

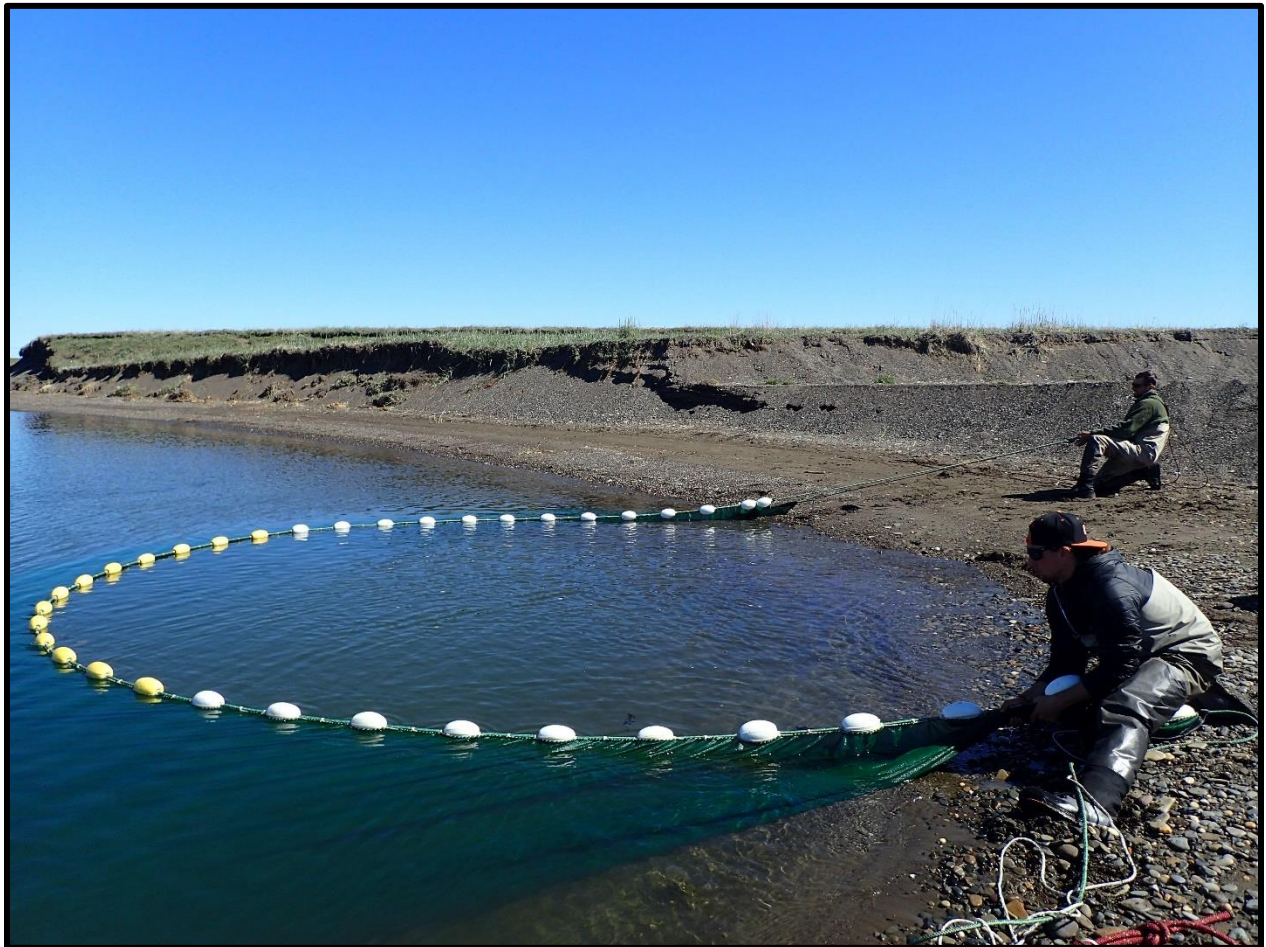


Coastal Lagoon Vital Signs Monitoring Protocol for the Arctic Network:

Standard Operating Procedures

Version 1.0

Natural Resource Report NPS/PWR/ARCM/NRR—2017/XXX



ON THE COVER

Field crew using a beach seine

Photograph by the Wilderness Conservation Society

Coastal Lagoon Vital Signs Monitoring Protocol for the Arctic Network: Standard Operating Procedures

Version 1.0

Natural Resource Report NPS/PWR/ARCN/NRTR—2017/XXX

Tahzay Jones and Sarah Apsens
National Park Service
240 W 5th Ave.
Anchorage, AK 99501

November 2017
U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Views, statements, findings, conclusions, recommendations, and data in this report are those of the author(s) and do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

This report is available from the Arctic Network I&M Program website (<https://science.nature.nps.gov/im/units/arcn/>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/NRPM>).

Please cite this publication as:

Jones Tahzay and Sarah Apsens. 2017. Coastal Lagoon Vital Signs Monitoring Protocol for the Arctic Network: Standard Operating Procedures. Natural Resource Report NPS/ARCN/XXXX – XXXX/XXX. National Park Service, Fort Collins, Colorado.

Revision Log

Changes in this document will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Contents

Revision Log	v
Contents	vi
Executive Summary	vii
SOP 1: Before the Field Season.....	8
SOP 2: Training Observers.....	22
SOP 3: Safety.....	28
SOP 4: Using GARMIN® Global Positioning System (GPS) Units.....	39
SOP 6: Water Quality Sampling	49
SOP 7: Operating the EXO2 Sonde Multiparameter Probe.....	57
SOP 8: Fish Collection and Sampling	62
SOP 9: Operating HOBO Level Loggers	77
SOP 10: Hydrosurveyor Operation.....	80
SOP 11: Field Form Handling Procedures	85
SOP 12: After the Field Season.....	88
SOP 13: Quality Assurance Project Plan.....	91
SOP 14: Handling Photographic Images	96
SOP 15: Data Entry, Verification and Certification	101
SOP 16: Data Analysis and Reporting.....	109
SOP 17: Standard Directory Structure for Data Deliverables	116
SOP 18: Metadata Development	122
SOP 19: Vital Sign Products Management in the IRMA Data Store.....	124
SOP 20: Revising the Protocol.....	131
SOP 21: Additional Research Ideas	134

Executive Summary

Within the report narrative of the Coastal Lagoon Vital Signs Monitoring Protocol for the Arctic Network, the authors explain the rationale for monitoring and the specific objectives to be met by the monitoring program. The standard operating procedures (SOPs) in this document include specific instructions for conducting monitoring tasks.

SOP 1: Before the Field Season

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Tables

Table S1.1. Recommended reference manuals.	14
---	----

Appendixes

Appendix SOP 1. A. Master Gear List.....	16
--	----

Purpose

Prior to the field season each year, usually beginning in early spring, observers are required to review the entire Marine Fish Protocol, including all SOPs listed in the protocol. This SOP outlines the annual steps to prepare for a field season ensuring the availability of proper equipment prior to the start of monitoring. More detailed descriptions of specific monitoring tasks are given in the SOPs for training observers (SOP 2), outlining safety procedures (SOP 3), using the GPS (SOP 4), conducting field work (SOP 5), water quality sampling (SOP 6), sonde probe operation (SOP 6), collecting fish (SOP 7), and operating the hydrosurveyor (SOP 8).

A master equipment list for the entire Coastal Lagoon Monitoring Protocol can be found in Appendix SOP 1.A of this SOP. The master equipment list should be updated simultaneously if any SOP associated with or containing gear lists is revised.

General Preparation and Review

Prepare Field Data Sheets and Notebooks

Field data sheets and notebooks from previous field sampling years need to be reviewed to identify unique events that may be encountered in the current/upcoming field season. A field notebook for the current survey year should be prepared with columns indicating sampling schedule, observer names, field hours, and unique occurrences. These fields may influence how field data is interpreted and reported. End of year reports are based on information recorded in data sheets and notebooks; therefore it is imperative these are clearly organized for ease of field note entry. Recommend that each member of the sampling crew carry a field notebook.

Compile Species Lists

A list of fish species from previous surveys in CAKR and or BELA, or local area should be compiled from the existing database and reference manuals to identify fish that have a probability of being encountered. Generate such a list by executing

```
SELECT CommonName, Family, Genus, Species  
FROM FishSpeciesList  
ORDER BY CommonName, Family, Genus, Species
```

Field guides should be made available in the field (see recommended reference materials in Table S1.1). For larger reference materials (e.g., Fishes of Alaska) copies of pages of previously encountered or likely to encounter species can be compiled and carried into the field in a three-ring binder or similar.

A list of invertebrates encountered in past sampling events should also be created and maintained. Though invertebrates are not currently sampled for, they may be encountered in fish sampling gear and can be noted in field notebooks. The World Register of Marine Species (www.marinespecies.org) is a good resources for marine invertebrate species names and distributions.

Load Waypoints

Waypoints for each sample site (random and fixed) in each lagoon must be loaded onto the Global Positioning System (GPS) unit prior to the start of the field season. Waypoints are the coordinates (latitude and longitude) for each sampling site point and are used to navigate to sampling locations. SOP 5 (Conducting Field Work) contains instructions for generating transect locations in latitude and longitude for each of the ARCN parks with their associated Universal Transverse Mercator (UTM) grid coordinates and SOP 4: Using GARMIN GPS Units contains instructions on loading transect locations into the GPS unit.

Review Equipment List

The equipment list should be reviewed prior to the field season by the PI and field personnel. Field notes from past field seasons will be reviewed for recommended additions or modifications to the equipment list. The PI and field crew will discuss additions and/or modifications and log changes to the equipment list.

All equipment will be inspected by the Fish Biologist and Technician(s). Equipment needing replacement or repair will be identified. Batteries will be replaced for all electronic equipment. The sonde probe will require pre-field season calibration (see SOP 7: Sonde Probe Calibration and Operation).

Scheduling Field Work

Sampling Dates

Sampling dates should be scheduled and logistics organized well before the start of each field season. The Coastal Lagoon Monitoring Vital Sign monitoring is conducted in ice-free summer months. It is preferable to sample at approximately the same time each year (± 1 month) and as early in time as possible at a given park. Inclement weather, rough sea conditions, or personnel workloads may preclude the scheduling of sampling events to specific annual dates.

Crew

Monitoring efforts within each ARCN park require a two to four person crew. Ideally, two people are needed to sample and one to serve as a boat operator, to keep lookout for bears, and assist with data entry and field notes. Having more than 4 crew members is possible, but will require more food, flights, and resources. All crew members must undertake the required safety trainings before participating in field operations (see SOP 3).

Timing

Time to complete all required sampling (fish and water quality sampling, at all fixed and random sites) varies among lagoons. For example, lagoons in BELA are much larger and challenging to navigate than those in CARK, and therefore will take more time to complete. Weather can impact the time required to complete sampling by delaying access to sample sites or operation of gear.

Recommend at least 3 days of scheduled sampling per lagoon for the smaller CAKR lagoons, and up to 5 days of sampling may be required for the larger BELA lagoons. Plan on up to two “weather days” for each lagoon if possible. Weather in the western Arctic is highly variable. The PI, Fish Biologist, and Flight Manager should monitor the forecast prior and during the field season and work with NPS or contractor flight managers to stay up to date about any major weather changes.

With weather days included, a full sampling period may be up to 15 days for CAKR and an additional 10 days for the BELA lagoons.

Organizing Supplies and Equipment

Review Equipment Lists

Before the field season, the Fish Biologist ensures that all equipment and supplies listed in the tables of Appendix SOP 1.A of this SOP have been compiled, organized, and made ready for the field season at least two months in advance. Advance preparation allows time to make needed repairs and order replacement equipment.

Note that while some equipment may be available for purchase in Kotzebue or Nome, it is generally cheaper to purchase items in Fairbanks or Anchorage and have the items shipped to the staging site. Recommend checking shipping cost and time tables before the field season to see if this is a viable option.

Field Data Forms

Data sheets for both fish sampling and water quality sampling are provided (SOP 6 for water quality sampling and SOP 8 for fish collection. Both datasheets are also available in Appendix E). In addition, a master project checklist is available in Appendix SOP 1.B. This checklist should be used to keep track of sampling and monitor progress throughout the field season.

During field work all data sheets should be kept in a clipboard or other safe place when not in use. Once back at basecamp (ranger station or field camp), transfer datasheets to a file folder, making sure to note date of data collection. If possible, enter data into an Excel file as soon as possible. Copies of the field data forms must be made on waterproof paper with waterproof photocopies or printer ink (e.g., Xerox laser/copier; never-tear paper or rite-in-rain®).

After the field season, ensure all data is entered and checked for quality assurance. All data sheets will be scanned and original hard copies will be archived in the lagoons monitoring shared network drive (O:\Monitoring\Vital Signs\Lagoon Communities and Ecosystems) and Data Store (<https://irma.nps.gov/DataStore/Reference/Profile/2308431>). See SOP 11 for more information on handling of data sheets and SOP 12 for handling of field data sheets after the field season.

Reference Manuals

Suggested reference manuals to facilitate identification of organisms encountered in fish surveys for each park should be available to pertinent staff (Table S1.1). Copies of species keys from suggested references can be copied and placed in a folder for use in field.

Table S1.1. Recommended reference manuals.

Author	Title
Johnson et al. 2015	A Handy Field Guide to the Nearshore Marine Fishes of Alaska
Mecklenburg et al. 2002	Fishes of Alaska
Thorsteinson and Love 2016	Alaska Arctic Marine Fish Ecology Catalog
Byersdorfer and Watson 2010	Field Guide to Common Marine Fishes and Invertebrates of Alaska

Camera Gear

Camera gear will occasionally be used to aid identification of fishes observed and supplement field notes. This method of fish identification is highly valuable especially for people with less identification experience; however, this method should only be utilized if it will not disrupt the further collection of data.

See SOP 14 for more information on handling of any photographic images collected in the field.

Boat and Motor

An inflatable boat and 9.9 hp short shaft propeller (or similar) outboard motor should be serviced and independently verified for each park for field operation. Ensure that this required preparation has been done in accordance with the Department of Interior (DOI) Motorboat Operator Manual. Marine Fish Protocol SOP: 12 (After the Field Season) also outlines the required post-field season maintenance for each.

Spare boat and engine parts (i.e., extra pull cord, fuel lines, spark plugs, boat patch kit) should put together before field season and kept in the boat or in camp. Other items to be kept in the boat include: marine safety kit (marine flares, whistle, other signaling device, etc...), spare paddle, first aid kit, and emergency camping supplies (for any outing where walking back to camp is not feasible or unsafe).

Fishing Nets

Fishing nets (beach seines, fyke nets, experimental gill nets) need to be checked for structural integrity before and after the field season. Nets may have been exposed to moisture, solvents, or corrosive materials during storage or chewed on by rodents. During equipment evaluation (April – May), nets should be laid out and inspected for holes or weak points. All holes and weak points need to be repaired. In general, if a hole is less than six inches across, then it can be stitched together using a needle and twine. If a hole is larger than six inches, or there are a series of holes in close proximity to one another, then the net manufacturer should be contacted for recommendations or a replacement net.

During field season, a net mending kit should be included in field gear (see Appendix SOP 1.A). A replacement net should be kept in Kotzebue, or another location where it can easily be transferred to the field site if necessary.

Post field season, all debris (twigs, algae, fish scales) will be removed from nets, nets will be rinsed with fresh water, and hung to dry in a warehouse or other large open space for a min of 24 hours. During this time nets can be inspected for holes, and repairs made. After drying, nets will be placed in totes, labeled, and stored for the next field season.

YSI Sonde Multiparameter Probe

The YSI Sonde multiparameter probe must be calibrated prior to sampling in the field. Details on how to calibrate the Sonde probe can be found in SOP 7 (Sonde Probe Calibration and Operation). The Water Quality Technician will be responsible for calibrating the probe, and for operating and maintaining the probe in the field.

Water quality samples

Also prior to field season, water quality sampling bottles will need to be ordered. Bottles need to meet the criteria required for the type of sampling being done (e.g., blue green algae, nutrients, carbon, contaminants). The receiving lab needs to be contacted and a shipping and sample handling plan developed. These task will be the responsibility of the Water Quality Technician, with support from the Fish Biologist and PI.

An equipment repair kit should be created that includes: net mending materials (needle, thread, monofilament line, handheld lighter, scissors), copies of pertinent manuals or SOP's, extra batteries, and duct tape.

References

- Byersdorfer S.C., L.J. Watson. 2010. Field guide to common marine fishes and invertebrates of Alaska. University of Alaska Press, Anchorage, AK.
- Johnson, S.W., A.D. Neff, and M.R. Lindeberg. 2015. A handy field guide to the nearshore marine fishes of Alaska. U.S. Department of Commerce, NOAA Technical Memorandum. NMFSC-AFSC-293, 211p.
- Mecklenburg, C.W., T.A. Mecklenburg, L.K. Thorsteinson. 2002. Fishes of Alaska. American Fisheries Society, Bethesda, MD.
- Thorsteinson, L.K., M.S. Love. 2016. Alaska Arctic marine fish ecology catalog. U.S. Geological Survey Scientific Investigations Report 2016-5038 (OCS Study, BOEM 2016-048), 768p.

