 2018). The project will also explore the feasibility of applying AEC to quantify net NO_3^- fluxes, which appears feasible but is less well-established. Lastly, the postdoc will use existing field data in Suisun Bay and the western Delta to quantify relevant nutrient transformation rates.

The fellowship covers the vast majority of costs (~$225k over two years). NMS funds will be used to support SFEI staff effort on study design, technical collaboration, and project management; and supplement the postdoc salary.

Project Relevance



The data collected for this project are needed to better understand metabolism and nutrient removal/storage in the Suisun Delta system, a region where very little rate measurement data is available. These data will be used to improve biogeochemical models for the region. This study will also compare rates before and after the Regional San upgrade, and will help to assess how the system responds to this major change in nutrient inputs.

Products/Deliverables

- QA/QC'd dataset from eddy covariance measurements
- Calculated rate measurements from analysis of existing data
- Technical report at the end of year 2; will be structured to facilitate converting the report into one or more manuscripts for submission to peer-reviewed journals.

Budget Justification: Total NMS project cost over 2 years will be ~$76,000, with remaining costs ($225k) covered by the DSC fellowship. NMS funds will cover 4 weeks of SFEI staff time per year ($22k/yr) for technical collaboration and project planning/management, and supplementing the postdoc salary ($16k/yr including fringe and indirect). Funds will be distributed as $22k in FY2021 and $54k in FY2022.

P2 Lateral Channel-Shoal Variability in Water Quality	Total Cost	NMS FY21 Funds
Collaborators: USGS-BGC, SFEI	$75,000	$25,000

Goals:

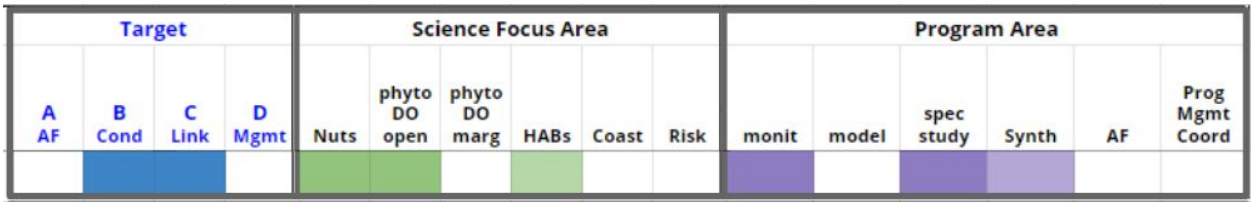
- Collect high-priority data (nutrients, phytoplankton assemblage, zooplankton) in FY2021 along the South Bay eastern shoal, to complement data collection from biweekly-monthly channel sampling (C1) and mooring data collection (C2).
- Inform monitoring program design by allowing comparisons between shoal and channel data for a number of parameters.

Early SFB studies in the 1980s and 1990s (e.g., Huzzey et al. 1990; Thompson et al., 2008) along with more recent NMS studies (moorings, 'high-speed mapping'; SFEI 2017, SFEI 2019) have shown that phytoplankton biomass and nutrient concentrations on South Bay's broad shoals can differ considerably from conditions in the adjacent deep channel. Measurements along SFB's shoals are not part of routine ship-based monitoring, and expanding monitoring to include shoal sites remains a

high priority NMS program goal (SFEI 2014; SFEI 2016). The FY2021 program plan includes 3 moorings on South Bay's shoal (see C2), which addresses some of this need; however moored sensors can not measure some relevant parameters, including zooplankton, phytoplankton community and HABs, and several nutrient forms (P, dSi, NH_4, PON, DON, etc.). Biogeochemical simulations suggest that zooplankton grazing rates could be several times greater along the shoal than in the channel; however there are currently no shoal zooplankton data to compare with channel data. In addition, we hypothesize that phytoplankton assemblage along the shoal could differ substantially from that in the channel, including the potential for higher abundances of HA taxa.

Project P2 aims to augment data collection on the South Bay shoal by undertaking a series of high-speed biogeochemical mapping cruises collecting a combination of flow-through optical sensor data (e.g., chl, nitrate, turbidity, temperature, salinity) along with discrete samples for subsequent measurement in the laboratory (e.g., nutrients, phytoplankton community including HABs, zooplankton (grazer) abundance). Mapping cruises will be timed to coincide with USGS R/V Peterson cruises, allowing comparisons between shoal and channel measurements. To the extent possible, mapping cruises will also be timed to coincide with satellite flyovers, to explore the potential utility of remote-sensed data for some relevant parameters (e.g., turbidity/SSC, chl-a). Funding will support 4 mapping cruises and sample analysis.

Project Relevance



This project will yield data relevant for measuring Condition (nutrients, phytoplankton biomass, DO, HABs) in a region of SFB that currently receives limited monitoring, and for improving quantitative understanding Nutrient cycling, and Linkages or dose-response relationships between Nutrients and Phytoplankton/DO and Harmful Algae.

Products/Deliverables:

- Four mapping cruises in South Bay, yielding one or more two-dimensional water quality maps per cruise, and the associated QA/QC datasets.
- Corresponding discrete sample data from 7-10 locations per cruise: nutrient samples, phytoplankton assemblage (including HAs), zooplankton abundance.
- Data will be interpreted/utilized within other projects.

