**Elkhorn Slough (ELK) NERR Water Quality Metadata**

**June 2015 to September 2015**

**Latest Update:** October 27, 2015

Note: This is a provisional metadata document; it has not been authenticated as of its download date. Contents of this document are subject to change throughout the QAQC process and it should not be considered a final record of data documentation until that process is complete. Contact the CDMO ([cdmosupport@belle.baruch.sc.edu](mailto:cdmosupport@belle.baruch.sc.edu)) or Reserve with any additional questions.

**I. Data Set and Research Descriptors**

**1) Principal investigator(s) and contact persons**

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**2) Entry verification**

Deployment data are uploaded from the YSI data logger to a Personal Computer (IBM compatible). Files are exported from EcoWatch in a comma-delimited format (.CDF) and uploaded to the CDMO where they undergo automated primary QAQC; automated depth/level corrections for changes in barometric pressure (cDepth or cLevel parameters); and become part of the CDMO’s online provisional database. All pre- and post-deployment data are removed from the file prior to upload. During primary QAQC, data are flagged if they are missing or out of sensor range. The edited file is then returned to the Reserve for secondary QAQC where it is opened in Microsoft Excel and processed using the CDMO’s NERRQAQC Excel macro. The macro inserts station codes, creates metadata worksheets for flagged data and summary statistics, and graphs the data for review. It allows the user to apply QAQC flags and codes to the data, remove any overlapping deployment data, append files, and export the resulting data file for upload to the CDMO. Upload after secondary QAQC results in ingestion into the database as provisional plus data, recalculation of cDepth or cLevel parameters, and finally tertiary QAQC by the CDMO and assimilation into the CDMO’s authoritative online database. Where deployment overlap occurs between files, the data produced by the newly calibrated sonde is generally accepted as being the most accurate. For more information on QAQC flags and codes, see Sections 11 and 12.

Persons responsible for sonde calibration and deployment were John Haskins, Rikke Jeppesen, Adam Chorazyczewski and Courtney Nawrocki. Persons responsible for data management and QA/QC were John Haskins and Rikke Jeppesen.

**3) Research objectives**

The goal of the research and monitoring of water quality at Elkhorn Slough NERR is to establish baselines for water quality parameters for Elkhorn Slough by using South Marsh as a control site while monitoring two impacted sites (Azevedo Pond and North Marsh) for possible problems. Additionally, in order to identify oceanic influence on the water quality parameters at Elkhorn Slough, we monitor a fourth site, Vierra Mouth (VM).Water quality measurements are recorded every 15 minutes over a four week period at the four sites in Elkhorn Slough. One site, South Marsh (SM), is in a relatively un-impacted side channel of the slough and the second site, Azevedo Pond (AP), is in a pond that receives fertilizer and pesticide run-off from an adjoining strawberry field. The third site, North Marsh (NM), was added in April 1999 and is located in an area where there is both agricultural and non-agricultural run-off. The fourth site, Vierra Mouth, is located at the mouth of the slough and is used to identify oceanic influence. This site was added March 14, 2001.

**4) Research methods**

The Elkhorn Slough water quality monitoring program began in July 1995. All four sites described above are monitored simultaneously. Prior to YSI deployment at SM, a 20-foot length of 4-inch diameter PVC pipe was placed in the slough to house the YSI. Holes were drilled in the pipe to remove 10% of the pipe's surface area and to allow water flow across the YSI. The pipe was positioned vertically in the slough with one end pushed into the soft bottom sediments and the other end secured to a permanent dock. A bolt inside and across the diameter of the pipe maintains the YSI about one foot (30cm) above the bottom. The setup is exactly the same at North Marsh except that the PVC pipe is secured to shore. Prior to YSI deployment at AP, a supportive framework of rope and PVC was placed at the site to house the YSI. The structure maintained the YSI exactly one foot (30cm) above the pond bottom. In 2012, a 40 ft board walk and a 5 ft black ABS pipe were installed to replace the original sonde support structure. A larger diameter ABS pipe slides up and down the 2-inch ABS pipe, which is protruding vertically from the substrate. Perpendicularly mounted on the sliding ABS is a 4-inch diameter white PVC pipe, 3-ft long, which functions as the housing for the YSI. The white PVC housing has been drilled with 1-inch diameter holes, in order to ensure water circulation at the YSI. At Vierra Mouth, the installed PVC pipe housing the YSI sonde is the same as at South Marsh. Every 15 minutes over a 30-day period, measurements of specific conductivity, salinity, dissolved oxygen, temperature, depth, turbidity, and pH are recorded. At South Marsh, additionally chlorophyll is recorded.