Appendix SOP 1. A. Master Gear List

Item Name	Description
General Safety Equipment	
Emergency locator beacon (1+)	Register to each user according to device instructions before field operations.
Satellite phone (1+)	Ensure operational and available
Water	Ensure the proper quantities are available
Water Filter	Ensure this equipment is available and operable
First Aid Kit	Keep stocked. Ensure that it contains materials for delayed response from first responders
Sunscreen	Ensure proper quantities are available
Insect Repellent	Ensure available
Bug Armor (Hats, shirts)	Ensure available
Sunglasses	Ensure available
Headlamp	Ensure available. Check batteries annually, or sooner, depending on use
Headlamp Batteries	Ensure available
Rain Gear, Float Coats, Appropriate Clothing	Ensure available
Tent, Sleeping Bag	Ensure available
Emergency Shelter/Blanket	Ensure available
Emergency Signal Device (Mirror, strobe, whistle)	Ensure available. Check batteries annually for strobe
Extra Food	Carry extra food to feed crew for three additional days
Firearm and/or Bear Deterrent	Ensure available
Water Quality	
YSI EXO2 multiparameter water quality sonde	Ensure proper functioning and battery power, calibrate probes, lubricate probe O-ring each trip, update firmware quarterly, change probe sponges when needed.
YSI probe guard (1-2)	Ensure that this equipment is available
C-size batteries (8-12)	Ensure that this equipment is available
YSI EXO2 probe display system (1)	Ensure proper functioning and battery power
Connecting cable for YSI display and probe (1)	Ensure that this equipment is available and functioning properly
Hex wrench(s) for YSI probe	Ensure that this equipment is available
Extra YSI probe sponges (3)	Ensure that this equipment is available
Microfiber towel	Ensure that this equipment is available

Item Name	Description
Spare YSI port plugs	Ensure that this equipment is available
O-ring lubricant	Ensure that this equipment is available
Phillips-head screwdriver for YSI battery compartment (1-2)	Ensure that this equipment is available
YIS calibration chemicals	Ensure that this equipment is available
Wiring, rope, or similar for securing sonde for continuous deployment	Ensure that this equipment is available
HOBO level loggers (2-4+, ask PI)	Ensure proper functioning and battery power
Level logger housing “shuttle” (2-4+, ask PI)	Ensure that this equipment is available
Wiring, rope, or similar for securing HOBO level loggers for continuous deployment (many)	Ensure that this equipment is available
BASE-U-4 base station with the required coupler (1-2)	Ensure proper functioning and equipment is available
HOBOWare Pro software (1)	Ensure that this equipment is available
Sterile Nalgene water collection bottles (90)	Ensure that this equipment is available
Insulated shipping boxes for water quality samples (5)	Ensure that this equipment is available and functioning properly
Water Quality data sheet	Ensure available; Print on water resistant paper; Bring extra copies in the field
Fish Sampling	
Beach seine	Ensure in working order
Fyke net	Ensure in working order and all pieces are present
Rebar	Ensure this equipment is available
Mallet for rebar	Ensure this equipment is available
Ties, rope for securing fyke net to rebar	Ensure this equipment is available
Gill net	Ensure this equipment is available
Net repair kit	Ensure this equipment is available
Fish measuring boards	Ensure this equipment is available
Fish ID keys	Ensure this equipment is available
Digital camera	Ensure this equipment is available and batteries are charged
5 gallon buckets for holding fish	Ensure this equipment is available
Extra lead weights for gill net (8)	Ensure this equipment is available
Extra buoys (5)	Ensure this equipment is available
General Supplies	
Clipboard for data sheets (1)	Ensure this equipment is available

Item Name	Description
Pencils (30)	Ensure available. Use mechanical pencils or bring a pencil sharpener
Global Positioning System (1)	Ensure equipment is available and set-up appropriately (see SOP 4)
AA batteries (20)	Ensure available and charged if rechargeable
Compass (2)	Ensure available. Store in field binder
Map of fixed and random sampling sites (3 copies)	Update prior to each trip with GIS specialist. Print in color on waterproof paper. Label sites. Store in field binder
Fixed sampling site descriptions (with photo and compass heading)	Print to waterproof paper and store in field binder. Update if necessary prior to subsequent field sampling
Plastic 3-ring binder	Ensure available
Field datasheets (50-75 depending on site)	Print to waterproof paper, store in field binder
Park permits (2 copies/park)	Ensure current. Print to waterproof paper and store in field binder
Pens (15)	Ensure that the proper quantities are available
Ultra-fine tip black Sharpie (10)	Ensure that the proper quantities are available
Black permanent marker (10)	Ensure that the proper quantities are available
Field notebook/log (2)	Make sure there is available room in notebook for field sampling and spare one in case the logbook ends. Store main copy in field binder.
Boat Equipment	
Marine safety kit (1)	To include marine flares, whistle, signaling device. Ensure available.
Boat repair kit (1)	To include spare engine parts, patch kit.
First aid kit (1)	This is in addition to the general project first aid kit (see General Safety Equipment).
USCG approved life vest (at least 1 for each crew member)	Ensure one is available for all members of the party and that they are worn at all times while in or around water and watercraft.
USCG approved float coats (at least 1 for each crew member)	Ensure available and in good working order. These are ideal for cold/windy days in the field.
Extra paddle (1)	To be used in case of engine failure. Ensure available.
Anchor and line (1)	Ensure available.
Foot or hand pump (2)	Ensure available.
Fuel tank (1)	Ensure available.

Item Name	Description
Fuel line (1)	Ensure in correct working order. Ensure correct connecting piece for motor.
15+ gallon fuel tank (or multiple 5 gallon jugs) and spill reservoir (1)	Ensure available.

Appendix SOP 1. B. Project Checklist

Example project checklist for the Coastal Lagoons Vital Signs Monitoring. Use this checklist to keep track of sampling efforts throughout the field season.

Coastal Lagoon Vital Sign Monitoring Checklist																						
Sample Year:																						
Sample Site		Cape Krusenstern																				
		Kotlik							Krusenstern							Akulaaq						
Sample	Site	TE	IF	ME	OF	R1	R2	R3	TE	IF	ME	OF	R1	R2	R3	TE	IF	ME	OF	R1	R2	R3
Fish	Beach Seine																					
	Date																					
	Number																					
	Fyke Net																					
	Date																					
	Number																					
Water Quality	Gill Net																					
	Date																					
	Number																					
Other	Point Measure																					
	Date																					
	Water Grab																					
	Date																					
Other	Phytoplankton																					
	Date																					
	Bathymetry																					
Date																						

Coastal Lagoon Vital Sign Monitoring Checklist																	Site Key:			
Sample Year:																	TE	Terrestrial Edge	R1	Random 1
Sample Site		Bering Land Bridge															IF	Inflow	R2	Random 2
		Kupik "Cowpack"							Ikpek								ME	Marine Edge	R3	Random 3
		TE	IF	ME	OF	R1	R2	R3	TE	IF	ME	OF	R1	R2	R3	OF	Outflow			
Fish	Beach Seine																	NOTES:		
	Date																			
	Number																			
	Fyke Net																			
	Date																			
	Number																			
Water Quality	Gill Net																			
	Date																			
	Number																			
	Point Measure																			
Other	Date																			
	Water Grab																			
	Date																			
	Phytoplankton																			
Other	Date																			
	Bathymetry																			
	Date																			

SOP 2. Training Observers

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Tables

Table S2.1. Required reference materials for NPS motorboat operator.	24
Table S2.2. Aviation safety classes required for all field personnel.....	25
Table S2.3. Survey gear reference materials.	26

Purpose

This SOP outlines the requirements and training procedures that field staff and office analysts should follow. All field personnel should learn how to operate survey gear such as Global Positioning System (GPS) Units, YSI EXO2 sonde multiparameter probe, digital cameras, and fishing nets in addition to any required certifications for field activities such as aviation and motorboat operations. Office personnel need to know (1) data management principles, infrastructure, and practices associated with this Vital Sign, (2) SOPs associated with field data collection practices, (3) sound statistical background for analyses (4) analysis and reporting principles outlined in the SOPs associated with this protocol.

A master equipment list for the entire Coastal Lagoons Vital Signs Monitoring Protocol can be found in Appendix 1A of SOP 1 (Before the Field Season). The master equipment list should be updated simultaneously if any SOP requiring an equipment list is revised.

Field Personnel

Field personnel must be familiar with all chapters and SOPs associated with field data collection and methods. All field personnel will participate in training on the use, care, and maintenance of the water quality instrumentation and fish collection materials. The PI is responsible for ensuring adequate training is received by all field personnel for the tasks they are assigned to do as part of this monitoring effort. The project lead will spend at least one sampling event each year with all field personnel to ensure compliance with processes and procedures outlined in the Coastal Lagoon protocol.

NPS Motorboat Operator Certification

All employees slated to operate motorboats must pass the NPS motorboat operator course prior to conducting field operations. Exceptions may be granted for personnel operating a boat under the supervision of an NPS motorboat operator instructor. All motorboat operators must be familiar with reference materials required of an NPS motorboat operator (Table SOP 2.1).

Table S2.1. Required reference materials for NPS motorboat operator.

Reference	Location
DOI Motorboat Operation Certification Course (MOCC) Manual (DOI DM 485, Chapter 22)	http://elips.doi.gov/ELIPS/DocView.aspx?id=1624
Chapmans' Piloting Guide: Maloney, E.S. and C.F. Chapman. 2013. Chapman Piloting: Seamanship & Small Boat Handling (67 nd ed.). Hearst. 920 pp.	Available in print form only

NPS Aviation Safety Certification

All employees slated to use fixed wing aircraft for field access must pass the NPS A100 Basic Aviation Safety. A water egress course is highly recommended as well for all field personnel (A-

312). Required courses can be accessed at Interagency Aviation Training (www.IAT.gov). Required trainings are listed in Table S2.2.

Table S2.2. Aviation safety classes required for all field personnel.

Course Number	Course Name	Description
A-100	Basic Aviation Safety	Covers employee safety while working around helicopter and airplane operations. Topics include passenger responsibilities, ground safety, air safety, five steps to a safe flight, and flight following. Class length 5 hours.
A-110	Aviation Transportation of Hazardous Materials	Training complies with U.S. Department of Transportation Regulations 49 CFR 171.8 whereby agency employees who transport hazardous materials by air must receive training on the requirements and conditions of the exemption to 49 CFR 175.5 (a)(2). Topics include handling procedures, policy requirements, mishap notification, packaging, identifying hazardous materials, and safety requirements. Class length 2 hours.
A-116	General Awareness Security Training	This course is designed to provide students with an introduction to DOI and USFS departmental aviation security requirements. Class length 30 min.
A-200	Mishap Review	This course provides an annual overview of the National Transportation Safety Board releasable information from the DOI and USFS aviation mishaps. Class length 2 hours.
A-312	Water Ditching and Survival	Class teaches students the proper procedures to follow in the event of aircraft ditching. Gives the students skills to safely egress and reach the surface water. Module includes the use and familiarization of personal flotation devices. Life raft and water survival techniques are stressed. Course includes hands-on in-water exercises. Recommended for all individuals flying over water.

*Note that all courses must be completed once, and A-100, A-110, and A-200 must be completed again every three years.

SOPs Associated with Field Data Collection Practices

The Fish Biologist will ensure that all field personnel thoroughly and adequately understand the SOP's associated with the Coastal Lagoon monitoring protocol. Chapters and SOPs related to these practices and procedures include Chapter 3 (Field Methods), SOP 5 (Conducting Field Work), SOP 6 (Water Quality Sampling), SOP 7 (Sonde Probe Calibration and Operation), SOP

8 (Fish Collection and Sampling), SOP 9 (Operating HOB0 Level Loggers), SOP 10 (Hydrosurveyor Operation), and SOP 12 (After the Field Season).

Operating Survey Gear

The Fish Biologist is responsible for ensuring that all field personnel have adequate and proper training in calibration and use of all field equipment associated with this protocol.

- YSI EXO2 sonde multiparameter probe(s): Field personnel must be familiar with the operation of the multiparameter probe in the field. See SOP 7 (Sonde Probe Calibration and Operation).
- HOB0 Level Loggers: Field personnel must be familiar with the operation of the level loggers. See SOP 9: Operating HOB0 Level Loggers for information on how to set up and operate equipment.
- GPS: Field personnel will need to learn how to operate the GPS to navigate to various waypoints. See SOP 4: Using GARMIN GPS Units and practice using the unit before heading out into the field.
- Digital Camera(s): Field personnel will need to be familiar with operating digital cameras. See SOP 14: Handling Photographic Images before going into the field.

Reference materials related to operating survey gear can be found in Table SOP 2.2.

Table S2.3. Survey gear reference materials.

Reference	Location
Operator manual for YSI EXO2 sonde multiparameter probe	I&M Library: hard copy and digital
Operator manual for HOB0 Level Loggers	I&M Library: hard copy and digital
Operator manual for camera	I&M Library: hard copy and digital
Operator manual for GPS to be used in the field	I&M Library: hard copy

Computer Software

All field and office personnel should be familiar with using Microsoft Word, Microsoft Office, Microsoft Excel, and any additional statistical software that will be used as part of the Coastal Lagoons monitoring protocol.

The PI and Fish Biologist will ensure that all personnel using statistical software for analysis or data management are familiar with the applications and functions.

Office Personnel

All office personnel will need to be familiar with the ARCN monitoring plan (<https://irma.nps.gov/DataStore/Reference/Profile/661340>). All office personnel with this protocol will read and be familiar with all chapters and SOPs of the Coastal Lagoon Vital Signs Protocol (<https://irma.nps.gov/DataStore/Reference/Profile/2216893>).

All office personnel will be familiarized with the ARCN I&M Program infrastructure and practices. All office personnel will be required to read and be familiar with the ARCN data management principles and infrastructure, which can be found in Chapters 4 (Data Handling, Analysis and Reporting) and 6 (Operations Requirements) of the protocol narrative.

SOPs associated with data management include:

SOP 13: Quality Assurance Project Plan

SOP 14: Handling Photographic Images

SOP 15: Data Entry and Verification

SOP 16: Product Delivery

SOP 17: Metadata Development

SOP 18: Product Posting

SOP 19: Initial Preparation of Analysis Log Files

SOP 20: Data Analysis and Reporting

SOP 22: Data Certification.

All office personnel will be familiar with Microsoft Office, especially Word and Excel. Office personnel will also need to be familiar with any statistical software used as part of the monitoring program.

SOP 3. Safety

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Tables

Table S3.1. Safety reference materials.	30
--	----

Appendices

Appendix SOP 3.A. List of Basic Survival Equipment	36
Appendix SOP 3.B. Emergency Contact Form.....	37
Appendix SOP 3.C. Medical Information Form for Office Personnel	38

Purpose

This SOP explains the safety protocol for the Coastal Lagoons Vital Signs Monitoring Protocol and associated SOPs for the Arctic Network. This document outlines safety considerations for conducting any aspect of the protocol. All observers should be familiar with this SOP in order to identify and use the most current procedures and ensure optimum safety.

A master equipment list for the entire Coastal Lagoon Vital Signs Monitoring Protocol can be found in Appendix S1 of SOP 1 (Before the Field Season). The master equipment list should be updated simultaneously if any SOP requiring an equipment list is revised.

General Preparation and Review

Prior to conducting field work, observers are required to review this entire lagoon protocol, including all SOPs listed in this protocol. In particular, all participants should be thoroughly familiar with the NPS Occupational Safety and Health Policies, watercraft manuals, various environmental safety guidelines, and procedures outlined in SOP 2: “Training Technicians,” as well as the various equipment lists in SOP 1.

The USGS National Field Manual is another recommended reference (<https://water.usgs.gov/owq/FieldManual/Chap9/content.html>) Table S3.1. provides a partial list of reference materials and websites with information on specific safety topics.

Table S3.1. Safety reference materials.

Safety Topic	Guidance	Location
Safety polices, regulations, and requirements	NPS RM 50B Occupational Safety and Health Program	https://www.nps.gov/policy/RM50Bdoclist.htm
	DOI SafetyNet	https://safetynet.doi.gov/
	USGS National Field Manual Section 9.1 (water sample collection specific)	https://water.usgs.gov/owq/FieldManual/
	29 CFR, Part 1960, “Elements of Federal Employee Occupational Safety and Health Programs”, Subpart C	
	Departmental Manual (DM), Part 485, “Safety and Health Handbook”, Chapter 4	
Safety Training Guidelines	SMIS Training Materials	https://www.smis.doi.gov/

Safety Topic	Guidance	Location
	DOI Office of Occupational Health and Safety	https://www.doi.gov/pmb/osh/
	29 CFR, Part 1960, “Elements for Federal Employee Occupational Safety and Health Programs,” Subpart H	
	Departmental Manual (DM), Part 485, “Safety and Health Handbook,” Chapter 13.	
Boating Safety	NPS Reference Manual 50B, Section 9.0 Watercraft Safety	https://www.nps.gov/policy/RM50Bsection9.pdf
	DOI Motorboat Operator Certification Course (MOCC)	
Aviation	Interagency Aviation Training	https://www.iat.gov/
Inclement Weather	National Weather Service	http://forecast.weather.gov/MapClick.php?lat=66.8983&lon=-162.5967#.WR85BPnytaQ
	USGS National Field Manual Section 9.4	https://water.usgs.gov/owq/FieldManual/Chap9/content.html

Safety is “the condition of averting or not causing injury, danger, or loss” (Lane and Fay 1997). As a Federal employee, partner, or cooperator, you are required to know and follow safety policies and requirements documented in Reference Manual 50 B Occupational Safety and Health Program (<https://www.nps.gov/policy/RM50Bdoclist.htm>). For boat operators, Reference Manual 9 Watercraft Safety (<https://www.nps.gov/policy/RM50Bsection9.pdf>) should be followed accordingly. In addition, individual parks also have park specific safety procedures, and operational protocols. This SOP recommends that these and all other available reference materials be used to address the topics below.

Safety Policies, Regulations and Requirements

All individuals participating in activities related to this Vital Signs must adhere to applicable safety policies, regulations, and requirements outlined in RM 50 B Occupational Safety and Health Program. This includes both field and office activities and applies equally to NPS staff, cooperators, partners, volunteers, and others. The applicable policies, regulations, and requirements of each participating agency should be compiled and reviewed each year as part of this SOP. Ensure that all field personnel obtain First Aid, CPR training. Additional highly recommended trainings include: wilderness first aid, advanced wilderness first aid, wilderness

first responder, and emergency oxygen administration. These trainings are also highly recommended for office personnel. Supervisory staff should ensure that all field staff are well trained in the safety guidelines and policies outlined below.

Transportation

Accessing field sites in the western Arctic involves multiple forms of transportation. Flights on commercial aircrafts are used to bring crew and supplies to Kotzebue, or other regional transportation hubs. From these transportation hubs, smaller aircraft are used to access field camps. Flights on small fixed wing aircraft requires additional safety training (see SOP 1: Before the Field Season for a list of required flight safety training]. See section 9.3.3 of the USGS National Field Manual for more information.

Once at field camps, boats or all-terrain vehicles (ATVs) are required to access sampling sites. All individuals operating a boat will need to have completed the Department of the Interior (DOI) Motorboat Operator Certification Course (MOCC). All boat operations must follow the operational and safety guidelines detailed in the NPS Reference Manual 9 “Watercraft Safety” (<https://www.nps.gov/policy/RM50Bsection9.pdf>) in addition to park-specific guidelines. In some cases, approval to operate motorboats may be granted to individuals holding comparable or greater certifications, but this is at the discretion of the Park Safety Officer. All individuals operating an ATV must have completed a DOI approved ATV operation and safety course (see DOI Learn: ATV Full Certification Course). See Section 6 “Motor Vehicle Safety” (<https://www.nps.gov/policy/RM50Bsection6.pdf>) of the NPS Occupational Safety and Health Program Reference Manual 50B for more information.

Weather

Sampling during inclement weather is of particular concern in lagoon environments. In larger lagoons wind can create significant wave action that can flood a boat in minutes. Wind and spray off lagoons or the ocean can dampen and quickly chill individuals lacking adequate clothing. Weather in the western Arctic is highly variable. Prior to departure, it is the responsibility of all personnel to be aware of the appropriate local weather, tide, and current forecast of the day and to decide whether sampling should commence. Consult the USGS National Field Manual Section 9.4 for more weather related safety considerations. Also review Manual 9 “Watercraft Safety” for additional information regarding weather.

Fixed Wing Aircraft Operations

Mandatory safety training (See SOP 1: Before the Field Season) is required of all field personnel for this monitoring program. Small fixed wing aircraft are required to reach remote field sites and flying in Alaska has its own risk. Water egress, or dunker training, will be required if float planes are utilized. Each passenger of a DOI contracted or operated aircraft must strictly adhere to the DOI aviation training and aviation safety guidelines as well as the guidelines required by each park unit. Aircraft safety training can be obtained through the interagency aviation training website (<https://www.iat.gov>). Park specific aircraft use guidance can be obtained by contacting the safety office or superintendent at each park where operations may take place. All aircraft operations will be conducted at the discretion of the designated authority having final approval of

aircraft operations at each park. The Flight Manager should be contacted prior to the start of field activities for assistance with park specific requirements and/or safety issues.

Environmental Conditions

The western Arctic can be a harsh and unforgiving environment. Weather conditions can change abruptly. A few hours of sunshine can be quickly followed multiple days of rain and wind. Average temperatures range from 60°F to 50°F (high, low) in July, and 47°F to 38°F in September. July, August, and September are wet months, averaging 1.46 to 2.17 inches of precipitation. Rain and wind can chill persons with inadequate clothing. Large swarms of insects are common. Working in and around water (marine and fresh) increases likelihood of persons getting wet. It is very difficult to dry wet clothing and gear without a heat source in these conditions. Snow and ice are common in September. In addition, operating in and around boats, hauling fishing nets, and carrying heavy gear are all potentially hazardous activities if done incorrectly. All field personnel need to be aware of their surrounding environment, use common sense, and not exceeded their limits (e.g., lifting heavy objects; physical tolerance to exertion, heat, and cold). See the USGS National Field Manual Section 9.8 for more information on environmental hazards. Section 3 “Occupational Safety” (<https://www.nps.gov/policy/RM50Bsection3.pdf>) of the NPS Occupational Safety and Health Program Reference Manual 50B also has more information on occupational hazards.

