

Elkhorn Slough (ELK) NERR Nutrient Metadata
(January- December 2003)
Latest Update: July 14, 2025

I). Data Set and Research Descriptors

1) Principal investigator(s) and contact persons

a) Reserve Contact

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b) Laboratory Contact

Same as above

c) Other Contacts and Programs

None

2) Research objectives

Elkhorn Slough (ESNERR) is a unique estuary along the central Californian coast. There are fresh water inputs during the wet season (October through May) causing a brackish environment, while during the dry season (June through September) there is very little freshwater input resulting in a much more saline environment. The surrounding area is mostly farmlands, which causes concern as they may be a source of significant amounts of nutrients entering the slough. With the base monitoring program we are able to quantify the variability of these nutrients in different areas of the slough.

a) Monthly Grab Sampling Program

Monthly grab samples are collected to quantify the spatial variability of important nutrients in the water column at sites representing the estuarine endpoints of the Elkhorn Slough estuary.

b) Diel Sampling Program

Once per month, samples are collected every hour through a 24-hour tidal cycle to quantify the temporal variability of important nutrients in the water column as a function of tidal forcing.

3) Research methods

a) Monthly Grab Sampling Program

Monthly grab samples were taken at the four principle ESNERR data sonde stations (Azevedo Pond, North Marsh, South Marsh and Vierra Mouth) within the Elkhorn Slough estuary. All grab samples were taken on the same day between +3 hrs before slack low-water and low-water. No distinction was made between neap and spring tide conditions. Efforts were made to allow for an antecedent dry period of 72 hours prior to sampling. Replicate (N=2) samples were collected by hand at an approximate depth of 10 cm. All samples were collected in amber, narrow-mouth, nalgene sample bottles that were previously acid washed (10%), rinsed (3x) with distilled-deionized water, dried, and followed by rinsing (3x) with ambient water prior to collection of the sample. Samples were immediately placed on ice in the dark and returned to the laboratory. Once in the laboratory, samples were shaken and processed for nutrient and Chl-a analysis.

At the time of sample collection, water temperature, salinity, and dissolved oxygen was measured with a YSI Model 650 meter. This data is not included in this dataset but will be available upon request by calling the reserve.

b) Diel Sampling Program

On the first Monday of every month, within the same 24-hour period of grab sample collection, we deploy an ISCO water sampler approximately 30 cm above the bottom from the bank of the marsh at South Marsh. This device automatically samples 500 ml of water every 1 hrs 2min. All samples are pumped into polyethylene sample bottles that were previously acid washed (10% HCL), rinsed (3x) with distilled-deionized water and dried. Samples are kept cold with ice until the end of the 24 hr period; the 24 samples are kept in the dark and returned to the laboratory for immediate processing.

4) Site location and character

Elkhorn Slough is located on the West Coast of the United States in Central California. It connects with the Pacific Ocean in central Monterey Bay near Moss Landing, California. There are four sampling sites.

Azevedo Pond (AP) (36°50'44.64"N, 121°45'13.24"W) receives fertilizer and pesticide runoff from a strawberry field in year-round production. The YSI is located about 10m from a culvert connecting the pond to the slough. Tide ranges from 0 to 1.3 meters while salinity ranges from 8.8 during heavy runoff to 41 ppt during strong evaporation. The sonde is located approximately 10 cm off the bottom, which is composed of silty mud. Depth for this site is approximately 1 meter.

North Marsh (NM) (36°50'04.75"N, 121°44'18.33"W) is located in between South Marsh and Azevedo Pond. This site is impacted by both agricultural and urban runoff. With a mean depth of 1 meter, the tidal range is approximately 0.4 meters while salinity ranges between 20 and 40 parts per thousand. There is freshwater runoff from upland and agricultural sites. The sonde is approximately 10 cm off the bottom, which is composed of silty mud.

South Marsh (SM) (36°49'05.00"N, 121°44'21.83"W), located about 3 km south of NM, is in a side channel of the slough and is relatively free from impact by anthropogenic influences as it is surrounded by mostly reserve land. The YSI is located on the side of a bank in one of the secondary slough channels. This site receives runoff mostly from uplands and some from cattle ranches, receiving the least amount of pollution. Tidal ranges from 0 to 3 meters while the salinity range is from 22 to 36 parts per thousand. The sonde is approximately 30 cm off the bottom, which is composed of compacted silty mud. Depth for this site is approximately 2 meters.

