Elkhorn Slough (ELK) NERR Nutrient Metadata
April – December 2002
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 during this time. During the dry season (June through September) there is very little freshwater input, creating a much more saline environment. The surrounding area is mostly farmlands, which 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
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 four principal 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) of ambient water prior to collection of the sample. Samples were immediately placed on ice and kept in the dark until they were 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 as our grab sample collection, we deploy an ISCO water sampler from the bank of the marsh at South Marsh approximately 30 cm from the bottom. 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 and kept in the dark until they are 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 30 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 30 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 wreaking yards located approximately 2 km east of this site.

5) Coded variable definitions

AP = Azevedo Pond, NM = North Marsh, SM = South Marsh, VM = Vierra Mouth

Sampling Site Codes:
elkapnut = Ellkorn Reserve nutrient data for Azevedo Pond
elknmnut = Ellkorn Reserve nutrient data for North Marsh
elksmnut = Ellkorn Reserve nutrient data for South Marsh
elkvmnut = Ellkorn Reserve nutrient data for Vierra Mouth

Each individual sample is given a 3-part name code in addition to other codes. The 3-part name code, "elkapnut" for example, gives the reserve name (elk = Elkorn), station name (ap = Azevedo Pond, etc), and SWMP program code (nut = nutrient monitoring program).

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 1 hour 2 minute interval.

6) Data collection period

Diel Sampling

Site	Start Date	Start Time	End Date	End Time
SM	08/04/02	0236	08/05/02	0222
SM	09/03/02	0244	09/04/02	0230
SM	09/30/02	1430	10/01/02	1416
SM	11/04/02	0301	11/05/02	0247
SM	12/02/02	0142	12/03/02	0128

Grab Sampling

Site	Start Date	Start Time	End Date	End Time
AP	04/01/02	0530	04/01/02	0530
AP	04/30/02	0600	04/30/02	0600
AP	07/01/02	0815	07/01/02	0815
AP	08/05/02	1200	08/05/02	1200
AP	09/03/02	1135	09/03/02	1135
AP	10/01/02	1040	10/01/02	1040
AP	11/05/02	1445	11/05/02	1445
AP	12/03/02	1440	12/03/02	1440

Site	Start Date	Start Time	End Date	End Time
NM	04/01/02	0550	04/01/02	0550
NM	04/30/02	0625	04/30/02	0625
NM	07/01/02	0835	07/01/02	0835

NM	08/05/02	1225	08/05/02	1225
NM	09/03/02	1200	09/03/02	1200
NM	10/01/02	1105	10/01/02	1105
NM	11/05/02	1510	11/05/02	1510
NM	12/03/02	1500	12/03/02	1500

Site	Start Date	Start Time	End Date	End Time
SM	04/01/02	0630	04/01/02	0630
SM	04/30/02	0710	04/30/02	0710
SM	07/01/02	0915	07/01/02	0915
SM	08/05/02	1315	08/05/02	1315
SM	09/03/02	1250	09/03/02	1250
SM	10/01/02	1150	10/01/02	1150
SM	11/05/02	1600	11/05/02	1600
SM	12/03/02	1555	12/03/02	1555

Site	Start Date	Start Time	End Date	End Time
VM	04/01/02	0700	04/01/02	0700
VM	04/30/02	0745	04/30/02	0745
VM	07/01/02	1000	07/01/02	1000
VM	08/05/02	1410	08/05/02	1410
VM	09/03/02	1345	09/03/02	1345
VM	10/01/02	1250	10/01/02	1250
VM	11/05/02	1650	11/05/02	1650
VM	12/03/02	1400	12/03/02	1400

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 Welschmeyer 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 to the slough.

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 verifies 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
iii) Plant pigments:			
	Phaeophytin	PHEA	µg/L
	Chlorophyll a, Fluorometric	CHLA_N	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
Phosphorus species:	PO4F
Other:	CHLA_N, PHEA

b) Computed Variables

NO3:	NO23F-NO2F

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. Table 1 presents the current MDL's; these values are reviewed and revised periodically.

Table 1. Method Detection Limits (MDL) for measured water quality parameters.

2002	Jan	no data	no data	no data	no data	0.045
2002	Feb	no data	no data	no data	no data	0.045
2002	Mar	no data	no data	no data	no data	0.045
2002	Apr	0.0009	no data	no data	no data	0.045
2002	May	no data	no data	no data	no data	0.045
2002	Jun	no data	no data	no data	no data	0.045
2002	Jul	no data	no data	no data	no data	0.045
2002	Aug	0.0009	no data	no data	no data	0.045
2002	Sep	0.0005	0.0018	0.0005	no data	0.045
2002	Oct	0.0001	0.0011	0.0007	no data	0.045
2002	Nov	0.0001	0.0012	0.0007	no data	0.045
2002	Dec	0.0003	0.0013	0.0008	no data	0.045

13) Laboratory Methods

a) Parameter: NO23F, 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 NO23F (nitrate + nitrite) concentration minus the nitrite concentration. Thus NO3 is calculated by subtracting
NO23F - N02F.

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

b) 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 um filter and analyzed the same day.

c) Parameter: CHLA, PHEA

i) Method Reference. EPA method 445.0UNESCO (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 know volume of 90% acetone and then stored a -4oC until analysis 24 hrs later.

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

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 started in stages. Data are missing in the beginning of the year because we started with just a few stations and parameters then conducted increased analysis throughout the year. We were unable to analyze for ammonia at our lab until June 2003. We initially measured only nitrite from grab samples in April and only NO23 (nitrate + nitrite) and orthophosphate from grab samples in July. Thus there are no data from January, February, March, May, and June, only nitrite in April, and only NO23 and orthophosphate in July. Beginning August 4, upon receiving the ISCO sampler, all nutrients were measured from both grab and diel samples.

August – Nitrate data for 08/04 05:42 is missing due to contamination.
All data for 08/04 23:16 is missing due to a broken sampling bottle.

October – All diel sampling data from 10/01 10:08- 13:14 are missing due to battery failure.
Extra grab samples (one NM sample taken at 11:05 on 10/01 and two VM samples taken at 12:50 on 10/01) were taken to test membrane filter reproducibility and were found to be within the variability of each individual site. Chlorophyll and phaeophytin were not analyzed on these extra grab samples.
Diel sampling was accidentally started after the low tide. The low tide on Monday Sept 30 was at 11:29 and sampling started at 14:30.
Thus the sampling ended at 14:16 Oct 01 following the low tide at 12:48.

November – Nitrate data is missing from 11/04 22:39 through 11/05 00:43 due to contamination.

Over all the nitrite is 13.5 % of the total nitrate + nitrite so this was still analyzed.

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 nitrate and phosphate standards on a semi-regular basis, variability was found to be with in 2%.
   iii) Inter-organizational splits – None
b) Accuracy
   i) Sample Spikes – blanks
   ii) Standard Reference Material Analysis – Pending
   iii) 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.

		Historic	
Flag/code	***If also C***	**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
no need to flag/code unless combined		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		N	Negative calculated value
(CRE) or F_Record {CRE}		P	Significant precipitation (reserve defined, see metadata for further details)
<0> (CUS)		U	Lab analysis from unpreserved sample
<1> (CSM)		S	Data suspect, see metadata for further details