Budget Justification: USGS-BGC: $40,000 (4 mapping cruises x $10,000/cruise); $20,000 sample analysis (7-10 discrete samples per cruise), analyzed for zooplankton ($200/sample), phytoplankton + HAs ($150/sample), and nutrients+chl-a ($150/sample). SFEI: $15,000 for project planning, project management, and data management. Reallocated RMP nutrient funds would cover $50k, with the remaining $50k coming from NMS FY2021

P3 Sediment/light (field, RS, model)	Total Cost	NMS FY21 Funds
Collaborators: AnchorQEA, others TBD, SFEI	$200,000	$150,000

Recent NMS modeling work (in particular recent sensitivity analyses) indicates that space-time variations in water column light extinction (light extinction coefficients, k_att) are among the most important data gaps with regard to predicting both phytoplankton production and nutrient cycling. In general, the main control on k_att in SFB is suspended sediment concentration (SSC; k_att proportional to 1/SSC). This project will address this critical data gap in three ways:

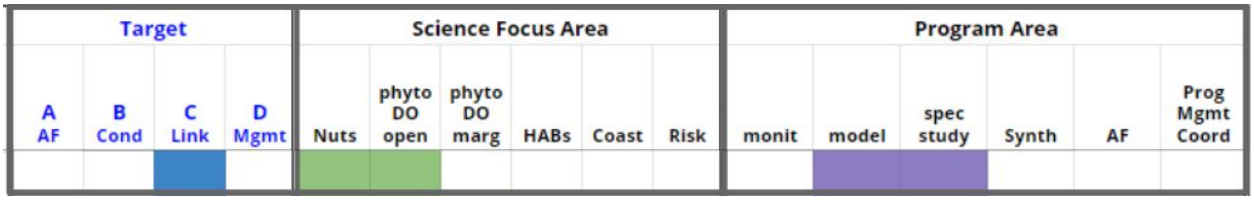
i) ($125k) Collaborate with SFB modelers simulating sediment transport modeling and acquire best-available hindcast SSC data (to compute time-space varying k_att). Some work is currently underway through a related project, supported in-part by other funds, working with Anchor-QEA to generate wy2013 and wy2017 output. A portion of this funding would be used to cover some of those costs. The remainder would be used for simulating other time periods, based on needs of C3 Modeling. The specific approach (and collaborators) for new work beyond those two years remains TBD. Potential approaches will be explored during the first quarter of FY2021. Although multiple criteria will be considered when identifying the best option (e.g., cost, turn-around time, quality of model output), the potential for the approach to build capacity that allows for efficiently and cost-effectively generating new results is an important consideration.

ii) (estimate $50k) Piggyback on NMS mooring work to add additional sensors (turbidity; PAR; in some cases wave gauges) at existing mooring sites (see P2). This element will be a cost share with the RMP sediment workgroup (if funded by the RMP; proposal submitted June 2020).

iii) ($25k) Pilot study to evaluate the utility of using remote-sensed products for near-surface SSC, and the potential to use that data to either assist with numerical model calibration/validation and/or to develop empirical predictions.

While (ii) and (iii) will not address the immediate data needs addressed by (i), these data can be used to calibrate subsequent sediment transport model runs, and may allow for improved model predictions in one to two years.

Project Relevance



Accurate and spatio-temporally resolved light attenuation information is crucial to biogeochemical model calibration and application. Output from an existing SFB sediment transport model represents the best available product for estimating baywide light attenuation conditions over space and time. The current “best available” product has limitations; additional data collections (items i and ii) will

improve evaluation of and refinements to the existing and/or future sediment transport models, or may provide alternative options for representing light conditions in the model.

Products/Deliverables
i) Model output of near-surface suspended sediment concentrations for water years 2013 and 2017 for all of SFB, along with provisional output for 1+ additional years.

ii) Dataset from additional turbidity sensors; data cleaning would happen under C2.

iii) Technical memo evaluating the potential utility of remote-sensed products for estimating surface turbidity and k_att.

Budget Justification: Hindcast model output of SFB sediment concentrations: $125k; this work would most likely be carried out by external collaborators. Shoal data collection and calibration of shoal turbidity-to-SSC relationships: $50k of cost-shared support (if funded) from the RMP Sediment Workgroup for relevant. Remote-sensing Pilot: $25k; this work would most likely be carried out by external collaborators.

P4 Lower South Bay Model Development	Total Cost	NMS FY21 Funds
Collaborators: RMA, UC Davis, SFEI	$100,000	$50,000

Observations in Lower South Bay (LSB) indicate that connections with restored salt ponds and sloughs can substantially influence nutrient, phytoplankton, and dissolved oxygen concentrations in slough and creek habitats, and may also influence conditions in LSB deep subtidal habitats. Numerical models will be an important tool for quantitatively exploring the combined influence of high-nutrients and salt-pond restoration on water quality. While the NMS' full-Bay, workhorse hydrodynamic/biogeochemical model includes LSB, that model version does not include a number of relevant salt pond connections, and does not resolve some sloughs at high enough resolution (including that level of spatial resolution would substantially increase full-Bay model run times).