The fourth site Vierra Mouth (VM) (36°48'39.95"N, 121°44'45.40"W) is located at the mouth of the slough and is used to identify oceanic influence. With a mean depth of 2.5 meters, the tidal range is from 0 to 3.2 meters while salinity ranges from 26 to 34 parts per thousand. The sonde is located approximately 30 cm off the bottom which is composed of compacted mud and sand due to strong tidal currents. This site receives drainage from the entire watershed due to its location at the mouth. There are several auto wreacking yards located approximately 2 km east of this site.

5) Code variable definitions

elkapnut= Elkhorn Slough Reserve Azevedo Pond nutrient data

elknmnut= Elkhorn Slough Reserve North Marsh nutrient data

elksmnut= Elkhorn Slough Reserve South Marsh nutrient data

elkvmnut= Elkhorn Slough Reserve Vierra Mouth nutrient data

The monitoring codes are set as "1" to indicate grab samples and "2" to indicate diel samples. Replicates are also given specific codes. Grab samples in which duplicates sample are taken utilize a "1" for the first sample and a "2" for the second sample. Diel samples are always labeled with a "1" since only one sample is taken at each interval.

6) Data collection period

Sampling occurred between January 7 07:28 and December 9 03:14.

Diel Sampling

Site	Start Date	Start Time	End Date	End Time
SM	01/07/03	0728	01/08/03	0714
SM	02/03/03	0514	02/04/03	0500
SM	03/03/03	0421	03/04/03	0407
SM	04/07/03	0936	04/08/03	0922
SM	05/05/03	0813	05/06/03	0759
SM	06/02/03	0711	06/03/03	0657

SM	06/30/03	0615	07/01/03	0601
SM	08/04/03	0946	08/05/03	0932
SM	09/08/03	0352	09/09/03	0338
SM	10/07/03	0323	10/08/03	0309
SM	11/04/03	0104	11/05/03	0050
SM	12/08/03	0328	12/09/03	0314

Grab Sampling

Site	Start Date	Start Time	End Date	End Time
AP	01/08/03	0730	01/08/03	0730
AP	02/04/03	0730	02/04/03	0730
AP	03/03/03	1525	03/03/03	1525
AP	04/03/03	1525	04/03/03	1525
AP	05/05/03	0810	05/05/03	0810
AP	06/02/03	0550	06/02/03	0550
AP	06/30/03	1535	06/30/03	1535
AP	08/04/03	0825	08/04/03	0825
AP	09/08/03	1440	09/08/03	1440
AP	10/07/03	1320	10/07/03	1320
AP	11/04/03	1115	11/04/03	1115
AP	12/08/03	1425	12/08/03	1425

Site	Start Date	Start Time	End Date	End Time
NM	01/08/03	0750	01/08/03	0750
NM	02/04/03	0750	02/04/03	0750
NM	03/03/03	1540	03/03/03	1540
NM	04/07/03	1540	04/07/03	1540
NM	05/05/03	0835	05/05/03	0835
NM	06/02/03	0607	06/02/03	0607
NM	06/30/03	1600	06/30/03	1600
NM	08/04/03	0850	08/04/03	0850
NM	09/08/03	1455	09/08/03	1455
NM	10/07/03	1340	10/07/03	1340
NM	11/04/03	1135	11/04/03	1135
NM	12/08/03	1445	12/08/03	1445

Site	Start Date	Start Time	End Date	End Time
SM	01/08/03	0815	01/08/03	0815
SM	02/04/03	0815	02/04/03	0815
SM	03/03/03	1605	03/03/03	1605
SM	04/07/03	1605	04/07/03	1605
SM	05/05/03	0905	05/05/03	0905
SM	06/02/03	0650	06/02/03	0650
SM	06/30/03	1645	06/30/03	1645
SM	08/04/03	0945	08/04/03	0945
SM	09/08/03	1515	09/08/03	1515