Animal Hazards

A number of large mammal species occupy both parklands in which monitoring will take place. This includes brown bear, moose, muskox, caribou, and wolves. Through confrontations with bears are generally rare, all field personnel will complete bear safety and shotgun training (see DOI Learn Bear Safety and Firearms) before the field season. Field personnel who have completed this training are required to take an annual refresher class.

Preventive measures **must** be taken to prevent bear encounters. All food and scented items must be stored in bear proof containers when left unsupervised (metal barrels and food cabinets are usually available at the ranger station, but check with park staff before the field season). Backpacks containing snacks, lunches, scented items (e.g., sunscreen, hand lotion, insect repellent) must be kept within reach of personnel when in the field. Portable bear fences are highly recommended for use around tents and campsites. Cooking activities should be conducted at least 100 yards away from sleeping areas, or in the cook cabin at the ranger station. In addition, store utensils, cooking pans, and anything that has come in contact with food away from sleeping areas. Do not clean fish in camp. Keep track of food wrappers as these are easily forgotten at the bottom of backpacks. Never travel alone. Make noise in high brush, when approaching blind corners, and when traveling in low visibility. Select campsites that do not limit passage by bears, and avoid areas with signs of bear activity (e.g., scat). All personnel must complete a bear safety and shotgun class before the field season.

Moose and muskox are common in CAKR. Keep a safe distance, and never approach these animals. Muskox will occasionally travel through camp at the ranger station. Muskox can damage equipment and gear left out unsupervised. They have been known to topple bear fences and use sides of the ranger station as scratching post. Consider temporarily dismantling bear

fences and moving sensitive equipment to a protected location if you suspect muskox will travel through camp. Avoid unexpected encounters by traveling in groups and making noise when traveling down river corridors with steep banks, walking around blind corners, leaving your tent, and exiting the cook cabin/bunkhouse.

In addition to large mammal species, biting insects are a common nuisance in the western Arctic. All field personnel should carry their preferred method of insect deterrence (e.g., bug net hat, bug spray).

Lastly, small mammals like mice and voles can chew holes in gear and contaminate unsecured food. Please keep the ranger station clean to prevent vermin infestation. In general, do not feed wildlife. Keep wildlife wild and report any aggressive or unusual animal behaviors (e.g., foxes approaching people or bears hanging around camp) to park staff immediately.

Field Preparations and Emergency Contacts

Basic planning is required before each field sampling event. A large component of the planning effort involves gathering safety information and documenting all aspects of field sampling trip plans in advance. All field personnel should complete an Emergency Contact Form (Appendix SOP 3.A) and a Medical Information Form (Appendix SOP 3.B) prior to conducting field work. A trip plan must be completed. One copy should be left at the office, and additional copies should be given to the park safety officer and field personnel involved in the trip. Weather and marine forecasts should be obtained prior to departure. Upon completion of the field work it is imperative that personnel check in with the park safety officer at the specified time noted on the plan.

It is the responsibility of all personnel to ensure that the appropriate safety equipment is present and in working condition. Examples of safety equipment checklists are provided below (Appendix SOP 3.C). These lists should be customized according to the specific field conditions and the needs of personnel. Additional safety equipment may be required at some parks, and the Park Safety Officer and PDO must be consulted prior to commencing sampling activities. No sampling activities will be conducted without all necessary safety equipment present and in proper working condition.

Emergency Procedure

In the event of an emergency, the first action is ALWAYS to take care of the injured person and seek help. In remote western Alaska satellite phones or emergency beacon may be the only means of reaching outside help. All personnel must know how to operate satellite phones and emergency beacons before entering the field. At least two forms of communication (e.g., a satellite phone and emergency beacon) must be carried by a field team at all times. All crew members should have at minimum have basic first aid training.

Once help is on the way and the situation is under control, the team leader or crew member should contact, or have someone else contact, the supervisor to inform them of the incident. The person that sustained the injury, or (if necessary) another team member who was witness to the accident must fill out report forms as soon as feasibly possible. The forms are available online on The United States Department of the Interior Safety Management Information System (SMIS) at

<https://www.smis.doi.gov/>. This website contains online accident reports and other documentation to be filled out by the injured crew member, witnesses, and supervisor. These documents must be completed as soon as possible, no later than 24 hours from the time of the accident.

References

National Park Service (NPS). 2008. National Park Service occupational safety and health program, reference manual 50B. NPS, Fort Collins, Colorado. Online (<https://www.nps.gov/policy/RM50Bcover.pdf>) Accessed 14 April 2017.

U.S. Geological Survey (USGS). Various dates. National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations. Book 9, Chapters A1-A9. USGS, Reston, Virginia. Online (<https://water.usgs.gov/owq/FieldManual/Chap9/chap9.pdf>) Accessed 14 April 2017.

Appendix SOP 3.A. List of Basic Survival Equipment

Note that a master gear list is located in SOP 1 (Before the Field Season). If any changes are made with regard to equipment type, quantity, or required items, please update SOP 1 simultaneously.

Item Name	Description
General Safety Equipment	
Emergency locator beacon (1+)	Register to each user according to device instructions before field operations.
Satellite phone (1+)	Ensure operational and available
Water	Ensure the proper quantities are available
Water Filter	Ensure this equipment is available and operable
First Aid Kit	Keep stocked. Ensure that it contains materials for delayed response from first responders
Sunscreen	Ensure proper quantities are available
Insect Repellent	Ensure available
Bug Armor (Hats, shirts)	Ensure available
Sunglasses	Ensure available
Headlamp	Ensure available. Check batteries annually, or sooner, depending on use
Headlamp Batteries	Ensure available
Rain Gear, Float Coats, Appropriate Clothing	Ensure available
Tent, Sleeping Bag	Ensure available
Emergency Shelter/Blanket	Ensure available
Emergency Signal Device (Mirror, strobe, whistle)	Ensure available. Check batteries annually for strobe
Extra Food	Carry extra food to feed crew for three additional days
Firearm and/or Bear Deterrent	Ensure available

Appendix SOP 3.B. Emergency Contact Form

Modified from USGS National Field Manual, Chapter A9.

Emergency Contact Form		
Employee Name:		
Personal Contacts:		
Name:		
Phone:		
Name:		
Phone:		
ARCN Contacts:		
BELA		
CAKR		
Local Emergency Contacts		
Kotzebue Health Center		
Kotzebue Police (911)		
Fire		
Utility		
AK State Troopers		
Emergency Beacon Info:		
Type		
Number		
Other		

Appendix SOP 3.C. Medical Information Form for Office Personnel

Modified from USGS National Field Manual, Chapter A9.

Emergency Contact Form		
Employee Name:		
Home Phone:		
Personal Contacts:		
Name:		
Phone:		
Name:		
Phone:		
ARCN Contacts:		
BELA:		
CAKR:		
Emergency Contacts		
Preferred Doctor:		
Hospital:		
Emergency Beacon Info:		
Type:		
Number:		
Other		
Allergies:		

SOP 4: Using GARMIN® Global Positioning System (GPS) Units

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Table

Table S.4.1. Coordinate system and datum for ARCN.	42
---	----

Purpose

This Standard Operating Procedure explains how to use an autonomous, non-differential Garmin® (or similar unit) GPS receiver and GPS transfer software. This protocol may be used for any Garmin® GPS that can average a waypoint. The GPS transfer process uses DNRGPS Version 5.1.1. and GIS software.

A master equipment list for the entire Coastal Lagoon Monitoring Protocol can be found in Appendix S1.A of SOP: 1 Before the Field Season. The master equipment list should be updated simultaneously if any SOP requiring an equipment list is revised.

The GPS units are required to generate deliverable L01, GPS waypoints.

Garmin GPS Pre-Field Preparation

Step by step procedures:

- 1) Read and remain familiar with GPS user manual, hardware, and software. User manuals for the GPS model currently used for this protocol (Garmin® 76CSx) can be found at: <https://support.garmin.com/support/manuals/manuals.htm?partNo=010-00469-00&language=en&country=US> (accessed April 2017).
- 2) Load freshly charged batteries (2 AA batteries for each device) and have extra, charged sets available. Extra rechargeable batteries should be placed in a water tight “dry bag” or a re-sealable plastic bag and stored in a hard sided tote or an enclosed space.
- 3) Initialize and download a fresh almanac into a Garmin® if more than one week has passed since last use or if the GPS unit has moved more than a straight-line distance of 240 km. Downloading the almanac takes roughly 20 minutes in open areas - away from buildings, canopy, and obstructions.
- 4) Delete old waypoints and tracks from memory (but download beforehand and save data elsewhere if appropriate).
- 5) Turn off active tracklog. Set “Tracklog” to the preferred collection method (“Time” is recommended) and an appropriate logging rate for the data collection (“5 seconds” is recommended for most walking collection, but keep in mind the total storage capacity of the GPS).
- 6) Ensure Simulator Mode is *not* ON when collecting data.
- 7) If necessary, transfer data (e.g., background maps) to the GPS unit using DNR Garmin® software. See below for DNRGPS® instructions.
- 8) Set Time and Date on the GPS Unit.
- 9) Make sure that “Interface Protocol” is set to Garmin.
- 10) Make sure that WAAS is enabled.

Set the Coordinate System (UTM or LAT/LONG) and Datum to ensure compatibility with any written coordinates you may need to navigate to or map. Recommended settings for UTM are in Table S4.1.

Table S4.1. Coordinate system and datum for ARCN.

Area	Datum	Projection
Alaska	NAD83/Alaska Albers	UTM zone_4N

Set Heading to Magnetic or True. If set to True, ensure compass has same declination.

If needed, use Trimble Planning® Software to ensure best time of day for GPS data collection.

Prior to use in the field, ensure the GPS has been placed in a “dry bag” with a recently dried desiccant pack. The 76CSx units are waterproof, however take care to dry them after accidental submersion and store in a dry place.

GPS Transfer Software (DNRGPS)

Step by step procedures:

- Uninstall any previous versions of DNRGPS
- As of Spring 2017, download and install Version 5.4.0 to any computer that will receive GPS data from the Garmin®. DNRGPS can be downloaded from the State of Minnesota Department of Natural Resources <http://www.dnr.state.mn.us/mis/gis/DNRGPS/DNRGPS.html> (accessed April 2017).
- In DNRGPS, set projection to ensure compatibility with data stored in GIS.

Note: DNRGPS is compatible with Windows 10 and ArcGIS 10.x (see link above for additional compatibilities). However, MxGPS (<http://www.mxgps.com/register>) is now the preferred GPS software as it integrates the entire Garmin GPS fleet with ArcGIS. Note that MxGPS requires purchase for download. The remainder of this section provides instruction for using DNRGPS, however other GPS units may be utilized.

Field GPS Data Collection

Data collection is not anticipated to be a frequent task. Initially, actual data collection locations will need to be documented, relative to sample design specifications. Other data collection needs are not anticipated.

Step by step procedures:

- Hold GPS unit or antenna at or above your head. Use an external antenna if needed to free hands.
- Electronically store all data (waypoints). Manually write down a position coordinates for backup.
- You can navigate to a waypoint using the “Go To” to navigate and follow the given heading (i.e., North, East, South, or West). If you go off course, use the compass pointer. To access the compass pointer, press PAGE repeatedly until the compass page appears.

Note that a Garmin® will collect data no matter what the GPS positioning quality is, so you will need to monitor the GPS Satellite Page continuously for anomalies and accuracy. Collect only

when “3D GPS” or “3D Differential” is shown. Do not collect data in 2D unless absolutely necessary. 2D Differential should not be used either.

Collect waypoints in “Averaged Position” mode. To ensure greatest accuracy possibly, either (1) collect a minimum of 10 points per location, or (2) collect points for a minimum of 20 minutes at that site. Depth from the boat sounder can also be recorded if conducting benthic habitat surveys for mapping purposes. Otherwise, use dive computers to record depth when diving at a waypoint.

Office Downloads and Management

Step by step procedures:

- Connect GPS to PC with cable and place GPS in Simulator Mode
- Check that TrackLog is OFF! Again, do not save Track!
- Open DNRGPS from the desktop (for ArcGIS® users) or from within ArcView® by loading the extension.
- Check Projection in DNRGPS one more time. This will define the projection the GPS file will be stored in.
- Download waypoints and save to Shapefile (if in ArcGIS®) or if saving a shapefile from the desktop DNR Garmin®, save to projected shapefile. Use naming conventions as below. These waypoints files are now deliverable L-01

The file-naming convention is to indicate the deliverable identifier, ‘L-01’, GPSModel, type of data (waypoint), projection and datum, and date (YYYYMMDD) separated by an underscore (_). For example, a set of waypoints collected with a Garmin GPS76c, using UTM and WGS84 as the projection and datum, on Christmas Day 2005, would be named “L01_GPS76c_waypt_UTMWGS84_20051225”.

If additional notes about GPS collection exist, such as data collected in ‘2D’ mode; create a simple text file with an identical filename in the same location which contains this information, with a .txt filename extension.

- Delete all waypoints for the next mapping mission.
- Turn off the GPS and disconnect cables, returning equipment to its proper storage location.
- Recharge batteries if appropriate

Options to Consider

Improve Accuracy: An external beacon for Differential GPS will improve the accuracy of your GPS location. Averaging will improve your GPS locations, if and only if, the satellite geometry improves during point collection. Otherwise, averaging can sometimes result in a less accurate position.

SOP 5. Conducting Field Work

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This Standard Operating Procedure (SOP) document provides details on conducting field work for the Coastal Lagoon Monitoring Protocol. This SOP covers general pre-, during, and post-field work activities. These include equipment list, shipping equipment, general considerations, and post-season handling of equipment and samples.

Before Field Season

This section builds upon the pre-field season procedures outlined in SOP 1: Before the Field Season. The following are tasks that will need to be completed in the month(s) prior to personnel stepping foot at field sites. These pre-season field tasks include: selecting sampling sites, shipping gear to field base sites, acquiring field gear, servicing field gear, and training field personnel.

Selecting Sampling Points

The lagoon sampling protocol includes seven sample sites. There are four fixed (marine edge; terrestrial edge; inflow; and outflow), and three random sites.

Fixed sites will have established coordinates and waypoints will be uploaded to GPS devices before entering the field (see SOP 4: Using GARMIN GPS Units). Except in the case of adverse weather conditions, these sites should be accessible. If there are changes to the site that inhibit sampling (e.g., presence of an animal carcass, thick ice, subsistence activities) then note this in the data field form and attempt to sample at a later date in the season. If this will not be possible, find an adequate site in close, but safe, proximity to the original site and note the coordinates. Fish sampling (see SOP 8: Fish Collection and Sampling) and water quality (SOP 6: Water Quality Sampling) will be conducted at each fixed site.

Random sites will be selected within ArcMap using the criteria outlined below. Randomly selected alternative sample site locations will also be generate in case the first site is unsuitable for sampling. Water quality sampling with the sonde (no bottle collection) will be conducted at random sites.

Procedures for Generating Random Sampling Sites:

- 1) Open ArcMap
- 2) Open the Alaska Pack Theme Manager and select an appropriate basemap (recommend: ARCN Themes/Basemap/Satellite Imagery/ARCN Landsat Mosaic – Natural Colors. For CAKR, you can overlay an aerial photomosaic located at CAKR Themes/Basemap/CAKR Coastal OrthoPhoto Mosaic 2003).
- 3) Locate one of the five lagoons in which sampling will take place.
- 4) Generate three random sites, and three backup random sites, with X and Y coordinates. There are a few ways you could do this. The following outlines how to use the Create Random Points in the Sampling Toolset for ArcGIS 10:
 - a. Create a polygon or raster file within the shoreline of the lagoon.
 - b. Specify the Number of Points (in this case 6) within the constraining feature class (the polygon around the shoreline of the lagoon).
 - c. The resulting output should list the coordinates of the generated random points.

Gear Preparation and Logistics

Prior to shipping sampling equipment to field sites all equipment should be calibrated and undergo a final inspection. This includes water sampling equipment (sonde probe(s), collection bottles) and fishing equipment (nets, measuring boards, and scales). An equipment repair kit should be created that includes: net mending materials (needle, thread, monofilament line, handheld lighter, scissors), copies of pertinent manuals or SOPs, extra batteries, and duct tape. All sampling equipment and repair kit will be packed in hard sided totes and labeled with an identification number, and contact information for the PI and Fish Biologist. Labels need to be easily visible, and made waterproof by covering them with clear packing tape or placing labels in a clear plastic sheath before affixing to the outside of a tote.

Once securely packed and labeled, sampling equipment will be shipped to Kotzebue. Shipping companies used in the past include: The U.S. Postal Service, Goldstreak® Alaska Air Cargo, and Everts Air Cargo Priority Freight. With adequate pre-planning, gear can be shipped overnight, next-day, and cold samples (e.g., water quality samples, fish tissue) can be kept chilled or frozen during shipping. Staff at the NPS Kotzebue office will need to be informed of when samples will be arriving from the field, where they are being shipped, required shipping methods (ice packs, coolers), and what time frame is required for shipping.

General Procedures

The amount of time required to complete sampling of a lagoon is variable depending on lagoon size, weather, and distance between sampling sites. Lagoons in CAKR are generally smaller than those in BELA. Depending on the location of sampling sites within a lagoon, time between sampling sites can differ from 10 to 45 min boat transit time. On average, sampling one lagoon in CAKR may take 2-3 days, and 3-4 days in BELA.

Gear and personnel will have to be moved between each lagoon (fixed wing float or tundra wheeled plane, ATV, or boat). Adequate transit time must be factored into the field sampling schedule. The transit from Kotzebue to Kruzenstern lagoon is ~24 min one way, meanwhile accessing the Cowpack and Ikpek lagoons in BELA requires up to 1 hour 40 min flight time one-way from Kotzebue. Multiple trips (usually 4 one-way flights) are required to move crew and gear between lagoon sampling sites (see Table 3.2 in Chapter 3 Field Methods).

Weather can impact the ability of the field crew to effectively sample. The large area of BELAs lagoons provides adequate fetch for large (3-4ft) waves to form. Sampling in this weather is discouraged, as it could result in swamping the boat and putting field crew at risk. The lagoon sampling plan should allow for 1-2 weather days.

Equipment

For a complete list of equipment needed to carry out this procedure, refer to the master gear list in SOP 1: Before the Field Season. Field personnel will ensure all necessary gear is available before arriving in the field and before conducting sampling.

Aircraft is required to move camping gear and sampling gear between field sites. See Chapter 3: Field Methods for estimated flight times between field camps. Transit time must be considered when developing the field schedule. Gear must be packed into aircraft and not exceed the

maximum carrying capacity of said aircraft. Additionally, room for field crew must be accounted for when packing gear into aircraft. No member of the field crew should ever be left alone in the field unless a hard sided structure is present.

Once at a field camp gear may require transportation by aircraft, boat, ATV, or by carrying depending on site location.

Locate Sampling Site

Waypoints for all sampling sites (fixed and random) will have been previously uploaded onto handheld GPS devices (see SOP 1 and SOP 4). GPS devices can be used to then locate sampling sites. When approaching a random site assess the area for safety. If the point is not a location that is safe to access or sample at, discard the point and adopt one of the alternative points.