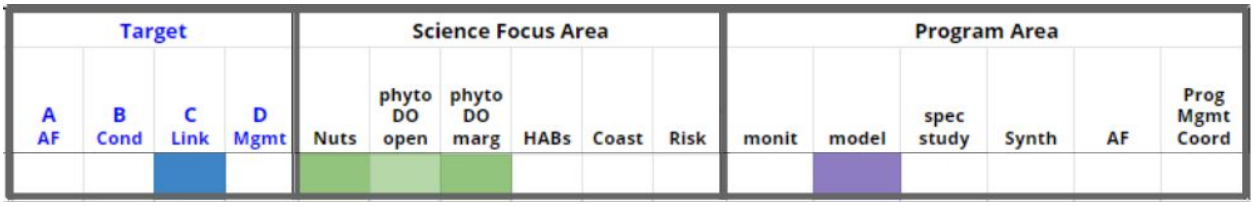
Another hydrodynamic model has been under development for LSB that resolves sloughs and includes connections to (and interconnections within) restored salt ponds. The model, developed jointly by SFEI/NMS and RMA and supported by a combination of NMS and non-NMS funds (SCVWD) has so far been calibrated and validated for a 4-month window in wy2016, with the primary calibration/validation focus on the Alviso complex and Coyote Creek.

FY2021 Work
This project will continue the development and application of the LSB-focused model. Work in FY2021 work will include:

- Extending hydrodynamic runs to additional time periods that will be valuable for investigating water quality - moored sensor data availability; a range of relevant water quality conditions; and changes in gate operations
- Additional hydrodynamic model calibration/validation, including priority refinements to the grid or bathymetry to improve predictions in some sloughs (e.g., Mowry);

- Initial applications of the model to inform interpretation of water quality observations, e.g., simulations using tracers or particle-tracking or potentially early biogeochemical runs.

Project Relevance



Addressing condition, nutrient impacts, and management strategies at the periphery of the LSB is a core charge of the NMS. Essentially every biogeochemical process in the LSB is affected by the complex tidal hydrodynamics within and around the interconnected slough-salt pond complexes. Properly resolving these complex flows will support the application of field data and the potential development of a LSB biogeochemical model.

Products/Deliverables

- Refined LSB hydrodynamic model, including calibrations in Newark and Mowry sloughs (long-term NMS monitoring sites).
- Hydrodynamic model output for use in interpreting observational water quality data
- If budget permits, targeted simulations (e.g., tracers, particles, basic biogeochem runs) to quantify exchange rates from slough-to-open Bay or slough-to-saltpond

Budget Justification: Work will be carried out collaboratively by RMA ($80k) and SFEI staff ($20k). Approximately ~$50k is available from prior contributions to the NMS (Sunnyvale, Palo Alto).

P5 HAB Special Studies

P5a mussels-toxins: SFB continuation, comparison w/ Tomales	Total Cost	NMS FY21 Funds
Collaborators: UCSC, SFSU-EOS, SFEI	$75,000	$75,000

This project will continue work that began in FY2016, measuring phycotoxins in naturally-occurring bivalves harvested from floating docks at locations in Central Bay and South Bay. In addition, a pilot study will be conducted to measure phycotoxins in mussels from Tomales Bay, to explore whether toxin signatures (multiple toxins, relative levels) are comparable, or different between the two systems (marine: domoic acid, saxitoxin, diarrhetic shellfish toxin; along with microcystins). The California Current transports similar water masses to the mouths of both SFB and Tomales Bay (TB). To the extent that marine harmful algae (HA) such as Pseudo-nitzchia, Alexandrium, or Dinophysis are being primarily transported into SFB from the coast (i.e., as opposed to growing within SFB), SFB and TB would have similar HA abundances and phycotoxin concentrations. Originally proposed a few years ago, this project did not move forward previously because of overall funding constraints and the logistical challenges of sampling in another system. However, after recent discussions with CA DPH staff it seems feasible to acquire Tomales Bay homogenized mussel samples from the CA DPH shellfish monitoring laboratory located in Richmond that receives

samples weekly from Tomales as part of the state's shellfish monitoring program. To help keep overall study costs down, the number of SFB stations will be decreased from 9 to 4-5. At SFB sites, basic water quality parameters will also be measured (T, salinity, nutrients, chl-a).

Project Relevance

This project will continue the collection of spatial and temporal information about HAB-related condition in SFB. Comparisons of toxin profiles of mussels harvested from SFB and Tomales Bay will allow for evaluating the role of the coastal ocean in transporting HABs and toxins in these estuaries, as opposed to internal production within the estuary, which is key information for disentangling potential roles of anthropogenic nutrients.

Products/Deliverables

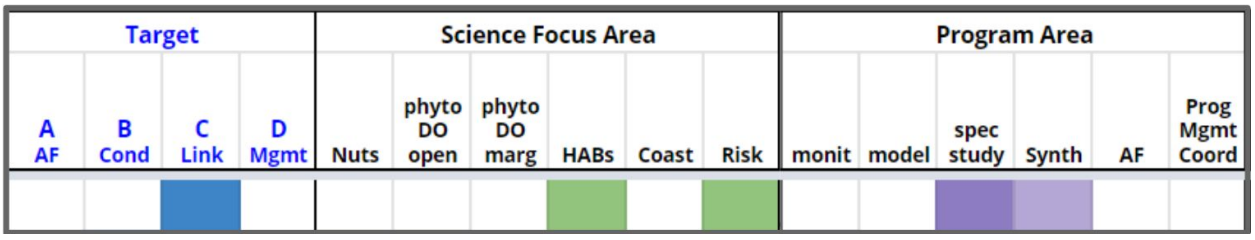
- Dataset with HA concentrations in mussel tissue, from the two estuaries
- Dataset with water quality conditions at time of sample collection
- A brief data report will be prepared, and analysis and interpretation of data will be included in the HAB synthesis (P10a) or in a subsequent synthesis effort.