SM	10/07/03	1415	10/07/03	1415
SM	11/04/03	1230	11/04/03	1230
SM	12/08/03	1520	12/08/03	1520

Site	Start Date	Start Time	End Date	End Time
VM	01/08/03	0840	01/08/03	0840
VM	02/04/03	0840	02/04/03	0840
VM	03/03/03	1425	03/03/03	1425
VM	04/07/03	1425	04/07/03	1425
VM	06/02/03	0715	06/02/03	0715
VM	06/30/03	1720	06/30/03	1720
VM	08/04/03	0800	08/04/03	0800
VM	09/08/03	1410	09/08/03	1410
VM	10/07/03	1500	10/07/03	1500
VM	11/04/03	1300	11/04/03	1300
VM	12/08/03	1540	12/08/03	1540

7) Associated researchers and projects

Ken Johnson et al. are looking at nutrient budgets in the slough with real time nitrate loggers in the main channel of the slough. , Adina Paytan, Scott Wankle et al are looking at nitrogen isotopes to assess the contributions of nitrogen through ground water. Nicholas Welshmier et al are looking at nutrients and phytoplankton populations in the main channel of the slough on a weekly basis. Marc Los Huertos et al are investigating nutrient budgets in the Elkhorn Slough watershed and identifying "hot spots" of nutrients in the slough and working with local farmers to attempt to decrease high nutrient loads.

8) Distribution

NOAA/ERD retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The PI retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the PI and NERR site where the data were collected will be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. Manuscripts resulting from this NOAA/OCRM supported research that are produced for publication in open literature, including refereed scientific journals, will acknowledge that the research was conducted under an award from the Estuarine Reserves Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data. NERR water quality data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Section 1. Principal investigators and contact persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information

link on the CDMO home page) and online at the CDMO home page <http://cdmo.baruch.sc.edu/>. Data are available in text tab-delimited format, Microsoft Excel spreadsheet format and comma-delimited format.

II. Physical Structure Descriptors

9) Entry verification

Monthly nutrient data is measured and entered into an excel file consisting of sampling station ID, date and time, and parameter values expressed in unit concentrations. John Haskins and Allison Myers verify all parameter values in the excel file by cross comparison with laboratory data sheets and by graphing the data and identifying anomalous data points or other problems. Monthly excel files were compiled into a yearly excel file. Missing data are verified through inspection of field logs and flagged by an “M” in the compiled excel file. Values flagged with a “K” are further explained in the metadata. Calculated values are flagged by a “C” in the compiled excel file.

10) Parameter Titles and Variable Names by Data Category

Required NOAA/NERRS System-wide Monitoring Program water quality parameters are denoted by an asterisks "*".

Data Category	Parameter	Variable Name	Units of Measure
i) Phosphorus:	*Orthophosphate	PO4F	mg/L as P
ii) Nitrogen:	*Nitrite + Nitrate, Filtered	NO23F	mg/L as N
	*Nitrite, Filtered	NO2F	mg/L as N
	*Nitrate, Filtered	NO3F	mg/L as N
	*Ammonium, Filtered	NH4F	mg/L as N
	*Dissolved Inorganic Nitrogen	DIN	mg/L as N
iii) Other Lab Parameters:	Chlorophyll a	CHLA_N	µg/L
	Phaeophytin	PHEA	µg/L

Notes:

1. Time is coded based on a 2400 hour clock and is referenced to Pacific Standard Time (PST).
2. Reserves have the option of measuring either NO23 or NO2 or NO3.

11) Measured and Calculated Laboratory Parameters

a)	Variables Measured Directly	
	Nitrogen species:	NO2F, NO23F, NH4F
	Phosphorus species:	PO4F
	Other:	CHLA_N, PHEA

- b) Computed Variables
 NO3: NO23F-NO2F
 DIN: NO23F+NH4F

12) Limits of Detection

Method Detection Limits (MDL), the lowest concentration of a parameter that an analytical procedure can reliably detect, has been established by the Moss Landing Marine Lab (MLML) Nutrient Analytical Laboratory. The MDL is determined as 3 times the standard deviation of a minimum of 7 replicates of a single low concentration sample. The following chart presents the current MDL's; these values are periodically reviewed and revised.