Water Quality Sampling

Water quality sampling will be done before any additional sampling to prevent contamination of the site. Ideally, the Water Quality Technician will have grab bottles, data sheets, and the sonde probe ready for deployment during the approach to the sample site. For more information see SOP 6: Water Quality Sampling.

General Considerations for Water Quality Sampling

- 1) Conduct water quality sampling before attempting to sample for fish to minimize site disturbance.
- 2) Make sure sonde probe is clear of obvious debris and is working properly (see SOP 7: Sonde Probe Calibration and Operation), and that water collection bottles are clean (see SOP 6: Water Quality Sampling).

Fish Sampling

Fish sampling will be conducted by the Fish Biologist and Biological Technician after water quality sampling at a site is complete. Materials for sampling fish can be prepared while water quality sampling is taking place (e.g., organize data sheets, unpack measuring boards/tape, etc...). For more information see SOP 8: Fish Collection and Sampling.

General Considerations for Fish Sampling Surveys

- 1) All fish collected within the sampling gear should be counted. Use consistent, standard fish taxa codes to minimize office data post-processing. Fish observed outside of nets (e.g., swimming adjacent to nets) or caught incidentally (e.g., fish captured accidentally pre- or post-net deployment) should not be counted, but can be recorded in field notes.
- 2) Use taxonomic keys and photos (see SOP 1. Before the Field Season) to identify fish in the field. If unable to identify fish in the field, take photos of right and left lateral sides, dorsal view, and ventral view. Photos can be used to consult with taxonomist or other experts.
- 3) Minimize stress to fish by deploying the sampling gear the recommended time (SOP 8: Fish Collections and Sampling), and promptly removing fish from gear once retrieved. Fish should be minimally handled and not left out of the water for longer than what is necessary for identification and measurement. Holding buckets can be used to temporarily hold fish while in-between collection and measuring.

After the Field

Once all sampling sites have been visited within a lagoon, all gear needs to be packed up and made ready for movement to the next site (a lagoon or Kotzebue). The PI or Fish Biologist is in charge of overseeing site clean-up and packing. Gear should be checked against the master gear list (Appendix S1.A).

Any water grab samples should be properly labeled and shipped back to NPS staff in Kotzebue to be immediately shipped to the receiving lab.

See SOP 12: After the Field Season for more information on this subject.

SOP 6: Water Quality Sampling

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Tables

Table S6.1. Water quality measurements for the Lagoon Monitoring Protocol.....	52
--	----

Appendices

Appendix SOP 6A. Equipment Needed for Collecting Water Quality Data and Associated Environmental Data and for Maintaining Water Quality Instrumentation.....	54
---	----

Purpose

This SOP outlines the water quality sampling directions for 1) use of the YSI Exo2 sonde multiparameter probe, 2) use of HOBO level loggers, and 3) collecting grab water samples. See SOP 1 (Before the Field Season) for further instruction on preparing the equipment and supplies needed prior to the start of each field season.

A master equipment list for the entire Coastal Lagoon Vital Signs Monitoring Protocol can be found in Appendix S1.A of SOP 1. The master equipment list should be updated simultaneously if this or any SOP requiring an equipment list is revised. A list of equipment required to complete the tasks specified in this SOP has been provided in Appendix SOP S7.A.

Instrument Operation: Basic Principles

Note: These are basic operating instructions only. For full procedures on how to operate the equipment, please read the appropriate instrument manuals.

Table S6.1 covers the four water quality data collection methods used for this protocol. Point and continuous samples will be taken. Water samples collected in bottles will require additional processing by an outside lab.

YSI Exo2 Sonde Multiparameter Probe

The sonde probe will be set at a depth of 50 cm and will be used to record water quality parameters at each site. Parameters include: water temperature (°C), dissolved oxygen, salinity, specific conductivity, turbidity, pH, and total chlorophyll. The sonde will be held at sampling depth for a minimum of 5 min, or until the sensors have stabilized readings. Once the sensors have stabilized, 3 point count readings will be taken.

For more information on calibration and use of the sonde probe see SOP 7: Sonde Probe Calibration and Operation.

HOBO Level Loggers

HOBO Level loggers collect continuous temperature (°C) and depth (m) data at a site. A level logger will be placed near the inflow of a lagoon for the duration of the field season (June through August). At least one logger will be placed in each park and rotated through all the lagoons to ensure that each lagoon is sampled at least once every three years.

For more information on use of continuous loggers see SOP 9: Operating HOBO Level Loggers.

Table S6.1. Water quality measurements for the Lagoon Monitoring Protocol. Water Quality Technician is responsible for collecting all metrics unless otherwise noted. Brand names indicate the current equipment in use within the region and do not represent in any way an endorsement to use this equipment in the future.

Instrument	Data Type	Variable	Unit	Frequency
EXO2 Sonde	Point and Continuous	Temperature	C	Each sample event, each site
		Conductivity	mS/cm	
		Salinity	ppt	
		Dissolved Oxygen	mg/L	
		pH	units	
		Turbidity	FNU	
		Chlorophyll	µg/L	
		Depth	m	
Hobo Logger	Continuous	Level	m	Each lagoon
		Temperature	C	
Hydrosurveyor	Hydrosurveyor data file	Bathymetry	Data File	Periodic
		Velocity	Data File	
Water Bottle	Lab Processing	Total Nitrogen	mg/L	3-9 Samples per lagoon
		Nitrate	mg/L	
		Phosphate	mg/L	
		Total Alkalinity	uEquiv/kg	
		aragonite	units	
		Dissolved Organic Carbon	µmol/kg	

Water Grab Samples

Water grab samples are collected in the field to be sent to a lab for analysis at a later date. These samples are collected at each fixed station (inlet, outlet, marine edge, and terrestrial edge). Water grab samples are not collected at random sites. Water grab samples must be collected before additional sampling that might disturb the water column (i.e., fish sampling). Preparations for water collection should be done before and during the approach to the sampling site.

Samples will be collected after rinsing the sample bottle with sample site water away from the direction of approach, a minimum of three times, to ensure that no contamination of the sample has occurred. Samples must be kept cool. Ideally, they will be placed on ice and shipped immediately to a receiving lab. Samples may be placed in an insulated cooler with ice packs while in the field, but they must be frozen as soon as possible, and shipped and received by the lab within one week of collection. Shipping may occur while transitioning between locations, by sending the sample back with the pilot to be mailed by park staff.

Hydrosurveyor

A hydrosurveyor will be used to collect data on velocity and bathymetry at the outflow of each lagoon once every 5 years. Measurements will be taken using a portable Acoustic Doppler Current Profiler at peak inflow, peak outflow, slack high, and slack low tides. See SOP 10: Hydrosurveyor Operation for more information on this sampling method.

Equipment List for Materials Needed in this SOP

Note that a master gear list is located in SOP 1 (Before the Field Preparations). If any changes are made with regard to type, quantity, or required items in the lists in the appendixes to this SOP, please simultaneously update SOP 1.

References

Environmental Protection Agency (EPA). 2001. National Coastal Assessment Field Operations Manual. U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA 620/R-01/003. pp72.

Appendix SOP 6.A. Equipment Needed for Collecting Water Quality Data and Associated Environmental Data and for Maintaining Water Quality Instrumentation.

Equipment (#/quantity)	Preparation & Maintenance
YSI EXO2 multiparameter water quality sonde	Ensure proper functioning and battery power, calibrate probes, lubricate probe O-ring each trip, update firmware quarterly, change probe sponges when needed.
YSI probe guard (1-2)	Ensure that this equipment is available
C-size batteries (8-12)	Ensure that this equipment is available
YSI EXO2 probe display system (1)	Ensure proper functioning and battery power
Connecting cable for YSI display and probe (1)	Ensure that this equipment is available and functioning properly
Hex wrench(s) for YSI probe	Ensure that this equipment is available
Extra YSI probe sponges (3)	Ensure that this equipment is available
Microfiber towel	Ensure that this equipment is available
Spare YSI port plugs	Ensure that this equipment is available
O-ring lubricant	Ensure that this equipment is available
Phillips-head screwdriver for YSI battery compartment (1-2)	Ensure that this equipment is available
YIS calibration chemicals	Ensure that this equipment is available
Wiring, rope, or similar for securing sonde for continuous deployment	Ensure that this equipment is available
HOBO level loggers (2-4+ ask PI)	Ensure proper functioning and battery power
Level logger housing “shuttle” (2-4+, ask PI)	Ensure that this equipment is available
Wiring, rope, or similar for securing HOBO level loggers for continuous deployment (many)	Ensure that this equipment is available
BASE-U-4 base station with the required coupler (1-2)	Ensure proper functioning and equipment is available
HOBOWare Pro software (1)	Ensure that this equipment is available

Equipment (#/quantity)	Preparation & Maintenance
Sterile Nalgene water collection bottles (90)	Ensure that this equipment is available
Insulated shipping boxes for water quality samples (5)	Ensure that this equipment is available and functioning properly

Appendix SOP 6.B. Field Form for Water Quality Sampling

Water Quality Data Collection Field Form					
Date (MM/DD/YY): _____ Park Unit: _____ Site Name: _____ Observer Initials: _____			Notes:		
Collection Type: (Check Box) Point Sample ☐ Bottle Collection ☐ Phytoplankton ☐ Bathymetry ☐					
Collection Location: Latitude: _____ Longitude: _____					
Pont Sample - YSI Sonde Multiparameter Probe					
Sample 1 Latitude: _____ Longitude: _____					
Metric	Unit	Value	Metric	Unit	Value
Temperature					
Salinity					
DO					
pH					
Bottle Collection/Water Grab					
Collected Yes ☐ No ☐			Notes:		
Number of Samples: _____ Sample ID Numbers: _____					
Frozen: Yes ☐ No ☐			Date: _____		
Shipped: Yes ☐ No ☐			Date: _____		

SOP 7: Operating the EXO2 Sonde Multiparameter Probe

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This Standard Operating Procedure document provides details on the calibration, general use, and maintenance of the EXO2 Sonde Multiparameter probe. The probe is used to take point measurements key environmental variables (i.e., temperature, pH, conductivity) essential to the Coastal Lagoon Monitoring Protocol. In addition, one probe will be placed in one lagoon in each park to collect continuous measurements. This probe will be rotated among lagoons annually, so that each lagoon is sampled at least once over a three year span. The Water Quality Technician is responsible for maintaining and operating the probe, and must review this SOP and appropriate operating manual(s).

These data collectively become data deliverable L03 (see SOP 17 for deliverable naming conventions).

Overview of EXO2 Sonde Probe

The EXO2 Sonde Probe is a handheld device used to collect water quality data (point and continuous). The multiparameter probe has up to six replaceable sensors in addition to a pressure transducer. Each probe measures a different parameter via a variety of detection methods. Collected data is stored onboard the sonde. The data can be transferred to a personal computer using a cable, USB, or Bluetooth connection (depending on model used).

Prior to Field Season

Calibration

All EXO2 sensors, excluding temperature, require calibration prior to the field season. Calibration steps follow the same basic procedure with slight variations for each sensor. First, rinse the EXO calibration probe with water, followed by a small amount of the calibration standard for the sensor being calibrated. Discard the rinse, then fill the calibration cup with fresh standard. Fill the calibration cup to the first (full sensor payload) or second fill line (small sensor payload), making sure sensor is submerged.

Once the sensor is submerged, go to the calibrate menu in the KOR software. Select the sensor to be calibrated. Next select the parameter for the sensor being calibrated. Select 1, 2, or 3-point calibration in the next menu. Enter the value of the standard being used. Check that the units entered match the units at the top of the menu. Click the “Start Calibration” button. Click the “Graph Data” button to compare the pre-calibration and post-calibration value in graph form. Confirm that the value is within the acceptable margin of error. Once readings are stable, click “Apply” to accept this calibration point. Repeat for each calibration point. Click “Complete” when all points have been calibrated. View and export the calibration summary. Save and send summary to the PI to be archived as data deliverable L03.

Information for calibration of specific probes can be located in the EXO User Manual, section 5.

Part Replacement

The EXO2 sonde probe uses four D-cell alkaline batteries (recommended). Rechargeable NiMH D-cell batteries may also be used. Batteries must be checked and replaced prior to the start of the field season. Backup batteries should be included in the field season packing list. To install batteries:

1. Unscrew and remove battery cap
2. Insert batteries with positive terminals facing up and negative terminals facing down towards the probes
3. Replace the battery cover and tighten (do not overtighten) until snug.

Individual sensors can be removed and replaced if necessary. All EXO sensors have identical connectors. If removal and replacement of a probe is determined necessary, first ensure that all parts are clean, dry, and lubricated before placement.

During the Field Season

Transport to field

The sonde probe and handheld display should be transported to the field in a hard sided case. Specific sensors on the probe must be kept in a moist environment during transport. This is especially true for the dissolved oxygen (DO) membrane. Keep a small amount of water in the sonde cup will be sufficient. See the section titled “Short Term Storage” at the end of this document for more information.

The probe and hand held display should be kept dry during transport to the field.

Before transitioning to a sample site, connect the handheld to the sonde with the EXO cable.

Collecting Point Measurements

- 1) Make sure the cable is attached to both the sonde probe and the handheld display.
- 2) Turn on the handheld display.
- 3) Upon startup, the KOR software will search for the hard-wire connected sonde. Once found, the KOR software will request to connect, say yes.
- 4) To start displaying the current data on the handheld go to the Run menu and choose “Dashboard”. Toggle between numeric Dashboard and Live Graph views. The screen will need to be on Dashboard view for data logging.
- 5) Create a file for the specific site being sampled. Follow standard naming protocol: ‘**L03_Park Unit_Lagoon_Site Name_Day**’ (see SOP 17). Collected point data will be saved in this file.
- 6) Place sonde probe sensors at a depth of ~50 cm. Hold the sonde at sampling depth for a minimum of 5 min, or until sensors have stabilized.
- 7) Once sensor has stabilized, collect three spot samples. To spot sample, click the soft key below the “Capture Data” button. Select the “Single Point” option to log the most recent data point. Data is captured in a .bin file and stored on the handheld.
- 8) When moving to the next sampling site, create a new folder name for the site.

Post Field Season

Post Field Calibration

EXO2 Sonde probes will be checked against standards to determine the drift of the sensor over the sampling period. If drift on a sensor is outside of QC standards, the data for that sensor may need to be removed from analysis.

Data Upload and Archiving

Upon returning from the field, and before the end of the field season, data from the probe must be uploaded by the Water Quality Technician. Ideally, data from a probe will be uploaded no later than the following day.

To upload data from the handheld:

- 1) Connect the handheld to the computer using the provided USB cable, and power on the handheld.
- 2) Once the PC recognizes the device, it may take a minute for the handheld shows up in KOR software.
- 3) With the handheld connected and the KOR software open, go to the “Options | Sync with Handheld” in the KOR window. Select “Sync All” or select individual files.

The data files will be examined to determine if the upload was successful and no corruption of the files occurred. Once this is confirmed, a backup file will be made by the user. The Sonde will then be cleared of memory, and battery levels checked.

The PI and Water Quality Technician will coordinate on entering data into the NPS database and on the initial analyses of water quality data.

Storage and Maintenance

Maintenance

- **Depth Sensor:** Locate depth ports (depth ports are located on the metal bulkhead face itself). Clean the depth ports with the syringe included in the EXO toolkit. Do not directly insert objects I the EXO2 sonde depths ports.
- **Standard Optical Sensor:** Turbidity, Total Algae, and fDOM sensors can be periodically cleaned using a non-abrasive, lint-free cloth.
- **Conductivity/Temperature Sensor:** To clean the sensor, use a cleaning bush (included in the sonde maintenance kit) dipped in clean water to sweep the channels leading to the internal electrodes. Sweep the channels 15-20 times. A mild solution of dish soap can be used to clean the channels if deposits have formed. Rinse the channels with clean water after sweeping.
- **pH Sensor:** Sensors will require occasional maintenance to clear fouling agents from sensing elements. First remove the sensor from the sonde. Soak the sensor for 10-15 min in clean water with a few drops of dishwashing liquid. Rinse the sensor after the soak with clean water. If contaminants are still on the bulb, you will need to do a hydrochloric acid (HCL) soak. Follow the instructions in Chapter 6.14 in the Sonde User Manual.

Short-term storage

For storage during the field season, the sensors should be kept moist but not submerged. Submersion during storage can cause drift. Place 0.5 in (1 cm) of water (deionized, distilled, tap, or environmental) in the bottom of the calibration cup. Place the sonde with sensors into cup and close it tightly. A moist sponge can also be used to create a humid storage environment. The

sonde itself should be stored in dry air. Leave cable connectors connected, or install the port plug, to protect the cable connector.

- **Conductivity/Temperature Sensor:** For short-term storage, keep the sensor installed on the sonde and stored in an environment of water saturated air.
- **Dissolved Oxygen (DO) Sensor:** For short-term storage, the DO sensor should remain installed in the sonde and stored in an environment of water saturated air.
- **pH Sensor:** Sensor should remain installed in the sonde probe and stored in an environment of water saturated air.

For EXO2 Handheld, clean the outside of the device with a soft cloth soaked in clean water. A small amount of dishwashing liquid can be used to remove grease. Power down the device by holding the power button for longer than three seconds. Store in a hard sided case or similar environment where it will be safe from bumps, spills, and direct sunlight.

Long-term storage

At the completion of the field season, after all data has been uploaded, the sensor will be prepped for long-term storage. To do this, remove all sensors according to their specific instructions (listed below). Plug all open ports, and store the probe in a dry place. Remove batteries to prevent battery leaks.

- **Standard Optical Sensor:** Sensors can be left in the probe for long term storage or removed and stored dry in their shipping cap(s).
- **Conductivity/Temperature Sensor:** For long-term storage, clean the channels leading to the internal electrodes. Then store the probes either wet or dry. If sensor is submerged, ensure liquid is not corrosive.
- **Dissolved Oxygen (DO) Sensor:** For long-term storage, leave the sensor installed in the sonde and submerge it in clean water using the calibration cap. Screw the cap on tightly to prevent evaporation. The sensor can be stored by itself by either submerging the end of the sensor in a container of water (check periodically to ensure water does not evaporate) or in water saturated air. The sensor can be re-hydrated if left in open air for longer than 8 hours by submerging the sensor in room temperature tap water for 24 hours and re-calibrating. DO sensors have a life of 12 months, so sensor caps will need to be replaced annually. See section 6.2: Dissolved Oxygen Sensor Cap Replacement in the EXO Sonde User Manual for more information on cap replacement.
- **pH Sensor:** Remove sensor from sonde and insert the sensing end into the bottle the sensor was shipped in. Install the bottle's o-ring cap and tighten. The bottle should contain a 2 molar solution of pH 4 buffer. If unavailable, the sensor can be stored in tap water. Do not store sensor in DI water. If desiccation occurs, the sensor can be rehydrated by soaking in a 2 molar solution of potassium chloride overnight/

For the EXO2 Handheld, remove batteries and replace the battery cover. Store in a dry place away from direct sunlight.

SOP 8: Fish Collection and Sampling

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Tables

Table S8.1. Example references for fish identification for the Coastal Lagoons Vital Signs Protocol.	64
Table S8.2. Nets used for the Coastal Lagoon Vital Sign Protocol.	66
Table S8.3. Metrics collected for specific fish species.....	70

Figures

Figure S8.1. Arctic Char captured in a coastal lagoon (Photo Credit: WCS).....	65
Figure S8.2. Field personnel retrieving a beach seine (Photo Credit: WCS).....	67
Figure S8.3. Side profile of a simplified fyke net.	68
Figure S8.4. Setting a fyke net in a coastal lagoon (Photo Credit: WCS).....	69
Figure S8.5. Examples of fork length and total length.	71

Appendices

Appendix SOP 8.A. List of Required Equipment for Fish Sampling for the Coastal Lagoon Monitoring Protocol	74
---	----

Purpose

This Standard Operating Procedure document provides details on the collection and sampling of fish (data deliverable L08) for the Coastal Lagoon Monitoring Protocol.