Budget Justification: SFSU-EOS ($35k) will be responsible for biweekly collection and processing of mussel samples from SFB; analysis of nutrient and chl-a samples; coordinating sample pickup from CA-DPH; and shipping mussel samples for analysis. Samples will be analyzed at UCSC ($30k). SFEI will manage the project (10k). All three groups will contribute to the data report write-up.

P5b: Factors influencing Pseudo-nitszchia growth and toxicity	Total Cost	NMS FY21 Funds
Collaborators: SFSU-EOS, SFEI	$65,000	$65,000

This project is a continuation of a 2-yr study approved by the NMS SC in March 2019. The study is investigating growth requirements of the toxic phytoplankton Pseudo-nitszchia spp (P-N). NMS funding is being combined with other recently awarded funding (OPC) to investigators at SFSU-EOS (PI: Bill Cochlan). The OPC-funded work will examine P-N growth and toxin production as a function of temperature and salinity, with a primary focus on conditions encountered outside the Golden Gate. NMS funding is allowing for the study to expand the range of temperatures to include relevant conditions within SFB, and to investigate the effects of light limitation, along with temperature, on growth and toxin production. SFEI staff will join the project as co-PIs and will contribute to study design and interpretation. (Yr 2 = $55k).

Project Relevance



This study directly targets the question of what conditions favor (or prevent) P-N from experiencing sustained growth and toxin production in SFB. As such, it will improve our ability to understand the potential Linkages between P-N growth and nutrients, along with other factors, and contribute to our ability to assess risk of major P-N events occurring.

Work Products

- Final project technical report, prepared in the form of one or more manuscripts for submission to peer-reviewed journals.
- Data/relationships documenting P-N growth and toxicity response to salinity and light.

Budget Justification: SFSU-RTC ($55k): continuation of lab growth and toxicity experiments, data analysis and interpretation, and reporting. SFEI ($10k): collaboration, project management.

P6 Phyto-HAB monitoring (molecular, sequencing techniques)	Total Cost	NMS FY21 Funds
Collaborators: Bend Genetics, UCSC, USGS, SFEI	$100,000	$0

Molecular/genetic techniques (amplicon sequencing, qPCR) for phytoplankton analysis have the potential to be cost-effective, sensitive, and accurate approaches for characterizing phytoplankton assemblages, and in particular for detecting harmful taxa. In a recently completed NMS pilot study (see SFEI 2020), comparisons of molecular techniques and microscopy found that detections and relative abundances of multiple HA taxa differed considerably between the two techniques, with molecular techniques apparently more sensitive and/or less prone to misclassification than microscopy. The molecular/sequencing results also revealed the presence of numerous phytoplankton taxa that have not previously been reported in SFB, including some that may contribute nontrivially to biomass. This project will further explore and assess the suitability of using molecular techniques for HA and phytoplankton monitoring, and will recommend a set of tiered analyses for cost-effective monitoring. Work will include some or all of the following: i) deeper analysis of data collected thus far with an eye toward developing a recommended approach for HAB-related measurements; ii) targeted lab analyses of recently-collected/archived SFB samples (sequencing, qPCR, particulate toxins) to improve interpretability of data or comparability between methods, and to hone decision-approach; iii) develop a recommended approach for a decision-tree process for HAB-related measurements that balances cost-effectiveness with collection of useful information.

Project Relevance

This project will yield recommendations for monitoring best-practices for detecting and quantifying HAs and for characterizing phytoplankton assemblage, which are essential for measuring Condition and having a meaningful Assessment Framework. Sensitive detection and accurate quantification are also essential for being able to make inferences about mechanistic Linkages between phytoplankton assemblage or HA/toxin occurrence and causal factors (nutrients, physical forcings). In addition to the method recommendations, we expect that the work will also yield new insights into SFB's phytoplankton community, and how community varies spatially and seasonally or response to important drivers.

Work Products

- Data from analyses performed as part of this work, combined with datasets from prior work.
- Technical report describing key findings, and recommended approach for HAB and phytoplankton and quantification.

Budget Justification: Bend Genetics ($60k): sample analysis, data analysis/interpretation, report preparation. Other collaborators (UCSC, USGS: $20k): technical input, recommendations for data analysis and interpretation, contributions to report preparation. SFEI ($20k): data analysis/interpretation, report preparation, project management.

Additional funds from the RMP (reallocating prior nutrient funds) will be used to support this work; so no additional FY2021 NMS funds are required.

P7 LSB slough/creek O2 dynamics, synthesis II	Total Cost	NMS FY21 Funds
Collaborators: Stanford, UC Berkeley, UCSB, USGS, SFEI	$100,000	$100,000

LSB's creek/slough/saltpond habitats have complex physical interconnections, strong tides, and sharp biogeochemical gradients, all of which make it challenging to arrive at straightforward interpretations or reach confident quantitative inferences. A synthesis report on O2 dynamics in LSB slough/creek habitats will be completed in June 2020. In May 2020, we convened a small expert working group to gather input on the analyses/interpretations completed thus far, and to identify tractable next steps for further work - including different approaches for analyzing existing data and additional field measurements. The group expressed support for the following tasks:

1) Refinement of existing rate estimates and publication of the associated work.

2) Refinement of LSB model (P4) to refine net tidal flux analyses.
3) A collaborative experiment (SFEI, Stanford, UC Berkeley, UC Santa Barbara) for summer 2021 to estimate metabolic rates in LSB sub-embayments where existing methods are inadequate.