At the end of each approximate 28-day period, the YSI datalogger is brought back to the lab to download the data, and to clean and recalibrate the sonde. Data are downloaded onto a PC and then all data are transferred to a server at the reserve ([\\SBSERVER](file:///\\SBSERVER)). Sonde body and probes are cleaned. Calibration is performed as outlined in the YSI manual. Buffer solutions of pH 7 and pH 10 are purchased from a scientific supply store and used for two-point calibration of the pH probe. Since the beginning of July 1999 a conductivity standard of 53 mS/cm was used to calibrate the conductivity probe. The turbidity probe is calibrated using a two-point calibration with DI water (0 NTU) and 126 NTU standard. Deionized water is used to calibrate the chlorophyll probe on the sonde at SM. The DO probe was calibrated using a 2-point calibration. A mixture of 2 g sodium sulfite dissolved in 1 L tap water was left for 2 hours to equilibrate at 0% saturation. Tap water saturated with an airstone for at least 15 minutes prior to calibration was used for the 100% saturation. Before retrieving a sonde from a site a new sonde is calibrated in the lab before retrieving the currently deployed one, in order to replace the one in the field. This eliminates the loss of data due to cleaning and calibration. QA/QC was done according to the CDMO manual by John Haskins and/or Rikke Jeppesen using the macros provided by the CDMO. Data are then looked over more rigorously to identify and document anomalies and missing data. Additionally, John Haskins uses Matlab, in order to better identify anomalies in the monthly data, by overlaying the current month’s data onto all data at a site, since 1995. This method allows to more easily identify probe drift and malfunction, in addition to natural variation in the data. This method has only been used for all four sites since 2011.

A Sutron Sat-Link2 transmitter was installed at the South Marsh station on 09/28/2006 and transmits data to the NOAA GOES satellite, NESDIS ID #3B026768. 3B026768 is the GOES ID for that particular station. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen minute data sampling intervals. Upon receipt by the CDMO, the data undergoes the same automated primary QAQC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QAQC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at [http://cdmo.baruch.sc.edu](http://cdmo.baruch.sc.edu/).

A Sutron Sat-Link2 transmitter was installed at the Vierra Mouth station on 6/27/2012 and transmits data to the NOAA GOES satellite, NESDIS ID #3B04D428. 3B04D428 is the GOES ID for that particular station. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen minute data sampling intervals. Upon receipt by the CDMO, the data undergoes the same automated primary QAQC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QAQC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at [http://cdmo.baruch.sc.edu](http://cdmo.baruch.sc.edu/).

A Sutron Sat-Link2 transmitter was installed at the Azevedo Pond station on 04/22/2014 and transmits data to the NOAA GOES satellite, NESDIS ID #3B053520. 3B053520 is the GOES ID for that particular station. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen minute data sampling intervals. Upon receipt by the CDMO, the data undergoes the same automated primary QAQC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QAQC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at [http://cdmo.baruch.sc.edu](http://cdmo.baruch.sc.edu/).

**5) Site location and character**

Azevedo Pond (AP)(36°50’44.64”N, 121°45’13.24”W) is in a pond that receives fertilizer and pesticide run-off from a strawberry field in year-round production. The sample station is located about 10m from a tidal control structure in front of a culvert connecting the pond to the slough. In 2014, the tide ranged from 1.16 to 2.49 meters and salinity ranged from 16.9 ppt during heavy run-off to 44.8 ppt during strong evaporation. Depth at mean low tide is approximately 1.5 meters. The YSI sonde associated with this site (collecting readings for the water quality dataset) is located approximately 30 cm off the bottom, which is composed of silty mud.

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 run-off. In 2014, the tide ranged from approximately 0.62 to 1.22 meters. Salinity ranged between 17.7 and 40.7 ppt and is affected by freshwater run-off from agriculture and upland run-off. Depth at mean low tide is approximately 1 meter. The YSI sonde associated with this site (WQ dataset) 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) which is located approximately 3 km south of NM and is surrounded by mostly reserve land, is in a side channel of the slough and is relatively free from impact by anthropogenic influence. This site receives run-off mostly from uplands with some run-off coming from cattle ranches. This site receives the least amount of pollution. In 2014, the tidal range was from -0.34 to 2.32 meters and the salinity range was from 25.0 to 35.8 ppt. Depth at mean low tide is approximately 3 meters. The YSI sonde associated with this site (collecting readings for the water quality dataset) is approximately 30 cm off the bottom, which is composed of compacted silty mud.