General Preparation and Review

Preparation for fish collection begins before the start of the field season. All field should review taxonomic keys for western Arctic fishes and be familiar with fish identification. Field crew should also be familiar with data recording methods (i.e., field form layout, metrics collected, required equipment).

Field Data Sheets and Notebooks

Data collected as part of fish collection and sampling will be recorded by hand onto field datasheets (Appendix S8.A) and will become data deliverable L08. These datasheets will be printed on water resistant paper. Print a sufficient number (~100 of data sheets before entering the field and include extras (~ 20 extra sheets). Data sheets are to be printed double sided.

Species Keys

Field personnel must be able to identify fishes encountered during lagoon sampling. Technicians should review applicable taxonomic keys and references to become familiar with lagoon fish species. The PI and Fish Biologist are responsible for ensuring all personnel can accurately and confidently identify encountered fish species.

A list of species should be prepared prior to the field season. Fishes collected during previous sample events of CAKR and BELA should be complies from the Identification keys should be printed on water resistant paper or laminated.

Table S8.1. Example references for fish identification for the Coastal Lagoons Vital Signs Protocol.

Author	Title
Johnson et al. 2015	A Handy Field Guide to the Nearshore Marine Fishes of Alaska
Mecklenburg et al. 2002	Fishes of Alaska
Thorsteinson and Love 2016	Alaska Arctic Marine Fish Ecology Catalog
Byersdorfer and Watson 2010	Field Guide to Common Marine Fishes and Invertebrates of Alaska

Photos of fishes encountered can be useful for later species identification or to document notable catches (Figure S8.1). Photos of fishes to be used for later species identification need to be properly labeled with the date, location, and species identification number (See SOP 14: Handling Photographic Images). Photos should include side profiles, dorsal, and ventral views of the subject fish. A ruler or other item to designate scale should also be included in the photo.



Figure S8.1. Arctic Char captured in a coastal lagoon (Photo Credit: WCS)

Fish Collection

Fish collection for the Coastal Lagoon Vital Sign Protocol will be conducted using a series of nets: a beach seine, a fyke net, and a variable mesh gill net (Table S8.2). Nets require 2-3 people to set and retrieve.

Nets are likely to be damaged during field work due to snags and normal wear and tear. A net repair kit should be included in field gear so that nets can be fixed in the field. A typical net repair kit should include: string or twine, scissors, a lighter, and a blunt needle for threading.

List of fish sampling equipment needed for this protocol is located in Appendix S8.A.

Table S8.2. Nets used for the Coastal Lagoon Vital Sign Protocol.

Instrument	Frequency	Species Captured
Beach Seine	8 samples per lagoon at fixed sites	Both large and small fishes. Primarily sticklebacks, sculpins, and other small fish.
Fyke Net	8 samples per lagoon at fixed sites	Both large and small fishes
Gill Net	8 samples per lagoon at fixed sites	Primarily larger fishes. Size captured dependent on panel mesh size

Beach Seine

A beach seine will be used to collect fish from the four fixed sites in each lagoon. A beach seine is a long net operated by two ropes at each end. It is deployed from the shore using a boat or by foot (if shallow enough) and brought back to form a U shape (see Figure S8.2). Two or more people then pull in the net at each end, as evenly as possible. Fish are herded into the center of the net, and eventually brought to shore in the ever shrinking center of the net.

The beach seine will be deployed twice per visit at each fixed site within a lagoon. Note in Figure S8.2 how the both technicians are pulling in the net while keeping the lead line (bottom rope) in contact with the substrate. This ensures no fish escape from underneath the net.

The beach seine is large and therefore can be stored in a tote or draped on top of other equipment in the boat. Make sure no loose lines are hanging from this net if draped across the bow or midsection of the boat for transport/deployment. The beach seine can be heavy when waterlogged, recommend two people load and unload this net from the boat when wet.



Figure S8.2. Field personnel retrieving a beach seine (Photo Credit: WCS)

Some general recommendations for setting and retrieving the beach seine include:

- 1) Before deploying the net, check for holes or tears in the netting and make sure no fish, twigs, or other debris are in the net from previous deployments.
- 2) Place the net in the boat in such a way so that it is free to unravel into the water as the net is deployed (i.e., try not to let the net get tangled or rolled on top of itself)
- 3) Have one person hold one end line of the net on shore, and two people in the boat to deploy the net (one person operates the boat while the other feeds the net into the water). Note this net can also be set by foot if water is shallow enough. If deploying by foot, always wear life vest and do not let water level go over the wader belt of the person deploying the net.
- 4) Watch for currents. Try not to let the net fold onto itself.
- 5) Keep the lead line (bottom of the net) in contact with the ground when retrieving the net to keep fish from escaping.
- 6) Try to retrieve the net evenly by matching retrieval pace and communicating when to speed up or slow down retrieval.
- 7) Person(s) not attending the net can set up fish measuring area and prepare data sheets.
- 8) Keep the “bag” of the net in the water as long as possible to keep fish submerged, and handle fish quickly and efficiently to minimize stress. Fish can be moved to sorting

buckets if needed. Buckets are for temporary holding of fish and should be kept in the shade and water changed between sampling events.

- 9) You can pull the net through the water (recommended do this by hand) after each sampling event to clean off any debris that may have become entangled in the net.

Fyke Net

A fyke net is composed of two large wings that act to funnel fish into a series of conduits (Figure S8.3). Fish enter voluntarily and become trapped due to inward facing bags. The wings are anchored using rebar, and set at a $\sim 45^\circ$ angle. The main line will be attached perpendicular to shore.

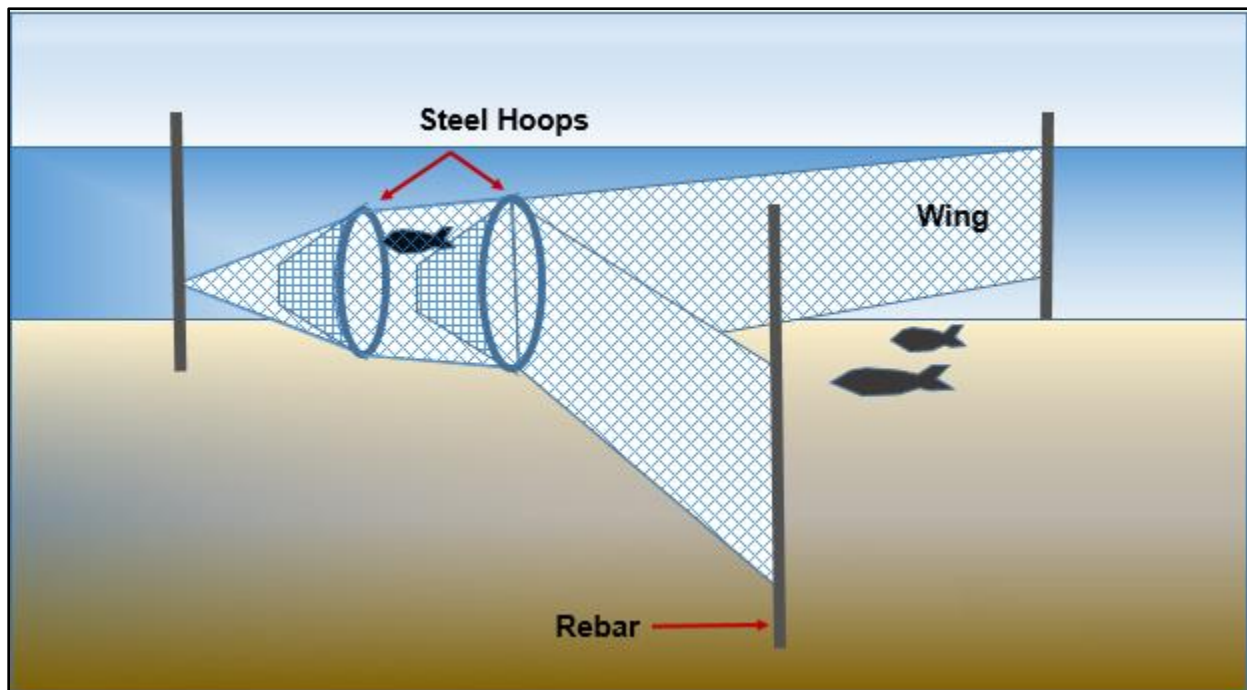


Figure S8.3. Side profile of a simplified fyke net.

The net will be set for a 3 hour sampling period. Fish will be removed from the terminal end at retrieval, identified, and length measured.

A fyke net will be set once at the outflow (fixed site) within a lagoon. Choose an area with adequate substrate and without strong cross currents if possible. As always, do not place fishing gear in an area where it may disturb subsistence fishing activities.

Haynes et al. (2017) used a fyke net with the following dimensions: 3.1 mm stretch mesh; 91.5 x 122 cm rectangular frame; 5 steel hoops; 2 throats; and a 15.2 m lead (Figure S8.4).



Figure S8.4. Setting a fyke net in a coastal lagoon (Photo Credit: WCS)

Gill Net

A gill net with multiple sized panels (also called an experimental gill net) will be used to collect larger fish (e.g., whitefish, char, and flounder). A gill net will be set perpendicular to shore at each fixed sampling site (i.e., inflow, outflow, marine edge, and terrestrial edge). A gill net will be used to sample twice at each sample site within each lagoon. Ideally, the panel with the smallest mesh will be anchored closest to shore. Gill nets should be set the net in ~2 m of water. This means that gill nets will often be deployed a ~10 m or more offshore. Deploy gill nets with the boat, one person letting out the net while the other drives the boat. Mark the time and location of deployment once the buoy has been dropped in the water. Gill nets will be checked once every hour for two hours. Streamers can be tied around buoys to increase visibility if nets are pulled under water due to high surf and/or entanglement.

It may be challenging or impossible to find water $\geq 2\text{m}$ in depth at Ikpek Lagoon. If you cannot find water $\geq 2\text{m}$, set the net in the deepest area available and note the actual depth on the data sheet. Some overlap of the lower part of the net is okay, however you must be vigilant about over entanglement of fish.

Gill nets can kill fish during capture or removal. Take care to collect fish promptly after capture. Keep fish in the water as long as possible, and handle fish carefully when removing them from the net. Be especially careful to avoid damaging gills and hyperextending pectoral fins. Note any unintended fish mortalities on the data sheet.

Collecting Fish Metrics

All fish captured will be identified to species and counted. Length measurements will be taken for specific species. These species include: Humpback Whitefish, Starry Flounder, and Ninespine Stickleback (Table S8.0.1). Species identification, count, and individual lengths will be recorded in field data sheets (Appendix S8.B)

Table S8.3. Metrics collected for specific fish species.

Species	Variable	Metric Collected
Humpback Whitefish	Abundance	Count
<i>Coregonus pidschian</i>	Length Distribution	Fork Length (mm)
Ninespine Stickleback	Abundance	Count
<i>Pungitius pungitius</i>	Length Distribution	Fork Length (mm)
Starry Flounder	Abundance	Count
<i>Platichthys stellatus</i>	Length Distribution	Fork Length (mm)
All Fish	Species Evenness	Species ID, Count
	Species Richness	Species ID, Count
	Species Diversity	Species ID, Count

Ideally, one person will identify and count fishes while a second person records this data in field data sheets.

Fish Count

All fish collected using any and all of the aforementioned sampling equipment will be counted and recorded. Fish are identified to the lowest taxonomic level possible by the Fish Biologist and Biological Technician. Species identification will be recorded on the appropriate data sheet, followed by the number of fish observed during a sampling event.

Subsampling may be necessary in instances where large numbers (> 500 individuals) of one or more species are encountered in a single sampling event.

Fish Length

Fork length (mm) will be measured and recorded for three fish species: Humpback Whitefish, Starry Flounder, and Ninespine Stickleback. Fork length is taken by measuring the linear distance from the anterior end of the fish to the fork on the caudal fin and the posterior end of the fish (Figure S8.5). Measure length when the fish is flat and relaxed. If possible, one person can take measurements and call them out another individual taking notes. Minimize handling of the fish to prevent unnecessary harm and mortality to fishes collected.

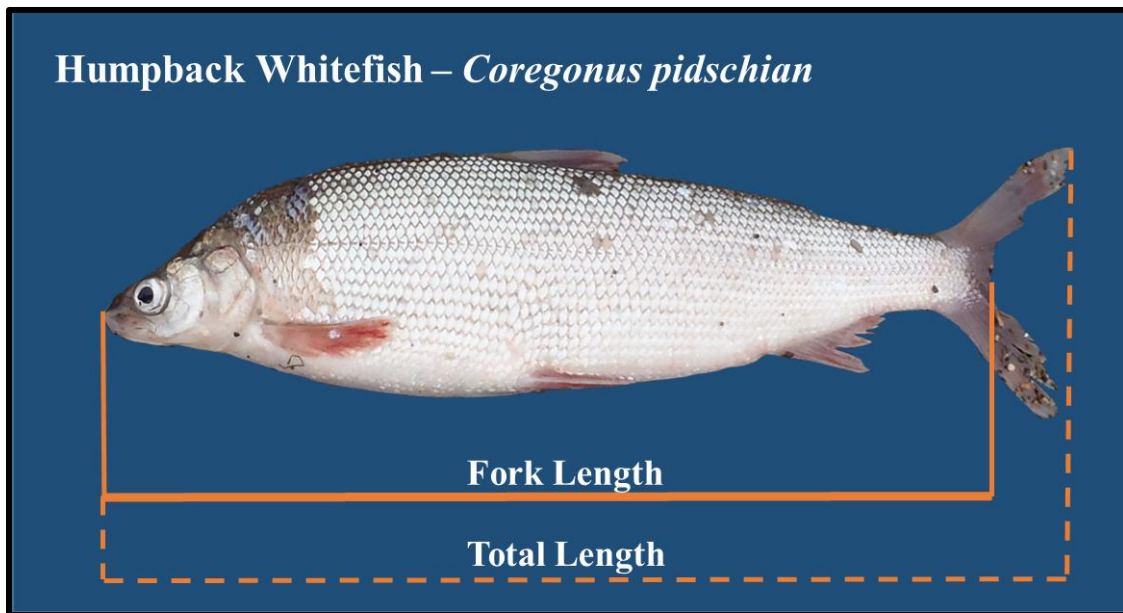


Figure S8.5. Examples of fork length and total length.

Other

Additional samples from selected fish species may also be collected if additional funding or personnel are available. Suggested additional metrics are listed in SOP 22: Additional Research Needs. Example additional metrics include: fish weight (g), fish age (otoliths and/or scales), contaminants (fish tissue), genetics (fish tissue), and fish diet (stomach samples).

Safe Handling of Fishes

Fish should be minimally handled in a way to minimize fish mortality. To accomplish this all personal handling fish must review this protocol before the field season to familiarize themselves with fish capture techniques to minimize unnecessary handling time in the field.

Fish will not leave the water until immediately before processing (measured for length, counted). Once processed, they will be immediately returned to the body of water from which they were captured. Field crew will take care to not touch gills, poke eyes, or do any action that would cause unnecessary distress to the fish (e.g., bending fish, dropping fish on substrate). Field crew should practice sample collection before the actual field sampling so that they operate quickly and efficiently. Killing fish is currently not required to fulfill **any** part of this protocol and **must be avoided**. All mortality events must be recorded. Field crews, NPS staff, and project supervisors should discuss plans for use of fish carcasses (e.g., tissue collection, freezing and donating fish to local community members) before the field season.

Occasionally fish may need to be temporarily placed in buckets. Water in buckets must be changed every 10 to 15 min, and more often in sunny conditions, to ensure adequate dissolved oxygen levels. Water must be collected from the same general area as the fish were collected in. Buckets should be kept in the shade when possible. The maximum number of fish per-bucket depends on fish size and activity level (note that recently captured fish will be stressed and will consume more oxygen than normal). Fish should be able to swim and move freely in buckets.

Buckets should be free of oil, soaps, chemicals, or irritants. If fishes are too large for buckets (e.g., Inconnu (Sheefish) and large whitefish) do not attempt to put the fish in buckets. Instead, sample these fish first, or find alternative holding containers (e.g., large plastic totes). Oxygen stones or bait bubblers should be used if storage of fish in buckets will be a regular occurrence.

Fish mortality is more likely with some activities than others. The gill net can damage fish gills if fish are allowed to thrash in the net or if fish gills are damaged during removal from the net. Wear cotton gloves to help grip fish without squeezing them so they can be removed quickly from the net (note: use waterproof gloves for warmth and general net handling). Have scissors or a multi tool on hand to cut the net, but only if absolutely necessary. Net repair materials should be kept with sampling equipment (See Appendix SOP 8.A).

Fish may be exhausted after being removed from nets and sampled. Exhausted fish may roll on their side when returned to the water. Gently cradle these fish upright, with their face in the current. The fish will swim away when revived. Never grab fish by the gills.

Recommended additional reading on the safe handling of fishes:

Use of Fishes in Research Committee (joint committee of the American Fisheries Society, the American Institute of Fishery Research Biologist, and the American Society of Ichthyologist and Herpetologist). 2014. *Guidelines for the use of fishes in research*.

Data Handling and Analysis

Data Entry

Data will be recorded in the field on water resistant paper (see Appendix SOP 8.B for example data sheet). Data must be legible. Do not use ink pens that may bleed when exposed to water. Mistakes should be crossed out with a single line and not erased. Field technicians will be responsible for recording data, and the fish biologist will be responsible for ensuring data is fully recorded and data sheets are accounted for at the end of the field season.

Note that a database structure for fish data did not exist at the time this protocol was written (see SOP 15: Data Entry, Verification, and Certification). The PI, fish biologist, and database manager will work together to build an appropriate database. For now, paper data sheets will be entered into Excel for analysis at the end of each field season and archived (see SOP 11: Field Form Handling Procedures). All entered data will need to undergo QA/QC procedures before analysis (see SOP 15).

Simple Analysis

Raw data of fish catch will be standardized for each gear type by calculating Catch per Unit Effort (CPUE). The unit of effort for sampling in this protocol is time (min). Therefore total soak time of all fish collection gear must be carefully recorded for each sampling event. Data collected from each gear type will be analyzed separately.

Species diversity, evenness, and richness will be calculated for the fish community for each lagoon. Simpson's Index (D_s) and Shannon's Index (H) will be used to express community diversity (Shannon and Weaver 1949; Simpson 1949). Evenness will be calculated with the

index for Simpson's diversity (V'). Richness will be the total count of fish species (n) observed in each lagoon. Mean, median, and variance will be calculated for each of these metrics. See SOP 16: Data Analysis and Reporting for more information.

References:

Shannon, C.E., and W. Weaver. 1949. The mathematical theory of communication. University of Illinois Press, Urbana.

Simpson, E.H. 1949. Measurement of Diversity. *Nature*. 163: 688.

See SOP 16: Data Analysis and Reporting for more information on specific analyses for fish data collected as part of this monitoring program.