This project supports refinement of ongoing metabolic rate estimate work and planning/coordination for summer 2021 experiments with university collaborators. Elements of the field experiments will be carried out in coordination with P1b.

Project Relevance

Condition assessment and nutrient impacts to the LSB are core charges of the NMS. Refined metabolic rate estimates may be the most direct approach to addressing both of these charges. Refining net tidal flux estimates will serve to synthesize sub-embayment scale rates with oxygen dynamics in the open LSB.

Work Products

- Follow-up technical report, updating the June FY2020 technical report, describing results from additional analysis of existing data.
- Converting technical report into manuscript on LSB metabolic rates, for submission to peer-reviewed journal.
- Experiment plan for summer 2021 (early FY2022?) to decompose the role of LSB sub-habitats (sloughs, salt ponds, marsh) on ecosystem-scale metabolic rates/oxygen dynamics.

Budget Justification SFEI ($80k): data analysis/interpretation; report/manuscript preparation; planning for FY2021 or FY2022 field work. Support for university collaborators/co-authors ($20k). Since Project P1b does not have a substantial data analysis/interpretation budget, any funds remaining from this project will be used to augment the interpretation budget.

P8 Synthesis Projects: We propose to pursue four synthesis projects in FY2021, each of which is continuation of a FY2020 project and includes rolling over remaining project funds.

P8a. Factors influencing the occurrence of high phytoplankton biomass events	Total Cost	NMS FY21 Funds
Collaborators: UC Berkeley, USGS, SFEI	$75,000	$50,000

Anticipating how SFB will respond in the future to its nutrient loads requires that we understand (and are able to predict) how it has responded in the past across a diversity of forcings. The conceptual model generally invoked to explain phytoplankton blooms in SFB points to the setup of vertical stratification when sufficient freshwater input co-occurs with relatively weak tidal mixing energy. However, in ~30 yrs of monitoring data in South Bay, multiple examples emerge when the occurrence, or lack thereof, of large biomass events cannot be readily explained by stratification, suggesting other potential mechanisms. In FY2021, this project will further analyze the observational record to extract information on forcings and responses to identify potential modes of productivity or high biomass.

Project Relevance

Comprehensive understanding of drivers of bloom events is essential to refining the conceptual models that guide all aspects of our work. Refined conceptual models will allow us to focus “future scenario” simulation on specific forcing mechanisms most relevant to algal blooms.

Work Products: Technical report and manuscript presenting statistical patterns on the interplay of stratification and algal blooms.

Budget Justification: Total $75k ($25k, carry-forward from FY2020, $50k FY2021), with funding supporting SFEI staff ($60k) carrying out data analysis/interpretation/writing, and external collaborators/advisors ($15k).

P8b. Analysis of seasonal and long-term variations in water quality in San Francisco Bay (e.g, chl, GPP, DO, SSC, phytoplankton community).	Total Cost	NMS FY21 Funds
Collaborators: UC Berkeley, TBEP, USGS, SFEI	$75,000	$30,000

How have water quality indicators varied temporally, and how have those changes varied by sub-embayment or sub-sub-embayment? What factors can explain the variations in chl-a and GPP (increases, and then decreases, in some regions)? How have DO levels varied over time? Do some of these indicators co-vary? Through a related project (P11a Trends) we are developing and refining methodologies for detecting and quantifying trends. One component of Project P8b will focus on the interpretative aspects of observed trends, including potential causal factors. The NMS has numerous projects that are generating large amounts of data that need on-going analysis and interpretation, and need to be presented to technical and non-technical audiences in the form of technical documents, progress reports, and graphics for presentations.

Project Relevance

Synthesizing long-term cruise/channel data will clarify sub-embayment-scale patterns in the ecological/biogeochemical processes driving nutrient cycling and ecosystem response in SFB. In addition to advancing descriptive understanding of condition (an explicit NMS charge), these analyses will help identify potential causal mechanisms.

Work Products

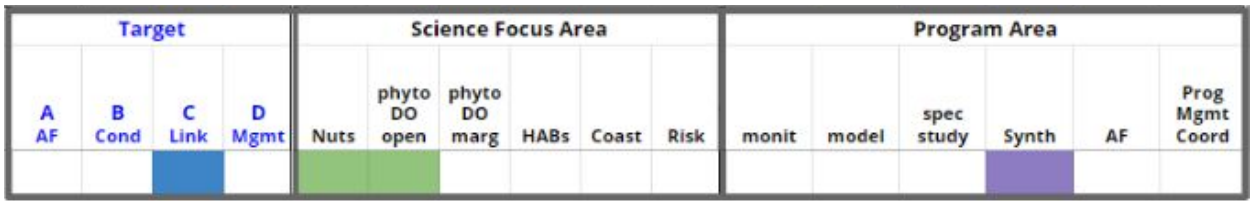
Technical report synthesizing interrelated spatio-temporal patterns in chlorophyll, GPP, and oxygen, and identifying potential causal factors.

Budget Justification

Total: $75k ($45k from FY2020; $30k from FY2021). $50-60k will support SFEI staff working on data analysis/interpretation and write-up, and $15-25k will support external collaborators.

P8c. Synthesis/interpretation of high frequency mooring data	Total Cost	NMS FY21 Funds
Collaborators: USGS-BGC, SFEI	$80,000	$20,000

This project will explore the variability in mooring chl-a data (and calculated GPP), including spring/neap variations, and whether the higher-resolution chl-a 'signals' provide additional insights into factors regulating productivity. We also plan to focus on shoal mooring data, including NO_3^- variations (and co-variations with chl-a and other parameters). Existing velocity data from the shoal mooring will be used to interpret the spatial scales of the patterns described above.