2003	Jan	0.0003	0.0017	0.0021	no data	0.045
2003	Feb	0.0007	0.0018	0.0008	no data	0.045
2003	Mar	-0.0001	0.0015	0.0008	no data	0.045
2003	Apr	0.0003	0.0013	0.0009	no data	0.045
2003	May	0.0003	0.0012	0.0013	no data	0.045
2003	Jun	0.0006	0.002	0.0019	no data	0.045
2003	Jul	no data	0.0011	0.0011	0.0053	0.045
2003	Aug	0.0012	0.0021	0.0012	no data	0.045
2003	Sep	0.0027	0.0018	0.0013	0.0025	0.045
2003	Oct	0.0185	0.0012	0.001	0.0033	0.045
2003	Nov	0.0031	0.0014	0.0012	0.0064	0.045
2003	Dec	0.0021	0.0014	0.0013	0.0033	0.045

13) Laboratory Methods

a) Parameter: NH4F

i) Method Reference: Stricklin and Parsons Determination of Ammonia.

ii) Method Descriptor: Samples collected and stored on ice in amber bottles prior to being filtered with a 0.45 um GFF filter and subsequently subjected to hypochlorite-phenol in the presence of NH3. Sodium nitroprusside is then used as a catalyst in the reaction. A oxidizing solution is then added (a mixture of sodium hypochlorite and alkaline reagent). The sample is then allowed to stand at a temperature between 20 and 27 C for at least 1 hour and then placed in a 10 cm cuvette and absorbance is measured at 640 nm.

iii) Preservation Method: Samples filtered and stored at 4 °C up to 24 hours.

b) Parameter: NO23F, NO3F, and NO2F

i) Method Reference: Stricklin and Parsons Determination of Nitrite.

ii) Method Descriptor: The water sample is first filtered then is passed through a cadmium column where the nitrate is reduced to nitrite. When only analyzing for nitrite the sample is not exposed to cadmium and thus the nitrite in the water is quantified. The nitrite is then exposed to sulfanilamide solution and allowed to react for 2 minutes then is exposed to N-(1-naphthyl)-ethylenediamine dihydrochloride solution and allowed to react for at

least 10 minutes. The sample is then placed in a 1 cm cuvette where the absorbance is measured at 543 nm. Nitrate concentration equals the (nitrate + nitrite) concentration minus the nitrite concentration. NO₂₃ is calculated by adding NO₂ + NO₃.

iii) Preservation Method: Sample is filtered through a 0.45 µm filter and analyzed the same day.

c) Parameter: PO₄F

i) Method Reference. Same as Nitrite with Alpkem machine.

ii) Method Descriptor: Ammonium molybdate is added to a water sample to produce phosphomolybdic acid, which is then reduced to phosphomolybdous acid (a blue compound) following the addition of dihydrazine (or hydrazine) sulfate. The sample is passed through a 50 mm flowcell and absorbance is measured at 820 nm.

iii) Preservation Method: Sample is filtered through a 0.45 µm filter and analyzed the same day.

d) Parameter: CHLA, PHAE

i) Method Reference. EPA method 445.0 UNESCO (1994) Protocols for the joint global ocean flux study (JGOFS) core measurements. pp. 97-100.

ii) Method Descriptor: CHLA is extracted in 10 ml 90% acetone for 24 hrs and then fluorescence is measured and recorded (Fo). Several drops (2-3) of 10% are added to convert the CHLA to phaeopigments (PHAE). The fluorescence is again measured and recorded (Fa). The concentration (µg/L) of CHLA and PHAE are calculated using the Fo/Fa ratio.

iii) Preservation Method: A known volume of sample is filtered onto a 25 mm GF/F filter, folded in half and placed in a known volume of 90% acetone and then stored at -4 °C until analysis 24 hrs later.