After the Field Season

Fishing nets need to be rinsed and hung to dry following return to the field season. Any debris (e.g., sticks, algae) need to be removed from netting by hand and nets need to be thoroughly checked for holes and tears. Small holes can be fixed with net mending tools. Consultation with the net manufacturer is recommended for larger holes or damages that may compromise the overall integrity of the net. Once nets are dry, they should be folded or rolled and stored in a dry location away from any solvents or corrosive materials and out of direct sunlight.

Data sheets used for fish collection will need to be prepared for storage post entry. See SOP 11: Field Form Handling Procedures and SOP 12: After the Field Season for more detailed information on fish data sheet handling. An excerpt from SOP 11 is included below for reference:

Post-Field Procedures for Handling Data

1. Wipe of any debris (scales, mud) that may have accumulated on data sheets. Allow data sheets to dry.
2. Store securely in a three ring binder or similar folder until a computer is available for data entry.
3. The Biological Technician will enter all field data sheets into the master database.
4. After entry, data sheets will be ordered and scanned into a single PDF file and saved as data deliverable L08 (see the deliverables schedule for detailed specifications)
5. Original field data sheets (data deliverable L09) should be stored in the designated filing cabinet for three years.

Appendix SOP 8.A. List of Required Equipment for Fish Sampling for the Coastal Lagoon Monitoring Protocol

Note that a master gear list is located in SOP 1: Before the Field Season. If any changes are made with regard to type, quantity, or required items in the lists in the appendixes to this SOP, please simultaneously update SOP 1.

Equipment (#/quantity)	Preparation & Maintenance
Beach seine	Ensure in working order
Fyke net	Ensure in working order and all pieces are present
Rebar	Ensure this equipment is available
Mallet for rebar	Ensure this equipment is available
Ties, rope for securing fyke net to rebar	Ensure this equipment is available
Gill net	Ensure this equipment is available
Net repair kit	Ensure this equipment is available
Fish measuring boards	Ensure this equipment is available
Fish ID keys	Ensure this equipment is available
Digital camera	Ensure this equipment is available and batteries are charged
5 gallon bucket(s) or totes for temporary holding fish	Ensure this equipment is available

Appendix S8.B. Field Data Sheet for Fish Collection

The following are templates for data collection sheets for fish sampling. Record changes to the SOP 8 Revision Log. Note data sheets are designed to be printed double sided.

Date (MM/DD/YY): _____		Pg. ____ of ____			
Park Unit: _____	Notes:				
Site Name: _____					
Latitude: _____					
Longitude: _____					
Gear Type: _____					
Gear Check Time(s): _____	Deploy: _____	Check 2: _____	Check 3: _____		

Haul Number	Species	Number	Length (mm)	Notes

SOP 9: Operating HOBO Level Loggers

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This SOP outlines the use of HOBO Level Loggers for collecting continuous environmental data as part of the Coastal Lagoon Monitoring Protocol. The HOBO Level Loggers generate data deliverable L07.

General Information

HOBO Level loggers collect continuous temperature (°C) and depth (m) data at a site. A level logger will be placed near the inflow of a lagoon for the duration of the field season (June through September). At least one logger will be placed in each lagoon. Ideally, a logger will be placed at each fixed site within each lagoon. Adding additional loggers is dependent on funding. The hobo logger is in addition to the multiparameter sonde (See SOP 7). At least one sonde will be placed in each park and rotated through all the lagoons to ensure each lagoon is sampled at least once every three years. .

Before the Field

Installing HOBOWare®

Detailed instructions for uploading and operating HOBOWare® can be found in the user's guide (<http://www.onsetcomp.com/support/manuals/12730-MAN-BHW-UG>, accessed April 2017). The following outlines basic steps needed for operating level loggers for the Coastal Lagoon Monitoring Protocol.

- 1) With HOBOWare open, connect logger to computer using the appropriate shuttle and USB cables.
- 2) Wait a few minutes for the computer to recognize the device. Once connected the device name should be listed in the bottom of the main HOBOWare window.
- 3) Click the launch icon in the toolbar, select launch from the device menu.
- 4) Select parameters (temperature (°C) and depth (m)), and start date/time of logging. Once launch settings have been selected, click the Start button.
- 5) To disconnect, unplug the USB or unplug the device from the shuttle or base station.
- 6) Connect another device and repeat steps to prep the device for the field.

Note that once the loggers begin logging they will continue until the configured end time/date, until the memory is full, or until the battery runs out. Any previously stored data on a logger will be erased once a logger is relaunched.

Setting up Level Loggers in the Field

Level loggers will be secured in one location within a lagoon for the duration of the field season. They will need to be secured in near the inflow of a lagoon, but away from any potential boat traffic or subsistence fishing activities. Level loggers will be secured using rebar and non-stretch wire or zip ties. Level loggers can be placed in a PVC pipe or other container (with adequate holes for water flow) to protect from the environment or curious animals or people. Loggers will need to be placed in a location where they will remain submerged throughout the field season. At installation, all logger points will be recorded using handheld GPS devices.

Retrieval

At the end of the field season (mid-late August), level loggers will be retrieved and data uploaded. The level logger can be located using the GPS waypoint collected at installation. All material (rebar, metal wires, and zip ties) must be removed from site. The level logger will be brought back to basecamp or park offices to upload data. The Fish Biologist and Water Quality Technician are responsible for ensuring the device is retrieved.

Data Upload

- 1) Connect logger to the computer using USB cable or shuttle.
- 2) Click the Readout icon on the toolbar. You can continue to collect data while uploading data, you will need to specify if you want logging to stop or continue.
- 3) Once upload is complete, select an area/file name to save the data. Use the prefix L04 for the uploaded file name (see SOP17). Use naming convention: L04_“Park”_“Unit”_“Lagoon”_“Site Name”_YYYYMMDD.
- 4) Click save
- 5) You can then plot the upload data within HOBOWare[®] if desired. More information on plotting data is available in Chapter 3: Reading Out, Plotting, and Analyzing Data of the HOBOWare Users Guide
- 6) The data will remain on the logger until the next logging event

Storage

When level loggers are not in use they can be stored in a cool dry place. Check to make sure that loggers are not collecting data.

With regular use, a level logger should have a battery life of ~5 years. The logger will report and log its battery voltage. If voltage falls below 3.1V, “bad battery” will appear in the log files and the logger should be returned to the manufacturer for battery replacement. DO NOT attempt to change the battery yourself.

SOP 10: Hydrosurveyor Operation

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

The Hydrosurveyor is to be only handled and operated by a
DESIGNATED PERSONNEL

Who has the required additional training and has been previously approved/identified by the PI

Purpose

This SOP briefly describes handling, storage, and general use of the hydrosurveyor. This device requires specialized training, and therefore should not be operated by untrained staff.

Summary

The hydrosurveyor will be periodically used to map lagoon bathymetry (most notably at inflow/outflow points). Measurements of particle velocity and direction will be recorded for the entire water column. Specialized software will take these data files and transform them into 3D imagery. These surveys will be conducted every few years. The PI will coordinate with personnel who are trained in hydrosurveyor operation.

Information

Note that the hydrosurveyor will be operated by a trained individual. Field crew should be prepared to provide assistance and aid when necessary. The following covers basic operation. See operators manual for detailed information on storage and handling.

Setup – Pre-field Season

Yuma-Portable Computer

- 1) Disable all of the Bluetooth ports using the Windows Device Manager. The BT ports interfere with the regular com ports and may make it so the Yuma cannot communicate with the ADCP.
- 2) Ensure that the FTDI driver for the radio dongle has been installed.

The link to the driver is below. Please install, restart your computer, and try again, after verifying the COM port #. If you double-click on the line that pops up under the Ports (COM and LPT) in the Device Manager, you will see properties for that port. Please verify under the Details tab that the Driver manufacturer is FTDI.

<http://www.ftdichip.com/Drivers/D2XX.htm>

- 3) Make sure you have the latest software/driver versions of the SonTek Utilities, Hydrosurveyor, and RiverSurveyor.
- 4) Adjust the power use settings to get the Yuma into field mode by clicking the battery icon on the lower right of the Yuma. You can make a custom setting and save it so you can select it right before starting your survey. Adjust the brightness and timeout settings as is appropriate. The dimmer the screen and the more it stays in standby mode, the longer the battery will last. You may end up adjusting the brightness in the field as you go, depending on the light conditions (and whether you are wearing a bug net).

ADCP-Trimaran

- 1) Attach the PCM and ADCP to the trimaran. Do not push the ADCP down until you are ready to launch it, but make sure the screws are tightened. Putting the sensors that are on the bottom of the ADCP onto the ground can damage them.
- 2) Attach the GPS antenna to the ADCP.
- 3) Attach the ADCP to the PCM. Wrap the wire around the ADCP to reduce the amount of extra cable that may drag in the water.
- 4) Connect the GPS to the PCM.
- 5) Attach the radio antenna to the ADCP.

Put both battery packs in the PCM. This will turn it on and allow the unit to start searching for satellites. The software will only communicate with the ADCP if it has a good GPS fix. When the light is a solid green, it is good to go. The radio light will just blink green when it is active.

Yuma-HydroSurveyor

- 1) Plug radio dongle into a USB port.
- 2) Turn on the Yuma
- 3) Go into Windows File Manager and create a working folder for your project area. Generally, it will be under My documents/SonTek. Each project/run will be placed in a subfolder under that primary folder. I suggest using the format of Park_Location_YYYY-MM-DD for your primary folder.
- 4) Double click the HydroSurveyor icon to open the program. The New Project dialog box will open automatically.
 - Type in the filename (i.e. “Lagoon-outgoing tide”)
 - Project Location – browse to the folder you created in Step 3
 - If you want to use a previous file as a template, check the box and choose the file you would like to use. By default, HydroSurveyor chooses the most recent file that was created
- 5) Click “OK” and the Project Configuration Dialog opens to the **Boat** tab.

For the Achilles with the trimaran tethered to the port side, use the following settings:

Length = 3.65; Width=2m; Height=0.5m

CAP: X-offset = 2m; Y-offset=0.0; Z-offset=0.0; Height above water

- 6) Click **Devices** tab; there should be two devices shown, the HydroSurveyor and the Auxiliary HydroSurveyor GPS. If those are not shown, you will need to add them using the **Add Devices** button at the bottom of the tab. Use the following settings for the devices:

HydroSurveyor: x=-2.1; y=1.2; z=-0.2; yaw=0; pitch=0; roll=0; Type= HydroSurveyor

Auxiliary HydroSurveyor GPS: x=-2.1; y=1.2; z=-0.2; yaw=0; pitch=0; roll=0; Type = Auxiliary HydroSurveyor GPS

- 7) Click **Data Streams** tab.

Position = Auxiliary HydroSurveyor GPS-GPS

Heading = HydroSurveyor-Magnetic Heading
Pitch and Roll = HydroSurveyor- Pitch and Roll

8) Click the **Project Settings** Tab

Fixed water level = 0

Set the declination for the project area

Set the salinity if you know it (0=fresh, 35=seawater); if you are using a CTD, the software will correct for measured salinity later

If you aren't using RTK, the next several entries do not matter

Leave Snap Heading and Snap Position checked

Velocity Vectors Section Start-End (does not affect data collection, only the display). The default is 2 to 3.5 m, but you can change this to reflect the general depth of your section

Manual Bathymetry Color Range – (does not affect data collection, only the display); Enter the range of bathymetry you want to see on the plan map or just click the “from soundings” box. Sometimes, the ADCP can give a large bounce at the beginning, showing a deeper sounding than you actually have, so the automatic sounding option can give unsatisfying results. The minimum and maximum here are different than other settings in the program. The minimum is a negative number representing the deepest sounding and the maximum is 0 if you want it to represent the water surface.

Interpolated Bathymetry- Point Spacing 5; Columns 150; Rows 150. These are the default values, but you can change them to better display your data. Keep in mind that the closer the spacing and the more rows and columns you have, the longer it will take to process the data to display it.

9) Hit **OK**; HydroSurveyor will now start the project with the default windows open (you can use the Windows menu item in HydroSurveyor to add additional data windows). The two most useful and the easiest to monitor your progress are the Vertical Control Beam range (the depth soundings) and the Boat Track, showing the line the boat is making on the map.

Calibrating the Compass

Now that the project has been created, perform the compass calibration test. Do not connect the devices before performing this step. When HydroSurveyor is communicating with the ADCP, the Utilities program will not be able to at the same time.

- 1) Select **Maintenance-Run Utilities** option under the **File** pulldown menu
- 2) Select RS-M9 5217 on Com5; this will open the calibration screen. If this selection does not appear then the ADCP is not communicating with the software. Check that both the ADCP radio and the radio dongle are fully attached and that the Yuma is recognizing the port. You can look in the device manager to see if there is a USB serial device attached to Com 5.
- 3) Once the device has been selected, choose the **Calibrate compass** option on the menu. This should bring up the calibration screen.
- 4) When you are ready to calibrate, hit the start button and rotate the boat slowly. It should take about one minute per rotation and you will want to do two full rotations. Make sure that the compass readings on each of the pitch and roll charts are being filled in.
- 5) Just before the timer hits two minutes, hit stop and wait for your calibration results. If the calibration is good, continue. If not, redo the calibration.

Exit the utilities completely until you are back to the main HydroSurveyor screen.

Running the Survey

- 1) Hit the **Connect Devices** button on the main HydroSurveyor screen. A new window will open and you should see the connection status of the HydroSurveyor and the GPS. The notices will turn yellow when searching and then green when the devices are found. If you get an error, the first thing to check is the lights on the PCM. They both need to be green for HydroSurveyor to communicate with them.
- 2) If everything connects OK, then hit the **Start** button. This will start the ADCP and GPS and exit you back to the main screen.
- 3) When you are in position to start the survey, hit the **Start Logging** button at the top of the screen. You should see depth data and your track appear on the screen.
- 4) As you are logging, if you run into problems or hit an area that you do not want to log, you can hit the **Stop Logging** button to stop collecting data until you are ready again. You also select this button at the end of your survey.
- 5) When you are finished with the survey and have stopped logging, select the **Disconnect Devices** button to put the ADCP and GPS into a standby mode (helps to save batteries).
- 6) Under the **File** menu, select **Close Project** to close out the file. This is if you are going to then open another project soon and want to get everything ready. If you leave the project open, the computer will begin processing the data to give you the bathymetric views and velocity views. This is very processor intensive and slow on the Yuma. If you are trying to conserve battery life, I suggest that you wait until the end of the day or back in the office before looking at these views.
- 7) If it is going to be a while between surveys, close HydroSurveyor and shut down the computer to conserve battery life. If there is little risk of getting the batteries or the inside of the PCM wet, you can also remove the PCM batteries to preserve life.

Post-Field Season

- 1) Ensure hydrosurveyor files have been downloaded. The files will be processed by the PI or trained hydrosurveyor operator.
- 2) Wipe down equipment with a soft cloth or similar to remove debris (mud, algae) before placing in case for long-term storage.
- 3) Name saved hydrosurveyor files as L02_“Park Unit”_“YYYYMMDD”_“Point Name”. See naming convention for Hydrosurveyor files in SOP 17.

SOP 11: Field Form Handling Procedures

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This Standard Operating Procedure describes how to process field data forms (data deliverable L08).

Field Form Handling Procedures

As the field data forms are part of the permanent record for project data, they should be handled in a way that preserves their future interpretability and information content. If changes to data on the forms need to be made either during or after field data acquisition, the original values should not be erased or otherwise rendered illegible. Instead, changes should be made as follows:

- 1) Draw a horizontal line through the original value, and write the new value adjacent to the original value with the date and initials of the person making the change.
- 2) All corrections should be accompanied by a written explanation in the appropriate notes section on the field form. These notes should also be dated and initialed.
- 3) If possible, edits and revisions should be made in a different color ink to make it easier for subsequent viewers to be able to retrace the edit history.
- 4) Edits should be made on the original field forms and on any photocopied forms.

These procedures should be followed throughout data entry and data revision. On a yearly basis, data sheets are to be scanned as PDF documents and archived. The PDF files may then serve as a convenient digital reference of the original if needed. Hard copies of all field forms will be archived with the PI, at the park, and within the park museum/library.

Annotating and Organizing Field Forms

At the end of each field day check that all appropriate fields are filled in on each form, especially the date and time of collection. Write initials of persons collecting the data in the appropriate field on each data sheet. For sampling events with multiple data sheets write “Page 1 of X” on the top right-hand corner of each sheet, where X is the total number of sheets in that set. Keep datasheets in chronological order whenever possible.

All physical datasheets must be kept organized and safe in a plastic file folder or similar. At the end of each sampling day, take out field forms from the field clipboard and move them to a plastic storage folder (or similar safe storage container). Make sure all data sheets are dry before storage (you can hang them in a dry preferably warm place like a bunkhouse overnight to dry).

Enter field data at the end of each sampling day if a field laptop or tablet is available. When entered, have the person entering the data write their initials followed by “entered” and the date on the top right-hand corner of each page.

A different person than the original enterer will then QAQC the entered data. This person will check 100% of data transferred from the field data form to the Excel spreadsheet. Once a data sheet has been QAQC'd that person conducting the check will write their initials, followed by “QAQC” and the date, at the top right-hand corner of the page.

If no laptop or tablet is available then keep the physical data sheets in a safe place until data entry is possible. If more than 3+ days of data collection will occur before data entry is possible, then it is recommended that photographs of data sheets be taken and saved as a backup. For all files, follow the naming conventions outlined in SOP 17.

Office Procedures

If not done previously, enter all field data into a project Excel sheet when returning from the field. Follow the entering and QAQC procedures described in the previous section. See SOP 15: Data Entry, Verification, and Reporting for more information on entering field form data into a digitized project database.

Scan all physical data sheets and save copies as PDFs as soon as feasibly possible after returning from the field. Save PDF copies of physical data sheets following the naming convention outlined in SOP 17 (also see SOP 17 for standard directory structure for Coastal Lagoons Vital Signs Monitoring Protocol). For example, a water quality collection data sheet from Krusenstern Lagoon, collected on June 14th, 2017 would be saved with the following name:

L08_CAKR_KR_NS_20170614_WQ

A fish data collection sheet from the outlet of Krusenstern Lagoon and collected using a beach seine on the same date would be named:

L08_CAKR_KR_OF_BS_20170614_FISH

Note that two sided field data forms should be scanned and saved as a single PDF.

IRMA Data Store

See SOP 19: Vital Sign Products Management for information on adding uploading field data forms to IRMA data store.

Original physical data sheets will ordered chronologically, and stored in designated filing cabinet for 3 years.

SOP 12: After the Field Season

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This SOP covers post-field work equipment maintenance for equipment used as part of the Coastal Lagoon Vital Sign Monitoring Protocol. It also covers post-field work handling of water samples, data, and data sheets.

A master equipment list for the entire Coastal Lagoon Vital Signs Monitoring Protocol can be found in Appendix S1.A of SOP 1: Before the Field Season. The master equipment list should be updated simultaneously if this or any SOP requiring an equipment list is revised/

Equipment Maintenance

1. After each field day, rinse all equipment with clean fresh water. Smaller equipment (i.e., fish measuring boards, pliers, water sampling equipment) can be rinsed with a few quick swishes in fresh water or less brackish lagoon water. Larger equipment (i.e., fish nets) do not need to be rinsed after each field day, but all debris (sticks, fish scales, mud) should be removed.
2. The YSI sonde should be prepared for short term storage (see SOP 7: Sonde Probe Calibration and Operation). Cables and handheld display should be dried with a clean towel before being placed in a hard sided container.
3. Cameras and other electronic equipment should be dried before being stored in a hard sided container.