The fourth site Vierra Mouth (VM) (36°48’39.95”N, 121°46’45.22”W) is located at the mouth of the slough and is used to identify oceanic influence. In 2014, the tidal range was from -0.32 to 2.30 meters and salinity ranged from 24.8 to 35.0 ppt. Depth at mean low water is approximately 4 meters. The YSI sonde associated with this site (collecting readings for the water quality dataset) 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 wrecking yards located approximately 2 km east of this site.

**6) Data collection period**

Sampling at Azevedo Pond and South Marsh began simultaneously at the end of June 1995 and data collection is ongoing. North Marsh began sampling on April 15, 1999. Vierra Mouth began sampling on March 14, 2001 at 13:00.

**Deployment recovery times and dates** TO BE INCLUDED IN THE ANNUAL FILE

**7) Distribution**

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data.  The NERRS retains the right to be fully credited for having collected and process the data.  Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used.  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.

Requested citation format:

National Estuarine Research Reserve System (NERRS). 2012.  System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: www.nerrsdata.org; *accessed* 12 October 2012.

NERR water quality data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see 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 [www.nerrsdata.org](http://www.nerrsdata.org).  Data are available in comma delimited format.

**8) Associated researchers and projects** (link to other products or programs) **–** Included in annual metadata document

**II. Physical Structure Descriptors**

**9) Sensor specifications –** Include the parameter description, units, sensor type, model #, range of measurement, accuracy and resolution for each sensor for all measuring devices (6600, 6600 EDS, 6600 EDS V2, 6600 V2, or EXO). ***Specify if all of your sondes are the same model and have the same configuration. If not, detail how many of each model you have, what different sensor configurations you use, and where the different models/configurations are deployed.*** See the following example, ***update for your sondes/sensors*** (do not include sondes/sensors that were not in use), and include the disclaimers below.

ELK NERR deployed mainly 6600 EDS data loggers in 2015. ROX DO sensors, and FR pH probes were deployed at all sites. At SM in 2015, ELK NERR deployed 6600EDS V2 data loggers.

**YSI 6600EDS data sonde**:

Parameter: Temperature

Units: Celsius (C)

Sensor Type: Thermistor

Model#: 6560

Range: -5 to 50 C

Accuracy: +/- 0.15

Resolution: 0.01 C

Parameter: Conductivity

Units: milli-Siemens per cm (mS/cm)

Sensor Type: 4-electrode cell with autoranging

Model#: 6560

Range: 0 to 100 mS/cm

Accuracy: +/- 0.5% of reading + 0.001 mS/cm

Resolution: 0.001 mS/cm to 0.1 mS/cm (range dependant)

Parameter: Salinity

Units: parts per thousand (ppt)

Sensor Type: Calculated from conductivity and temperature

Range: 0 to 70 ppt

Accuracy: +/- 1.0% of reading pr 0.1 ppt, whichever is greater

Resolution: 0.01 ppt

Parameter: Dissolved Oxygen % saturation

Sensor Type: Optical probe w/ mechanical cleaning

Model#: 6150 ROX

Range: 0 to 500% air saturation

Accuracy: 0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading

Resolution: 0.1% air saturation

Parameter: Dissolved Oxygen mg/L (Calculated from % air saturation, temperature, and salinity)

Units: milligrams/Liter (mg/L)

Sensor Type: Optical probe w/ mechanical cleaning

Model#: 6150 ROX

Range: 0 to 50 mg/L

Accuracy: 0-20 mg/L: +/-0.1 mg/l or 1% of the reading, whichever is greater

20 to 50 mg/L: +/- 15% of the reading

Resolution: 0.01 mg/L

Parameter: Non-vented Level - Shallow (Depth)

Units: feet or meters (ft or m)

Sensor Type: Stainless steel strain gauge

Range: 0 to 30 ft (9.1 m)

Accuracy: +/- 0.06 ft (0.018 m)

Resolution: 0.001 ft (0.001 m)

Parameter: pH – bulb probe or EDS flat glass probe

Units: pH units

Sensor Type: Glass combination electrode

Model#: 6589 FR

Range: 0 to 14 units

Accuracy: +/- 0.2 units

Resolution: 0.01 units

Parameter: Turbidity

Units: nephelometric turbidity units (NTU)

Sensor Type: Optical, 90 degree scatter, with mechanical cleaning

Model#: 6136

Range: 0 to 1000 NTU

Accuracy: +/- 2% of reading or 0.3 NTU (whichever is greater)