Project Relevance
The NMS has collected several years of high-frequency data at a range of South Bay and Lower South Bay sites. Synthesizing these data with cruise/channel data will elucidate mechanisms underlying the sub-embayment scale patterns described in P8b.

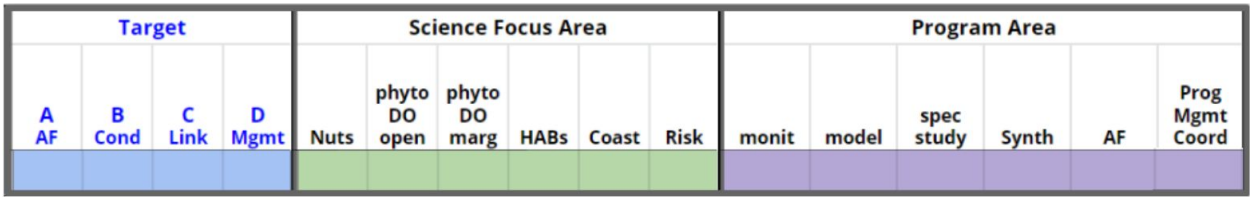
Work Products
-Technical report summarizing main findings. This report will be prepared in the form of a manuscript for eventual journal submission.

Budget Justification: Total: $80k ($60k from FY2020; $20k FY2021 funds). The $60k from FY2020 includes funds earmarked for USGS-BGC to collaborate on shoal mooring and other mooring data interpretation. The remaining $50k will support SFEI staff on data analysis/interpretation and report preparation.

P8d. Annual report	Total Cost	NMS FY21 Funds
	$40,000	$0

This funding will support the development of a graphics-rich Annual Report, presenting highlights of main findings and advancements over the prior 1-3 years.

Project Relevance



High level report-out covering all major activities and goals.

Work Products
- Annual report

Budget Justification: SFEI-NMS staff time developing content and graphics ($25-30k), and graphics design and layout support ($10-15k).

P9 Monitoring Work Group	Total Cost	NMS FY21 Funds
Collaborators: USGS-BGC, SFEI, others TBD	$50,000	$25,000

Developing a sustainable monitoring program is among the NMS' highest priorities. Over the past several years, NMS work products have put forward numerous monitoring program recommendations (SFEI 2014; SFEI 2016), many of which have been at least partially implemented, and others that have not yet moved forward.

This project will establish a monitoring program workgroup to advise on monitoring program design and priorities for next steps in program development. The group would be comprised of academics/researchers, applied scientists, managers, and stakeholders/regulators, and would be convened twice during the first year, and once every 1-3 years thereafter, to provide input on the questions such as: Are we investing in the right monitoring? Should we add/revise locations for ship-based sampling, in particular to include shoal stations? Where do we need high-frequency data versus ship-based samples? What other parameters are worthwhile investments? Is it worthwhile to explore the potential of remote-sensed measurements to address some data gaps?

Project Relevance

Condition assessment is a core charge of the NMS. Comprehensive, but cost-effective, characterization of current and future conditions requires monitoring at the proper scales in space and time. This project will evaluate how current monitoring efforts are and are not capturing the scales of variability in the system, and are and are not sufficiently addressing current and potential future data needs. Discussion outcomes will be used to guide the iterative management of the NMS monitoring strategy.

Work Products

- Framework for evaluating and weighing trade-offs related to monitoring activities
- Recommendations for iterative improvement to NMS monitoring program.

Budget Justification Approximately half of the funds ($20-25k) will be used to recruit and convene a group of 5-7 workgroup members (honoraria when allowable and needed; travel if necessary). Remaining funds will support SFEI staff time developing workshop program and materials, follow-up work (e.g., analyses, report-outs) stemming from workshop #1, and Year 1 report.

P10a HAB synthesis	Total Cost	NMS FY21 Funds
Collaborators: UCSC, Bend Genetics, USGS, others TBD	$150,000	$150,000

Over the past ~5 years, the NMS has substantially increased data resources related to HABs and toxins, in response to science/management priorities. This project will invest in synthesizing and interpreting recent and longer-term HA and toxin data. P10a will be closely integrated with P10b, and synthesis work will be in part informed/shaped by input from the HAB expert group.

Project Relevance

The primary goal of this effort will be to improve understanding of mechanistic Linkages between HA/toxin occurrences and potential causal factors. Through exploring those issues, we also expect

to extract valuable information related to Condition measurement (monitoring) and Assessment Framework development.

Work Products

- Technical report developed in the form of a manuscript to be submitted to a peer-reviewed journal.

Budget Justification: TBD (collaborator, SFEI staff if appropriate skill set match): $100k, e.g., postdoc or researcher to lead on data analysis and interpretation, and be the first author of report. Collaborators (~$25k): advising, contributing to report; SFEI ($25k): contributing to analysis and report, project management.

P10b HAB expert workgroup	Total Cost	NMS FY21 Funds
Collaborators: SFEI, others TBD	$25,000	$25,000

Convene an expert panel to advise on interpretation of data in P10a, and to inform approaches for analyzing those data with respect to Assessment Framework development/refinement.

Project Relevance

Potentially advising on all aspects of HABs, but may need to pick highest-priority sub-discipline (e.g., mechanisms, toxicity to humans/wildlife).