Downloading Data

Data may be downloaded after sampling events (if field computer is available) or back at park offices (NPS office in Kotzebue). Data should be entered or downloaded by the person responsible for collecting field data (water quality data should be downloaded by the Water Quality Technician, fish data by the Biological Technician) under supervision by the Fish Biologist or PI. This should be done as soon as possible after a sampling event, and not after the close of the field season.

YSI EXO2 Sonde Multiparameter Probe

1. Rinse the sonde probe with fresh water, and dry the cable and handheld display.
2. Fill the calibration cup with fresh water and screw on over the sensors to keep them moist.
3. Allow unit to dry.
4. Upload data onto a computer (see SOP 7)
5. Put the sonde in a hard sided container

Digital Cameras

1. Rinse camera if soiled or exposed to brackish or salt water.
2. Dry with a clean cloth.
3. Upload pictures to the computer (see SOP14)
4. Remove camera batteries and charge. Do not leave batteries in camera for long term storage.
5. Put camera in case for storage.

HOBO Level Loggers

1. If removing HOBO Level Loggers from the field, note the day and time of removal on a data sheet, and carefully remove the logger from its housing.
2. Remove any material used to anchor the logger in the field and follow leave no trace practices.
3. Upload data from level logger onto the computer (SOP 9).
4. Rinse the logger and store in a dry location.

Post-Field Procedures for Water Samples

Water samples should be kept cold at all times. Upon return from the field, water samples will be logged-in on a chain of custody (COC) form, then cold-shipped to a receiving lab. Alternatively, samples can be frozen until later processing. A representative from the receiving lab must sign off on the COC form upon sample arrival.

The signed COC form should be scanned and saved electronically with the title:
L07_Park_Lagoon_Site Name_YYYYMMDD_COC.

All returned water quality lab results should be scanned (if in hard copy) and saved electronically with the title:

L06_PARK_Lagoon_Site Name_YYYYMMDD_WQ

See SOP 17 for standard directory structure and data deliverables naming conventions.

Post-Field Procedures for Handling Data

6. Wipe of any debris (scales, mud) that may have accumulated on data sheets. Allow data sheets to dry.
7. Store securely in a three ring binder or similar folder until a computer is available for data entry.
8. The Biological Technician will enter all field data sheets into the master database.
9. After entry, data sheets will be ordered and scanned into a single PDF file and saved as data deliverable L08 (see the deliverables schedule for detailed specifications)
10. Original field data sheets (data deliverable L09) should be stored in the designated filing cabinet for three years (see SOP 11: Field Form Handling Procedures).

SOP 13: Quality Assurance Project Plan

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This Standard Operating Procedure explains the quality assurance and quality control project plan for the Coastal Lagoons Vital Signs Monitoring Protocol and associated Standard Operating Procedures (SOPs) for the Arctic Network. Field work for this protocol cannot begin until the selection and verification of sampling stations is completed. Water quality and fish sampling can then be conducted in a systematic fashion. Field personnel should be familiar with and follow this SOP after each round of sampling is completed. This SOP outlines the proper quality assurance procedures and quality control processes necessary to fully account for water quality instrumentation, fish collection, data handling, and results for each objective of the protocol.

A master equipment list for the entire Coastal Lagoon Vital Signs Monitoring Protocol can be found in Appendix 1A of SOP 1: Before the Field Season. The master equipment list should be updated simultaneously if any SOP pertaining to or containing equipment lists is revised.

Summary Information

The purpose of this SOP is to provide information on the quality assurance of data collected for this project. A more in depth examination of this is included in the Lagoon protocol data quality standards. This SOP outlines the data quality objectives and intents for representativeness, site location quality, and data quality of biological and physical measurements.

Data Quality Objectives

Measurement quality objectives for the water quality parameters measured by the ARCN coastal lagoon protocol (both field and laboratory) are expressed in terms of bias, precision, and completeness goals (Table SOP 13.1). Bias is defined as the difference between a measured value and the true value (representation of net bias); precision is defined as variation among individual identical measurements (representation of random error); and completeness is the number of samples taken relative to the number of samples expected. These objectives were established by estimating the most likely realistic achievable data quality based on instrument manufacturer's specifications, scientific experience, or historical data.

Table 13.1. Measurement Quality Objectives for Arctic Lagoon Monitoring Protocol (Jones et al. 2017).

Measure / Quality Indicator		Quality Objective
Site Recon		
	Location Accuracy	Sample location within +/- 10m of established waypoint.
Site Establishment		
	Location Accuracy	+/- 3m (horizontal)
	Location Description Detail	Description provided with enough detail to relocate without use of GPS equipment
Photopoints		
	Image resolution	10 megapixel
	Image format	TIFF w/ embedded EXIF metadata
Nutrient samples		
	MDL, Precision, Bias	See lab method performance requirements for specifications

Table 13.2. Laboratory method performance requirements and analysis methods to be used for nutrient chemistry analysis in the Arctic Lagoon Monitoring Protocol (Jones et al. 2017).

Analyte	Units	MDL Objective	Transition Value	Precision Objective	Accuracy Objective	Potential Methods conforming to NELAC guidance
Ammonia (NH ₃)	mg N/L	0.01 (0.7 µeq/L)	0.10	± 0.01 or ±10%	± 0.01 or ±10%	EPA Method 350.2 (1979)
Nitrate-Nitrite (NO ₃ -NO ₂)	mg N/L	0.01	0.10	± 0.01 or ±10%	± 0.01 or ±10%	-EPA Method 353.2 (1979) -Enzyme Catalyzed Reduction
Total Nitrogen (TN)	mg/L	0.01	0.10	± 0.01 or ±10%	± 0.01 or ±10%	Standard Methods #4500-N C, 4500-NO ₃ F and EPA Method 353.2 (1979)
Total Phosphorous (TP)	µg P/L	2.0	20.0	± 2 or ±10%	± 2 or ±10%	Standard Methods #4500-P.B.5, #4500 P.E, and EPA Method 365.1 (1979)

Table 13.3. Sensor performance requirements for use in the Arctic Lagoon Monitoring Protocol (Jones et al. 2017).

Sensor	Range	Accuracy	Response	Resolution
Temperature	-5 to 35°C	±0.01°C	<1 sec	0.001 °C
Conductivity	0 to 200 mS/cm	0 to 100: ±0.5% 100 to 200: ±1%	<2 sec	0.01 mS/cm
Salinity	0 to 70 ppt	0.2 ppt	Calculated from conductivity	0.01 ppt
Dissolved Oxygen	0 to 50 mg/L	0 to 20 mg/L: ±0.1 mg/L 20 to 50 mg/L: ±5%	<5 sec	0.01 mg/L
pH	0 – 14 units	±0.1 pH unit	<3 sec	0.01 units
Turbidity	0 – 4000 FNU	0 – 1000 FNU: 2% 1000 – 4000 FNU 5%	<2 sec	0.1 FNU
Chlorophyll	0 to 400 µg/L Chl	Linearity: R ² >0.999	<2 sec	0.01 µg/L Chl
Depth	0 – 10 m	0.004 m	<2 sec	0.01 m
Level	1.0	20%	30%	95%

Representativeness

The sampling design for the Coastal Lagoon monitoring protocol incorporates both fixed and random sampling sites. The inclusion of randomly chosen stations should represent a spatially unbiased characterization of the water quality parameters monitored within lagoons. The inclusion of fixed sites will allow for monitoring of trends by park resource managers.

Site Location

Sampling locations for each lagoon will be provided to field personnel as coordinates of latitude/longitude and decimal degrees. The crew will use global positioning system (GPS) equipment to locate each sampling site. The acceptable tolerance goal for locating sampling stations is within ± 100 ft of the given coordinates.

Unless there are substantiated reasons that prevent field crew from sampling within a define area, field crews will strictly adhere to the above guidelines for establishing a sampling station. Randomly selected sites may fall in locations not suitable for sampling. If this situation occurs, field personnel will note the current environmental conditions and proceed to the next random point.

Water Measurements

Water measurements will be collected to ensure the most appropriate use of the instrument. Pre-season calibration and post season calibration provide for the opportunity to understand and correct for instrument sensor drift. The accuracy of the data collected by the water quality instruments is reflected in the sensor specifications for individual sensors. As changes to sensors occur the accuracy is likely to increase.

Biological Measurements

Biological measurements and species identifications are frequently the subject of concern with regards to data quality. Representative images are taken of the species collected to provide for a way to check identifications at a future data and ensure that appropriate measures are in place to verify the information collected. This is particularly important when species in question are collected and identification structure may be damaged (such as by the net). It is expected that technicians carrying out field operations will be able to satisfy the PI in an office setting as to their ability to identify potential species. The fisheries biologist may provide this assurance as appropriate.

Training

All field personnel must first successfully demonstrate proficiency in each component of field sampling data and collection before they will be authorized to collect field data and samples. The PI and Fish Biologist will be responsible for ensuring that all personnel are adequately trained in all aspects of field operations. Training will include selecting and locating sites and the operations of field equipment. See SOP 2 (Training Technicians). Review of training processes and procedures will be conducted annually.

Changes in Instrumentation

Any changes in instrumentation must follow the following requirements:

- Equipment must currently be under use by the other agencies doing comparable water quality work in the Artic region.
- Equipment must have been certified through the International Organization for Standardization
- Equipment must have been verified as performing to manufacturer published specifications through an external program such as the EPA sponsored Environmental Technology Verification (ETV) program.
- All probes must be field replaceable without opening the sonde or exposing the internal electronics to the environment.
- Batteries must be field replaceable without exposing the internal electronics to the environment.

- The equipment as listed must meet all standards set by the government, including partner agencies such as EPA and USGS.
- Equipment sensors must have anti-fouling capabilities to protect against bio-fouling under extended deployment operations.

Multi-parameter Water Quality Data logging Sonde

Equipment Standards

The equipment will be checked and verified for proper functioning prior to and after all field deployments. Equipment will be cleaned and maintained following field operations and should be sent in annually to the manufacturer for servicing.

All sensors will be assessed for proper function and replaced based on the manufacturer's recommendation. In cases where the sensor is functioning properly beyond the manufacturer's recommendation, it should not be used beyond the current field season. The potential for the sensor to fail during deployment beyond a single field season of use is not worth the cost of replacement or lost data.

Pre and post field calibration reports will be saved as a part of the metadata for future comparison.

Monitoring Process

Field operations will include deployment of multiparameter sondes. Data collected in the field will be collected consistent with outlined SOPs. Any deviations from those SOPs must be noted and appropriate explanation as to why there was a deviation. This data will be flagged.

Biological data collected will be collected as outlined in the SOPs. Representative images will be taken of all species to verify the accuracy of species identifications. All questionable species will be photographed as will all abnormalities associated with individual species. Field data will be collected and entered into the database following the field operation.

Data Verification

Images

All images of species will be used to verify the accuracy of the species. If there are any misidentifications of species, these will be corrected as will the associated data. Site photographs will be used along with GPS coordinates to verify sampling in the appropriate locations.

Reporting Standards

Any data flagged should not be included in the overall trend analysis unless appropriate qualifications are included. Data used for reporting should be verified and certified prior to use for reporting purposes. And data released prior to data certification must have appropriate preliminary data caveats attached to the data. This should only be done in purposes where management must make a decision based on existing data available. Data should not be disseminated more broadly until data certification occurs.

SOP 14: Handling Photographic Images

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This Standard Operating Procedure describes how to process deliverable L05, photographic images, collected by field crew during the course of conducting project-related activities. Images that are acquired by other means—e.g., downloaded from a website or those taken by a cooperating researcher—are not project records and should be handled separately.

Uploading Photographs

1. Connect the digital camera to the computer using its USB cable
2. Turn on the camera
3. Upload images
 - a. On the computer select Start>My Computer>(Drive Destination)
 - b. The camera will appear under “Devices with Removable Storage”
 - c. Open the data files for the day(s)/month photos were collected
 - d. Highlight all images
 - e. Drag the images into the data files folder
4. Open all photos on the computer to ensure that the data was accurately transmitted and correct orientation
5. Save photos in the appropriate folder on the designated computer, in a L05_Lagoon_PHOTOS folder with a subfolder named, L05_Park Unit_Lagoon_Site_YYMMDD (see SOP 17 for naming conventions). Use a batch renaming software program for the bulk of the trip photos with the naming convention.
6. Double check that all photos have been uploaded, then delete files from the camera
 - a. In the camera folder, drag all photos to the trash can
 - b. Click on YES when REALLY DELETE? appears
7. Disconnect camera from computer
8. Turn off camera
9. Remove camera batteries, recharge, and store as appropriate

Overview

Care should be taken to distinguish data photos from incidental or opportunistic photos taken by project staff. Data photos are those taken for at least one of the following reasons:

- To document a particular feature or perspective for the purpose of site relocation
- To capture site habitat characteristics and possibly to indicate gross structural changes over time
- To aid in identifying a fish to species

Data photos are linked to specific records within the database, and are stored in a manner that permits the preservation of those database links. Other photos—e.g., of field crew members at work—may also be retained but are not necessarily linked with database records.

Effectively managing hundreds of photographic images requires a consistent method for downloading, naming, editing, and documenting. The general process for managing data photos proceeds as follows:

1. File Structure Setup: Set up the file organization for images prior to acquisition (see SOP 17 for standard directory set up and file naming conventions)
2. Image Acquisition
3. Download and Process
 - Download the files from the camera.
 - Rename the image files according to convention.
 - Copy and store the original, unedited versions
 - Review and edit or delete the photos
 - Move files into appropriate folders for storage
4. Establish Database Links
5. Deliver Image Files for Final Storage

File Structure Setup

Prior to data collection for any given year, project staff will need to set up a new folder under the IMAGES folder in the project workspace.

[Year] >	The appropriate year – 2017, 2018, etc.
_Processing >	Processing workspace
[Park Code] >	Arrange photos by park: BELA or CAKR
Data >	Data images
[Site_code]	Arrange by sampling locations, or by
[Date]	date, for images not taken at sampling locations
Miscellaneous >	Non-data images taken by project staff
[Site_code]	Arranged by sampling locations, or by
[Date]	by date, for images not taken at sampling locations
Originals >	Renamed by otherwise unedited image file copies
[Site_code]	Arranged by sampling locations, or by
[Date]	by date, for images not taken at sampling locations
Non-NPS >	Images acquired from other sources

This folder structure permits data images to be stored and managed separately from non-record and miscellaneous images collected during the course of the project. It also provides separate space for image processing and storage of originals. For all images that are to be linked to the database, the image files will need to be copied to the appropriate image folder under the database folder, as shown below. This will ensure that the links to the database are preserved at all times. See below for database image workspace structure.

```

Coastal Lagoon Database >
    Database_Images >
        1_Station_Images >
            [Year]
                [Park]
  
```

2_Sampling_event_images
[Year]
[Park]

Folder Naming Standards

In all cases, folder names should follow these guidelines:

- No spaces or special characters in the folder name
- Use the underscore (“_”) character to separate words in folder names.
- Try to limit folder names to 20 characters or fewer.
- Dates within folder names should be formatted as YYYYMMDD (for better sorting).

Image Acquisition

Capture images at an appropriate resolution that balances space limitations with the intended use of the images. Although photographs taken to facilitate future navigation to the site do not need to be stored at the same resolution as those that may be used to indicate gross environmental change at the site, it may be more efficient to capture all images at the same resolution initially. A recommended minimum raw resolution is 1,600 x 1,200 pixels (approximately 2 megapixels).

Processing of Photos

1. Download raw, unedited images from the camera in the appropriate “_Originals” folder
2. Copy images to be processed into the “_Processing” folder
3. Set contents in “_Originals” folder as read-only by right-clicking in Windows Explorer and checking the appropriate box. These originals are the image backup to be referred to in case of unidentified file alteration or deletion.
4. Rename images according to convention (see below)
5. Process the images in the “_Processing Folder”. Suggested processing steps are as follows:
 - a. Delete any poor quality photos, repeats, blurred or otherwise unnecessary photos. Low quality photos might be retained if the subject is highly unique, or the photo is an irreplaceable data photo.
 - b. Rotate the image to make the horizon level.
 - c. Photos of people should have ‘red-eye’ glare removed.
 - d. Photos should be cropped to remove edge areas that grossly distract from the subject
6. When finished, move the image files that are to be retained and possibly linked in the database to the appropriate folder; data images under the “Data” folder, other images under the “Miscellaneous” folder. Photos of interest to a greater audience should be copied to the park Digital Image Library. To minimize the chance for accidental deletion or overwriting of needed files, no stray files should remain in the processing folder between downloads.
7. Images that are to be linked to the database should be moved into the appropriate image folder within the database folder.

8. Depending on the size of the files and storage limitations, contents of the “Originals” folder may be deleted if all desired files are accounted for after processing.

Large groups of photos acquired under sub-optimal exposure or lighting can be batch processed to enhance contrast or brightness. Batch processing can also be used to resize groups of photos for use on the web. Batch processing may be done in ThumbsPlus, Extensis Portfolio, or a similar image software package.

Image File Naming Standards

In all cases, image names should follow these guidelines:

- No spaces or special characters in the file name
- Use the underscore (“_”) character to separate file name components
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters
- Park code and year should either be included in the file name or conclusive by the directory structure

The image file name should consist of the following parts:

- The date of data capture (formatted as YYYYMMDD)
- The sampling location (if recorded at a sampling location)
- Optional: a brief descriptive word or phrase
- Optional: a sequential number if multiple images were captured
- Optional: time (formatted as HHMM)

Delivering Image Files for Final Storage

Note: Please refer to SOP 16: Data Analysis and Reporting and SOP 19: Vital Signs Product Management in IRMA Data Store

At the end of the season, and once the year’s data are certified, data images for the year may be delivered along with the working copy of the database to the Data Manager on a CD or DVD. To do this, simply copy the folder for the appropriate year(s) and all associated subfolders and images onto the disk. These files will be loaded into the project section of the ARCN Digital Library, and the database links to data images will be updated accordingly.

Prior to delivery, make sure that all processing folders are empty. Upon delivery, the delivered folders should be made read-only to prevent unintended changes.

SOP 15: Data Entry, Verification and Certification

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Figures

Figure S15.1. Schematic of data flow to the STORET database.....	104
Figure S15.2. Schematic of data flow to the Aquarius database	106

Purpose

This Standard Operating Procedure document describes the general procedures for entry, verification and certification of lagoons monitoring field data

Tidy data principles

It is critically important that everyone involved in the lagoons monitoring program commit to tidy data principles ([Hadley, 2014](#)) so that we may focus on data analysis rather than the enormously time-consuming process of tidying messy data.

“Tidy data is a standard way of mapping the meaning of a dataset to its structure. A dataset is messy or tidy depending on how rows, columns and tables are matched up with observations, variables and types. In tidy data:

- 1. Each variable forms a column of a consistent data type.*
- 2. Each observation forms a row.*
- 3. Each type of observational unit forms a table. (Hadley, 2014):*

Reviewing Hadley (2014) before embarking on any data management activity will improve the quality of our science and minimize data processing time.

Discrete Water Quality

Water quality data collected under the ARCN lagoons monitoring protocol must be entered, quality-checked, documented, managed, and made available to others for a variety of purposes, such as management decision-making, research, and education. The National Park Service (NPS) Water Resources Division (WRD) developed a database application called the Water Quality Database Template, or NPSTORET, to facilitate management of water quality data. NPSTORET facilitates the importing of water quality data into a copy of Earthsoft’s EQUIS database maintained by WRD. From EQUIS, water quality data is imported into the National STORET (STORage and RETrieval) Data Warehouse administered by EPA, as required by the water quality component of the Natural Resource Challenge (NPS 1999), NPS-75, and NPS Reference Manual 77. NPSTORET is best suited for water quality data that comes from discrete sampling during individual site visits.