Resolution: 0.1 NTU

Parameter: Chlorophyll Fluorescence

Units: micrograms/Liter

Sensor Type: Optical probe w/ mechanical cleaning

Model#: 6025

Range: 0 to 400 ug/Liter

Accuracy: Dependent on methodology

Resolution: 0.1 ug/L chl a, 0.1% FS

Data disclaimers:

**Dissolved Oxygen Qualifier (Rapid Pulse / Clark type sensor):**

The reliability of dissolved oxygen (DO) data collected with the rapid pulse / Clark type sensor after 96 hours post-deployment for non-EDS (Extended Deployment System) data sondes may be problematic due to fouling which forms on the DO probe membrane during some deployments (Wenner et al. 2001). Some Reserves utilize the YSI 6600 EDS data sondes, which increase DO accuracy and longevity by reducing the environmental effects of fouling. Optical DO probes have further improved data reliability. The user is therefore advised to consult the metadata for sensor type information and to exercise caution when utilizing rapid pulse / Clark type sensor DO data beyond the initial 96-hour time period. Potential drift is not always problematic for some uses of the data, i.e. periodicity analysis. It should also be noted that the amount of fouling is very site specific and that not all data are affected. If there are concerns about fouling impacts on DO data beyond any information documented in the metadata and/or QAQC flags/codes, please contact the Research Coordinator at the specific NERR site regarding site and seasonal variation in fouling of the DO sensor.

**Depth Qualifier:**

The NERR System-Wide Monitoring Program utilizes YSI data sondes that can be equipped with either vented or non-vented depth/level sensors.  Readings for both vented and non-vented sensors are automatically compensated for water density change due to variations in temperature and salinity; but for all non-vented depth measurements, changes in atmospheric pressure between calibrations appear as changes in water depth.  The error is equal to approximately 1.02 cm for every 1 millibar change in atmospheric pressure, and is eliminated for vented sensors because they are vented to the atmosphere throughout the deployment time interval.

Beginning in 2006, NERR SWMP standard calibration protocol calls for all non-vented depth sensors to read 0 meters at a (local) barometric pressure of 1013.25 mb (760 mm/hg).  To achieve this, each site calibrates their depth sensor with a depth offset number, which is calculated using the actual atmospheric pressure at the time of calibration and the equation provided in the SWMP calibration sheet or digital calibration log.  This offset procedure standardizes each depth calibration for the entire NERR System.  If accurate atmospheric pressure data are available, non-vented sensor depth measurements at any NERR can be corrected.

In 2010, the CDMO began automatically correcting depth/level data for changes in barometric pressure as measured by the Reserve’s associated meteorological station during data ingestion. These corrected depth/level data are reported as cDepth and cLevel, and are assigned QAQC flags and codes based on QAQC protocols. Please see sections 11 and 12 for QAQC flag and code definitions.

**NOTE: older depth data cannot be corrected without verifying that the depth offset was in place and whether a vented or non-vented depth sensor was in use. No SWMP data prior to 2006 can be corrected using this method.** The following equation is used for corrected depth/level data provided by the CDMO beginning in 2010:

((1013-BP)\*0.0102)+Depth/Level = cDepth/cLevel.

**Salinity Units Qualifier:**

In 2013, EXO sondes were approved for SWMP use and began to be utilized by Reserves. While the 6600 series sondes report salinity in parts per thousand (ppt) units, the EXO sondes report practical salinity units (psu). These units are essentially the same and for SWMP purposes are understood to be equivalent, however psu is considered the more appropriate designation. Moving forward the NERR System will assign psu salinity units for all data regardless of sonde type.

**Turbidity Qualifier:**

In 2013, EXO sondes were approved for SWMP use and began to be utilized by Reserves. While the 6600 series sondes report turbidity in nephelometric turbidity units (NTU), the EXO sondes use formazin nephelometric units (FNU). These units are essentially the same but indicate a difference in sensor methodology, for SWMP purposes they will be considered equivalent. Moving forward, the NERR System will use FNU/NTU as the designated units for all turbidity data regardless of sonde type. If turbidity units and sensor methodology are of concern, please see the Sensor Specifications portion of the metadata.

**Chlorophyll Fluorescence Disclaimer:**

YSI chlorophyll sensors (6025 or 599102-01) are designed to serve as a proxy for chlorophyll concentrations in the field for monitoring applications and complement traditional lab extraction methods; therefore, there are accuracy limitations associated with the data that are detailed in the YSI manual including interference from other fluorescent species, differences in calibration method, and effects of cell structure, particle size, organism type, temperature, and light on sensor measurements.