Work Products

- Workgroup report and recommendations

Budget Justification: Note that the researcher and collaborators on project 10a will be heavily involved in shaping this workshop, developing materials for it, and putting recommendations into action. Experts: ~$15k for honoraria and travel. SFEI ($10k): project management, workshop planning.

11a Assessment framework - robust approaches for detecting and quantifying trends in important indicators	Total Cost	NMS FY21 Funds
Collaborators: UC Berkeley, TBEP, UMCES, SFEI	$50,000	$50,000

An FY2020 Trends project was launched as a 1.5-2yr $100k project. When the FY2020 Program Plan was approved, $50k of this project's costs were deferred to FY2021. This project is the continuation of the approved FY2020 trends project.

Project Relevance

This project is closely aligned with developing an Assessment Framework module for Phytoplankton/DO in openBay habitats, detecting and characterizing trends. It has benefits for Condition measurement and for informing mechanistic Linkages.

Work Products

- Technical report documenting the approach, strengths and limitations, prepared in the form of a manuscript.
- Interactive webtools for visualizing trends and easily updating with new information.

Budget Justification Funds for Year 2 will support collaborators (~50%) and SFEI staff (25%) to finalize technical report.

11b Assessment framework- Deep subtidal habitats, priority analyses	Total Cost	NMS FY21 Funds
Collaborators: SFEI, others TBD	$200,000	$150,000

During FY2020, SFEI has been working with a subcommittee of the NMS-SC to gather stakeholder input to be incorporated into an Assessment Framework Workplan. This workplan is still under development, with the goal of having a complete draft version available by end-June. This project will pursue a subset of the highest priority analysis or other work identified in the AF Workplan. An early step of this effort will likely involve convening an expert group, to identify specific types of analysis to explore.

Project Relevance

Focused on Assessment framework development in deep subtidal habitats for phytoplankton/DO and HABs.

Work Products

- One or more technical reports.

***Budget Justification*:** The project is expected to be a major project, with the total budget estimate ($200k) likely representing more than can be accomplished in one year. During the first year, funding would likely be distributed 50% external collaborators/experts and 50% SFEI staff, with both working on various aspects of data analysis, and SFEI staff managing the overall project.

P12a Assessment framework- DO in LSB slough/creek habitats: data analysis/synthesis	Total Cost	NMS FY21 Funds
Collaborators: UC Berkeley, UC Davis, SERC, SCCWRP, SFEI	$150,000	$75,000

P12a Assessment framework- DO in LSB slough/creek habitats: data analysis/synthesis. Similar to the background in **P11b**, work has been moving forward over the past year on developing an AF workplan for DO in LSB slough/creek habitats. During May 2020, an expert workgroup was convened to advise on potential approaches for identifying protective DO conditions, and expert and stakeholder input will be used to develop a draft LSB slough/creek DO AF Workplan. Work in **P12a** will pursue the highest priority topics identified in the work plan. Draft priorities that emerged from the expert workgroup include: i) Pursue analyses following the concepts and structure laid out in the Virginia Province Approach; ii) scoping level analysis of multi-stressor approach(es), i.e., T, DO and biota metabolism, including a literature review, and exploration of data needs, data availability, and feasibility. iii) Scoping level analysis of fish trawl data to identify the types of analyses or interpretations that current data can support, and potential opportunities or needs for additional data collection to address important gaps.

Project Relevance

Work will Target Assessment Framework development and Condition assessment in LSB slough and creek habitats, focused on DO. The proposed approach based on expert input will establish several lines of evidence for establishing protective DO objectives for LSB slough and creek habitats.

Work Products

- Application of the VPA to characterize habitat condition in LSB sloughs and creeks, including critical assessment, and exploration of the value of new experimental data to improve confidence in numbers.
- Brief report-out exploring the feasibility of a multi stressor approach, including data needs, potential usage within regulatory or management decision frameworks, assessment of whether analysis has the potential to 'move the needle' in terms acceptable DO levels or confidence in condition assessment; and recommended next steps.
- Brief report-out on scoping level analysis of fish trawl data, including types of questions that could be explored with this type of data, potential usage within regulator or management decision frameworks, feasibility (based on actual data) of analysis yielding confident insights, and major limitations of data or major data gaps that could be addressed with additional field work.

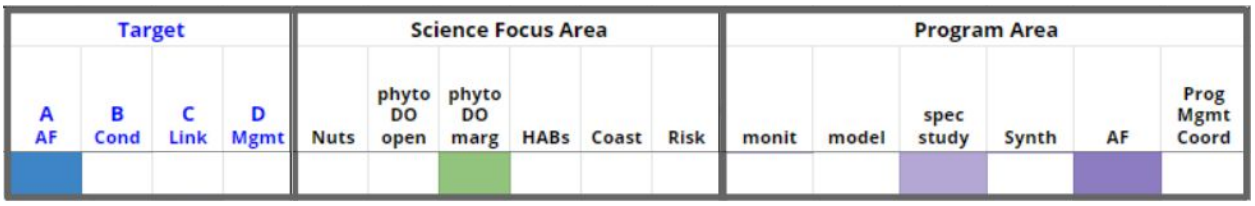
Budget Justification

Total: $150k ($75k is being carried forward from FY2020 P22). Exact distribution of funds across the three main tasks will depend on additional information about effort required for some types of work (e.g, VPA). Approximately 50-60% of funds will support external collaborators working on these projects, and the remainder supporting SFEI staff on data analysis/interpretation and leading / managing overall project.