14) Reporting of Missing Data, Data with Concentrations Lower than Method Detection Limits etc

Nutrient/Chla comment codes and definitions are provided in the following table. Missing data are denoted by a blank cell “ ” and commented coded with an “M”. Laboratories in the NERRS System submit data that are censored at a lower detection rate limit, called the Method Detection Limit or MDL. MDL's for specific parameters are listed in the Laboratory Methods and Detection Limits Section (Section II, Part 14) of this document. Measured concentrations that are less than this limit are replaced with the minimum detection limit value and comment coded with a “B” in the variable code comment column. For example, the measured concentration of NO₂₃F was 0.0005 mg/L as N (MDL=0.0008), the reported value would be 0.0008 with a “B” placed in the NO₂₃F comment code column. Calculated parameters are comment coded with a “C” and if any of the components used in the calculation are below the MDL, the calculated value is removed and also comment coded with a “B”. If a calculated value is negative, the value is removed and comment coded with an “N”.

Note: The way below MDL values are handled in the NERRS SWMP dataset was changed in November of 2011. Previously, below MDL data from 2002-2006 were also coded with a B, but replaced with -9999

place holders. Any 2002-2006 nutrient/pigment data downloaded from the CDMO prior to December November of 2011 will contain -9999s representing below MDL concentrations.

Comment Code	Definition
A	Value above upper limit of method detection
B	Value below method detection limit
C	Calculated value
D	Data deleted or calculated value could not be determined due to deleted data, see metadata for details
H	Sample held beyond specified holding time
K	Check metadata for further details
M	Data missing, sample never collected or calculated value could not be determined due to missing data
P	Significant precipitation (reserve defined, see metadata for further details)
U	Lab analysis from unpreserved sample
S	Data suspect, see metadata for further details

This nutrient sampling program was almost in full swing in Jan 2003. All tier 1 parameters were being analyzed with the exception of ammonium, which began in June.

January – May - No ammonium analysis was performed and thus no DIN was calculated either.

Phaeophytin was analyzed only January through April because the Fluorometer that was utilized afterwards operates with specific filters for Chl-a preventing analysis of phaeophytin.

15) QA/QC Programs

a. Precision

- i) Field Variability –ELKNERR collects two successive grab samples for the determination of water mass variability within each site.
- ii) Laboratory Variability – Laboratory replicates are done for ammonium, nitrite, nitrate and phosphate standards on a semi-regular basis, variability was found to be within 3%.
- iii) Inter-organizational splits – None

b. Accuracy

- iv) Sample Spikes – blanks
- v) Standard Reference Material Analysis – Pending
- vi) Cross Calibration Exercises - None

16) Other Remarks

On 7/14/2025 this dataset was updated to include embedded QAQC flags and codes for anomalous/suspect, rejected, missing, and below detection limit data. System-wide monitoring

data beginning in 2007 were processed to allow for QAQC flags and codes to be embedded in the data files rather than using the original single letter codes used for the nutrient and pigment dataset along with the detailed sections in the metadata document for suspect, missing, and rejected data. Please note that prior to 2007, rejected data were deleted from the dataset so they are unavailable to be used at all. Suspect, missing, rejected and below minimum detection flags and appropriate three letter codes were embedded retroactively for dataset consistency. The QAQC flag/codes corresponding to the original letter codes are detailed below.

Flag/code	<i>If also C</i>	Historic Letter Code	Historic Code Definition
<1> [SUL]		A	Value above upper limit of method detection
<-4> [SBL]	<-4> [SCB]	B	Value below method detection limit
<i>no need to flag/code unless combined</i>		C	Calculated value
<-3> [GQD]	<-3> [GCR]	D	Data deleted or calculated value could not be determined due to deleted data, see metadata for details
<1> (CHB)		H	Sample held beyond specified holding time
<0> (CSM) unless other flag		K	Check metadata for further details
<-2> [GDM]	<-2> [GCM]	M	Data missing, sample never collected or calculated value could not be determined due to missing data
<-3> [SNV] and <1> [SCC] for components (CRE) or F_Record (CRE)		N	Negative calculated value
<0> (CJS)		P	Significant precipitation (reserve defined, see metadata for further details)
<1> (CSM)		U	Lab analysis from unpreserved sample
		S	Data suspect, see metadata for further details

Rainfall was less than 5mm 72 hours prior to sampling for each sampling period with the exception of December, where 6mm fell on 12/5/03 and 7.6 mm fell 12/6/03 and the sampling occurred 12/8 –12/9/03.