**10) Coded variable definitions –** List the sampling station, sampling site code, and station code used in the data.

Sampling station: Sampling site code: Station code:

Azevedo Pond AP elkapwq

North Marsh NM elknmwq

South Marsh SM elksmwq

Vierra Mouth VM elkvmwq

**11) QAQC flag definitions**

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter’s associated flag column (header preceded by an F\_). During primary automated QAQC (performed by the CDMO), -5, -4, and -2 flags are applied automatically to indicate data that is missing and above or below sensor range. All remaining data are then flagged 0, passing initial QAQC checks. During secondary and tertiary QAQC 1, -3, and 5 flags may be used to note data as suspect, rejected due to QAQC, or corrected.

-5 Outside High Sensor Range

-4 Outside Low Sensor Range

-3 Data Rejected due to QAQC

-2 Missing Data

-1 Optional SWMP Supported Parameter

0 Data Passed Initial QAQC Checks

1 Suspect Data

2 *Open - reserved for later flag*

3 Calculated data: non-vented depth/level sensor correction for changes in barometric pressure

4 Historical Data: Pre-Auto QAQC

5 Corrected Data

**12) QAQC code definitions** – This section details the secondary QAQC Code definitions used in combination with the flags above. Include the following excerpt:

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the deployment or YSI datasonde, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point, but some comment codes (marked with an \* below) can be applied to the entire record in the F\_Record column.

General Errors

GIC No instrument deployed due to ice

GIM Instrument malfunction

GIT Instrument recording error; recovered telemetry data

GMC No instrument deployed due to maintenance/calibration

GNF Deployment tube clogged / no flow

GOW Out of water event

GPF Power failure / low battery

GQR Data rejected due to QA/QC checks

GSM See metadata

Corrected Depth/Level Data Codes

GCC Calculated with data that were corrected during QA/QC

GCM Calculated value could not be determined due to missing data

GCR Calculated value could not be determined due to rejected data

GCS Calculated value suspect due to questionable data

GCU Calculated value could not be determined due to unavailable data

Sensor Errors

SBO Blocked optic

SCF Conductivity sensor failure

SCS Chlorophyll spike

SDF Depth port frozen

SDG Suspect due to sensor diagnostics

SDO DO suspect

SDP DO membrane puncture

SIC Incorrect calibration / contaminated standard

SNV Negative value

SOW Sensor out of water

SPC Post calibration out of range

SQR Data rejected due to QAQC checks

SSD Sensor drift

SSM Sensor malfunction

SSR Sensor removed / not deployed

STF Catastrophic temperature sensor failure

STS Turbidity spike

SWM Wiper malfunction / loss

Comments

CAB\* Algal bloom

CAF Acceptable calibration/accuracy error of sensor

CAP Depth sensor in water, affected by atmospheric pressure

CBF Biofouling

CCU Cause unknown

CDA\* DO hypoxia (<3 mg/L)

CDB\* Disturbed bottom

CDF Data appear to fit conditions

CFK\* Fish kill

CIP \* Surface ice present at sample station

CLT\* Low tide

CMC\* In field maintenance/cleaning

CMD\* Mud in probe guard

CND New deployment begins

CRE\* Significant rain event

CSM\* See metadata

CTS Turbidity spike

CVT\* Possible vandalism/tampering

CWD\* Data collected at wrong depth

CWE\* Significant weather event

**13) Post deployment information** – Included in annual metadata document.

**14) Other remarks/notes –** Use this section for further documentation of the research data set. Include any additional notes regarding the data set in general, circumstances not covered by the flags and comment codes, or specific data that were coded with the CSM “See Metadata” comment code. You may include the metadata worksheets here if so desired. You may also include information on major storms or precipitation events that could have affected the data recorded at the sample sites. Include the following excerpt:

Data are missing due to equipment or associated specific probes not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. Any NANs in the dataset stand for “not a number” and are the result of low power, disconnected wires, or out of range readings. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

Additional metadata for elkapwq2015Q3:

No comments

Additional metadata for elknmwq2015Q3:

07/27/2015 10:00:00 to 08/23/2015 22:15:00

Depth on sonde was incorrectly calibrated. Therefore 1.192m was added to all depth readings upon retrieval.

Sonde ran out of battery because the battery compartment was flooded. Hence, data are missing from 08/23/2015 22:15:00 to 08/24/2015 10:30:00

Additional metadata for elksmwq2015Q3:

No comments

Additional metadata for elkvmwq2015Q3:

08/03/2015 10:15:00 to 08/31/2015 11:00:00

Depth on sonde was incorrectly calibrated. Therefore 2.227m was subtracted to all depth readings upon retrieval.