P12b LSB-DO fish/benthos surveys	Total Cost	NMS FY21 Funds
Collaborators: SFEI, UC Davis	$50,000	$25,000

An extensive fish surveying effort has been underway in Lower South Bay, funded currently by San Jose and previously by the salt pond restoration program. This funding is expected to primarily support field work by UC Davis researchers, if there is agreement that additional field work be informative. Exact activities will be determined based on output from P12a.

Project Relevance



Data generated from fish surveys may be used in a variety of ways (pending findings in 12a) in the service of developing protective DO objectives for LSB slough and creek habitats.

Work Products

- Fish community dataset and associated water quality parameters
- Brief technical report on abundance/community data collected to-date
- Dataset will also be used for task P12a work products, or follow-up studies

Budget Justification Funds will go primarily to UC-Davis ($45-50k).

P13 Coastal nutrient exchanges/fluxes	Total Cost	NMS FY21 Funds
Collaborators: UCLA, UCSC, SCCWRP, SFEI	$200,000	$150,000

A sizable proportion (e.g. 50% or more, depending on season) of the nutrients that enter SFB exit via the Golden Gate to the coastal ocean. This project will fund year 2 of an anticipated 3 -year project joining an on-going study (collaborators SCCWRP/UCLA/UCSC) to explore the fate of nutrients leaving SFB. The project aims to determine boundary condition estimates for nutrients entering SFB. [Project already approved by NMS-SC, Mar 2019; see FY2020 Program Plan]

Project Relevance

This study examines the Link between nutrient exports via the Golden Gate and potential adverse impacts along the Coast (OA, hypoxia, harmful algal blooms).

Work Products

- Progress reports at the ends of Years 1 and 2 (Feb 2021 and Feb 2022)
- One or more manuscripts for submission to peer-reviewed journals.

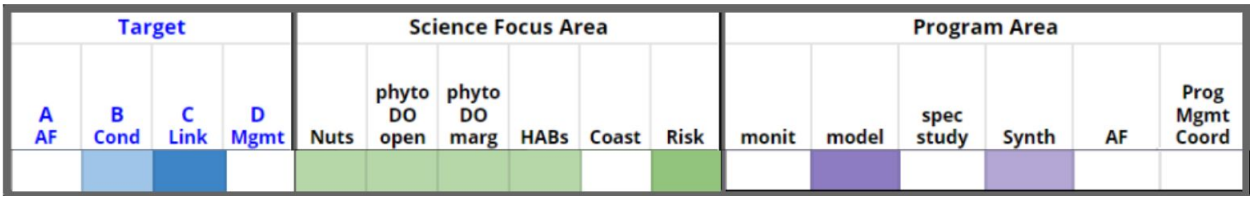
Budget Justification: Annual project costs are $200,000, and cover postdoc and faculty advisor (UCSC/UCLA), additional support for generating forcings or other datasets, and support for SFEI staff on project management (~10k/yr).

P14 Future Scenario / Risk: Develop a workplan and begin undertaking studies	Total Cost	NMS FY21 Funds
Collaborators: SFEI	$200,000	$100,000

Although nitrogen and phosphorous concentrations in SFB are elevated relative to those in many other US estuaries, those levels were thought to pose little ecological-health risk in SFB because of physical and biological factors that limit nutrient conversion into phytoplankton biomass (SFBRWQCB, 1975). However, multiple recent studies have documented how physical and biological drivers of ecosystem response have changed over the past ~20 years (Cloern et al., 2007, 2010; Schoellhamer 2011), leading some areas of the Bay to exhibit greater sensitivity, or responsiveness, to ambient nutrient concentrations, as evidenced by increasing chl-a concentrations in South Bay (Cloern et al., 2007) and other subembayments. Climate change predictions suggest that additional changes are ahead (Cloern et al. 2011). The magnitudes and combined influence of those changes on ecosystem responses to nutrients have not been quantitatively explored. In addition, the 2015 harmful algal bloom along the entire US west coast served as a stark reminder that “atypical” conditions, or events, can have widespread, unforeseen impacts and that nutrient-related responses may need to be evaluated in a risk-based framework. Since any large-scale nutrient management actions in SFB will take years to decades to implement, NMS guidance documents call for exploring ecosystem response under both current conditions and plausible future conditions (Strategy document; NMS Science Plan; NMS Conceptual Model). Although characterizing likelihood, or risk of occurrence, of future scenarios and SFB response under these future scenarios is of paramount importance, so far the vast majority of NMS work has been focused on current conditions.

In this project, we will develop a risk-based framework for evaluating nutrient-related effects in SFB, and begin the work of quantitatively examining these scenarios within this framework. Future scenarios for detailed exploration will be identified and prioritized through input from experts and stakeholders. Scenarios will be explored through a combination of hydrodynamic and water quality models. This is anticipated to be a 3-4 year study.

Project Relevance



This project examines the Linkages between high Nutrients and the Risk of major adverse-impact events in the future (phyto blooms, DO, HABs), as a result of shifts in environmental forcings.

Work Products
- Convene Expert workgroup to advise on approaches, and work with that group to develop an analysis framework and study design.
- Additional work products would become available in Year 2 of the project

Budget Justification The current funding level ($100k in FY2021) would allow for a strong start to workplan development and initial simulations. Exact approach to scoping and staffing the project remains TBD, and requires further input from a core group of advisors.