NPSTORET Database

Water quality data are managed according to guidelines from the NPS Water Resources Division. In accordance with these guidelines, the desktop database application NPSTORET will be used to enter, store, document, and transfer discrete (or snapshot) water quality data. The ARCN oversees the use of NPSTORET per the Network’s water quality monitoring protocols and ensures that data are transferred at least annually to the NPS Water Resource Division for upload to the EPA STORET database/Water Quality Exchange (WQX) (Figure 1).

STORET is an interagency water quality database developed and supported by the Environmental Protection Agency (EPA) to house local, state, and federal water quality data collected in support of managing the nation’s water resources under the Clean Water Act. NPS Director’s Order 77 indicates that the NPS should archive water quality data in STORET, and the

NPS WRD mandates that any data collected as part of a WRD-funded project get archived in STORET. The NPS uses STORET as a repository of physical, chemical, biological, and other monitoring data collected in and around national park units by park staff, contractors, and cooperators. The NPS operates its own Service-wide copy of STORET and makes periodic uploads to the EPA STORET National Data Warehouse so that data collected by and for parks will be accessible to the public.

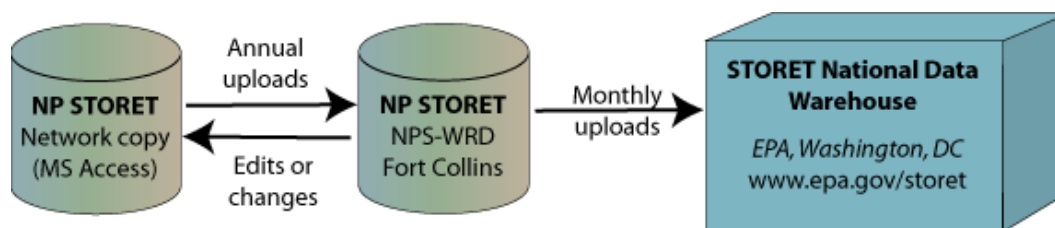


Figure S15.1. Schematic of data flow to the STORET database: water quality data are transferred from the Network to the national master database and ultimately to the master database. Public access to STORET is available via an online clearinghouse.

The database design for NPSTORET is described in its associated documentation. Maintenance and documentation of NPSTORET is performed by NPS WRD. Because it must be compatible with the Oracle-based EPA STORET, NPSTORET is a complex MS Access implementation. The latest version of NPSTORET can be found at: <http://nrdata.nps.gov/programs/water/npstoret/>.

The lagoons monitoring program will maintain one master copy of NPSTORET, available in the lagoons working directory on the ARCN shared drive. This is the only copy of NPSTORET that can be used to export data to other locations (i.e., WRD). For analysis, the data from the master copy of NPSTORET, that has passed all QA/QC procedures, must be used.

Data Entry

Requirements for data entry into NPSTORET are detailed in the documentation for users. We present a summary of data entry below, and refer staff to the most recent NPSTORET documentation for the specifics.

Project staff enters site establishment data in the NPSTORET Station Entry Template as soon as possible following the initial site visit to each sample location. This prompt action is a good data management practice and an NPSTORET requirement that enables parameter data entry.

Any notes taken in the field regarding collection of data with the sonde are transcribed to NPSTORET in a field for comments and notes. Results of laboratory analyses typically are sent to the project manager in a MS Excel spreadsheet and on hard copy forms. The project manager will verify both sets of data and follow-up with the contract laboratory if any discrepancies are noted or any questionable results are reported. Project staff will import the verified data into NPSTORET.

Non-electronic field data recorded on hard copy data sheets are manually-entered into a MS Excel spreadsheet. At the end of the season when all data are entered, the project leader will

perform or coordinate a check of 100% of this manually-entered data prior to import into NPSTORET.

Data Verification and Quality Assurance

A random check of 3% of all electronically transferred data (GPS, multiprobe, and laboratory data) is also performed after it is imported into NPSTORET, to ensure no problems occurred during data transfer. As data are entered into NPSTORET, either by keyboard or using an import routine, a suite of QA/QC procedures exist that compare the entered data with expected formats and accepted data value ranges or domains. If the entered data do not pass a form-based QA/QC test, NPSTORET prompts the user to make corrections and re-enter the data. For most of the form-based tests, the NPSTORET database will not accept out-of-bounds data, and correction is mandatory; for some range tests, out-of bounds data are accepted after a user prompt, but are flagged accordingly. The QA/QC procedures on imported data perform similar tests, but exceptions that do not pass QA/QC are presented to the user and must be reconciled before the record or dataset can be accepted by NPSTORET.

Additional comparison tests will be run on data in NPSTORET to flag records that are outside the expected rate of change for a parameter based on previous records for that parameter. These suspect data points are reviewed by an expert user and can be corrected, flagged, or excluded from the dataset.

As mentioned above, NPSTORET performs numerous QA/QC checks on the data as they are entered and stored. Additionally, once the data are transferred to WRD, more QA/QC procedures are performed. The Network's water quality data records are regarded as being in provisional status until they are returned to ARCN from WRD, or are accepted by WRD without changes after the final QA/QC steps. Each individual record in the water quality dataset always has one, and only one, status flag indicating its status as provisional or final. Finalized data can still be edited and changed if errors are discovered after review in reporting and analysis, but the status of those records reverts to provisional and they must be resubmitted to the master STORET version at WRD and returned before they can be reassigned as finalized data records.

A user's identification is assigned to each aspect of data handling, from collection through the final steps of QA/QC. On data sheets, the identity of the data collector(s) is recorded and is transcribed into the data entry forms in NPSTORET. Additionally, NPSTORET records the user name (login) for every table entry or modification. Only qualified users who have been trained and given edit permissions are allowed to edit data in NPSTORET. These procedures protect the integrity of the data and allow the history of each data record to be traced.

Certification

Prior to distributing the data for any type of use, the project manager or other appropriate water resource specialist validates the NPSTORET database content in the master water quality data file. Validation is performed at least once each year after data collection and entry are complete and before data are submitted to the NPS Water Resource Division, usually by the end of each calendar year. Laboratory results must be imported and validated in NPSTORET as soon as possible following receipt of the results. The project manager coordinates receiving and entering

data with project staff and then performs or coordinates the validation of lab results. Certification of discrete water quality data will be an iterative process between ARCN and WRD. A validated copy of the NPSTORET database is sent to WRD for review. WRD accepts the database or returns it with a data quality report and suggested corrections. The back and forth continues until the product is acceptable. At this point a standard lagoons certification form is filled out and archived in the IRMA Data Store.

Continuous Water Quality

Database Design

The NPS Inventory and Monitoring program's Water Resources Division has adopted Aquatic Informatics' Aquarius system for storage and visualization of continuously monitored water quality data. ARCN's lagoons monitoring program will utilize a version of Aquarius hosted by WRD for remote data entry, analysis and visualization.

Data Entry

ARCN will follow WRD's standard operating procedures with the documentation provided by Aquarius to flow data from loggers and data import files into Aquarius. A general data flow schematic for continuously collected data is shown in Figure 2.

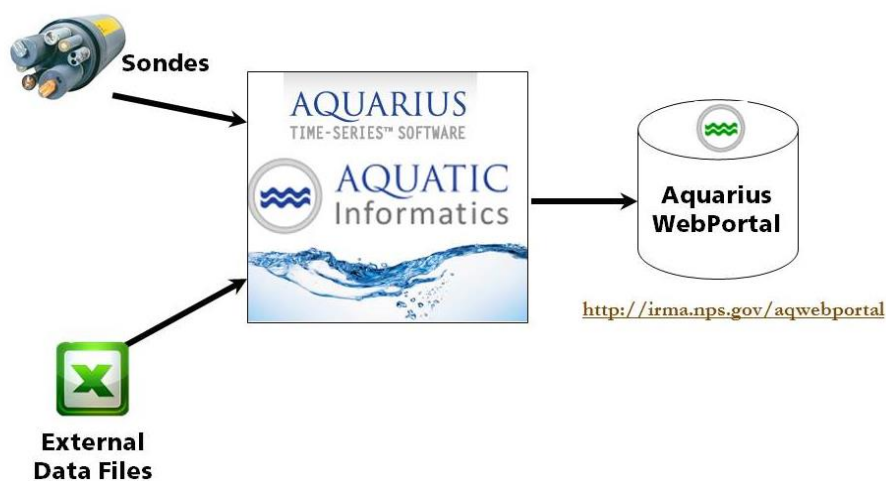


Figure S15.2. Schematic of data flow to the Aquarius database: water quality data from data loggers are transferred from the Network to the WRD-hosted version of Aquarius. Public access to this data is provided through the Aquarius WebPortal.

Quality assurance and Certification

Guidelines for managing time series data are being developed by NPS Water Resources and Inventory and Monitoring (IMD) divisions. At the time of this SOP revision, WRD and IMD are in the process of creating SOPs covering quality assurance, validation and certification of continuous water quality data.

The Aquarius database software used for continuous water quality data has built-in QA/QC tools specifically tailored for time series data. These features tools are particularly useful for dealing

with data gaps, overlaps and out of range values, and will be utilized as part of the QA/QC process used for continuous data imported into Aquarius. At the time of this SOP development WRD and IMD are working cooperatively to create SOPs for quality assurance and data certification for the Aquarius tool. ARCN will adopt the SOPs for these tasks when they are completed.

Executive Order 12906, mandates federal agencies to “...document all new geospatial data it collects or produces, either directly or indirectly...” using the Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata. Water quality monitoring meets the definition of geospatial data and, thus, ARCN is responsible for documenting all public datasets using metadata that meets that standard. NPSTORET and Aquarius require and store a great deal of metadata at the record and project level. Metadata will be developed, using NPSTORET and Aquarius as primary sources that meet the federal standard.

Fish

[Draft]

Data entry

Initial quality control

Review will be accomplished by comparing the original field data sheets against entered data.

Staff will check if all records were imported and fish species identities were correctly assigned against the original hardcopy data sheets. Corrections to data entry errors will be tracked in order to quantify data importing error rates. All of the records will be reviewed by the PI and corrected by the Fish Biologist as needed.

The geospatial component of the Coastal Lagoon Monitoring database will be verified each field season. A database utility linking the database to ArcGIS® software will be used to evaluate all geospatial coordinates. Any corrections will be tracked, and an error rate greater than 10% will require a detailed review of the coordinate fields for all records.

- Ensure:
 - Lagoon names are spelled correctly
 - SiteTypes are allowable
 - Remove any NAs, setting them blank
 - Ensure the Dates are valid
 - Ensure numeric columns do not contain text (example: ‘>200’ entered in the numeric Count column)
- Once the initial quality control procedures above are done export the fish data to CSV format and open in GIS to validate the spatial distribution of sites and to confirm the SiteType designations.
 - Correct or document incorrectly positioned sites

Database integration
Secondary quality control
Validation
Certification

Data on fish collected by the lagoons monitoring program will be stored in a database hosted in ARCN's SQL Server data bank. Various front end applications such as Microsoft Access, ESRI ArcGIS and R, among others, will allow data editing, quality assessment and visualization. These applications, as well as data management scripts, software and documentation will be available in GitHub at <https://github.com/NPS-ARCN-CAKN/ARCN-Lagoons>.

Database Design

As of the time this SOP was written the lagoons monitoring database is not yet built. We will begin development of a database and data management applications as they become necessary. Time and resource constraints dictate an iterative, 'minimum needs' database and application development model at the ARCN, i.e. 'baby steps'. Basic data files will be used until a database makes the work more efficient. Database application development will proceed when user needs become critical. Analytical views will be developed as analyses mature. We will plan for ongoing database and application development and dedicate ourselves to updating technical documentation in lockstep with technical improvements.

Certification

Database records are by default tagged 'Provisional' until all data verification and quality assurance procedures have been run. The project leader authorizes some or all the records in the master database as of analytical quality and these records are tagged 'Certified'. Database controls prevent further editing on such records. Certified records are exported to comma separated values text files and documented with metadata. This dataset package is then published to the master lagoons program's certified Dataset reference.

SOP 16: Data Analysis and Reporting

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This SOP addresses data analysis and reporting for the Coastal Lagoon Vital Signs in the Arctic Network. Data analysis for water quality parameters and fish are outlined with examples to show data structure and statistical tests. Integrated reporting of these components is also identified. This protocol outlines two initial steps of data analysis at each of the unit, landscape, and trend-assessment levels. These steps summarize and determine the range of variation. Reporting types are identified according to the categories in the ARCN monitoring plan, with most reporting occurring on an annual basis. Additional, multi-vital sign synthesis analysis and reporting is not addressed in this SOP.

Analysis Overview

Data analysis is defined here as the processes by which observations of the environment are interpreted into meaningful information. Data analysis also includes quality assurance and control efforts that occur in the field, during exploratory analysis, in summarization, during interpretation, and when drawing conclusions.

For all parameters, the first step will be to summarize measures of mean, median, and variance at each site. Water quality analysis will use the replicates for chemical analyses and the stabilized sensor readings from the sonde. Non-detects and censored data will be used only in non-parametric analyses. These data will be used to calculate a site mean, median, and variance. This information will then be separated into two categories: fixed sites and random sites. Values will be compared to determine if there is a statistically significant difference between the two categories. If there is no difference, the two categories will be grouped and analyzed together. If a difference exists, the following analyses will be done on both groups separately as appropriate (i.e. fixed will not be used for status).

Status of resources (water quality, fish) for the park will be calculated by summarizing the mean, median, and variance of the data. Data will be described both annually and interannually. Water quality data will be compared to applicable water quality criteria standards and the differences noted. Any parameters exceeding the applicable water criteria standard will be highlighted. Those approaching (i.e. within 5%-10% of criteria value) will be noted.

Data from the extended deployment sonde will be used to normalize all physical parameters (this cannot be done for nutrient analyses). For example, DO changes throughout the day, so measurements at the beginning of the day are not comparable to measurements taken at midday. The differences between the extended deployment sonde and the point sample sonde will be compared, and the data then normalized to the first sampling period. Normalized data will then be imported into GIS for spatial analyses. Using the spatial analyst tool, the data for each parameter will be plotted and interpolated, using land mass masking, to give a graphical representation of parameter variance across the park unit as a whole. This is a graphical representation to aid management in identifying areas that would be potential target areas if there was management concern over an aquatic resource. It is intended for identification of potential management target areas only.

All water quality data will be plotted (pH is log data and must be treated as such) with a regression around the points. Correlograms of raw data, data with seasonality removed, and seasonality and trend data removed along with 95 % confidence intervals will be plotted for reporting (McBride2005).

Fixed sites will be used to examine trend. Analytical Strategies

Two basic steps are identified in data analysis for all monitoring data: summarization and establishing the range of variation. All data for fishes and physical and chemical water quality parameters will undergo these two initial steps of data analysis at each of the unit, landscape, trend-assessment, and synthesis levels.

Analytical Approach

Step One: Summarization

This step includes identification and documentation of outliers, missing data, quality control and quality assurance issues, mean or median values, and other descriptive statistics. Data visualization (see Cleveland 1993, 1994; Tufte 1983, 1990, 1997) and exploratory data analyses are an integral component of this process.

Summarization: Fish Specific Analysis

Raw data of fish catch will be standardized for each gear type by calculating Catch per Unit Effort (CPUE). The unit of effort for sampling in this protocol is time (min). Therefore total soak time of all fish collection gear must be carefully recorded for each sampling event. Data collected from each gear type will be analyzed separately.

Species diversity, evenness, and richness will be calculated for the fish community for each lagoon. Simpson's Index (D_s) and Shannon's Index (H) will be used to express community diversity (Shannon and Weaver 1949; Simpson 1949). Evenness will be calculated with the index for Simpson's diversity (V'). Richness will be the total count of fish species (n) observed in each lagoon. Mean, median, and variance will be calculated for each of these metrics.

Community Diversity

Simpson's index values range from 0 (no diversity) to 1 (high diversity) and is based on the assumption that diversity is inversely dependent on the probability that two randomly selected individuals in a community belong to different categories. This probability is calculated as:

$$P_i = \frac{F_i}{T_F}$$

Where, F_i = Number of individuals of a given species found, and T_F = Total number of individuals found for all species combined

Finding the sum of the probabilities yields the Simpson's measure:

$$D = \sum_{i=1}^s (P_i^2)$$

Where s = the number of species

Finally, the Simpsons Diversity Index is:

$$D_s = 1 - D$$

Shannon's index of diversity (H) will also be calculated. Although this index provides similar information to Simpson's, it is more sensitive to rare species. Shannon's index is calculated as follows:

$$H' = - \sum_{i=1}^s (p_i)(\log_e p_i)$$

Where p_i = the proportion of the total sample represented by the i th species, and s = the number of species.

Community Evenness

Evenness will be calculated using an index of evenness (V') based on Simpsons Diversity Index, and is calculated as follows:

$$V' = \frac{1 - D}{(1 - D)_{\text{Max}}} = \frac{(1 - D)}{(1 - \frac{1}{s})}$$

Where $(1 - D_{\text{Max}})$ is the maximum possible value of Simpson's index, and s = the total number of species. Simple mean and variance will also be calculated for Simpsons D_s (see SOP 8: Fish Collection and Sampling for more information).

Community Richness

Community richness is a simple count of unique species present within each lagoon. Species count will be represented by n .

Length Frequency Distributions

Length data will be compiled into length frequency histograms for each fish species within each lagoon. Length (mm) will be measured and recorded for select fish species. These are: Humpback Whitefish, Ninespine Stickleback, and Starry Flounder. Length frequency distributions will be calculated for each species, for each gear type, for each lagoon, annually. These distributions will be used to visualize the size composition of the fish community and identify possible age classes. Step Two: Range of Variation

This step establishes expected boundaries for response variables, typically as quartiles, and identifies data that falls outside these expected bounds. Establishing a range of normal variation may take years or decades for many parameters, but providing managers and decision-makers with the best available information will strengthen adaptive management feedback.

Step Two: Fish Specific Variation and Long-Term Trends

Range of variation for fishes needs to be calculated separately for each gear type. Each gear type (i.e., gill net, fyke net, beach seine) all function differently, and therefore have bias towards the type and size of fish captured. Data collected from each gear type must be analyzed separately

for basic summarization, and interannual analysis. Comparison among gear types is encouraged, and can provide insight on individual gear type bias.

Change in community composition will be calculated by comparing indices over time. A simple analysis of variance (ANOVA) will be used to detect significant difference in variance of Diversity (D_s and H'), evenness (V), and richness between years. Regression analysis of each metric will be used to detect change over multiple years. Power to detect change is discussed in section 2.4 Existing Estimates of Expected Variation in the main Lagoon Protocol narrative.

Integration of Water Quality and Fish

Integration of water quality and fish community data is not a part of the current analysis portion of the protocol. A number of multivariate analyses may be appropriate for the lagoon monitoring data to examine the potential correlations between variables and fish populations or lengths. However, the specific analyses are beyond the scope of this SOP at this time. Consultation with a biometrician is recommended.

Reporting Overview

Reporting Types

Unlike the analysis log files which will generate individual files for each park and each of the three analysis strategies (unit, landscape, and trend assessment levels), reporting documents will integrate both parks and analysis strategies. We have identified a cohesive suite of seven product categories: (1) program and protocol reviews, (2) monitoring protocol and project reports, (3) status and trends reports, (4) scientific writing and presentations, (5) management briefings, (6) website communication, and (7) interpretation and outreach.

Reporting Preparation Process

Reports identified in Table 16.2 are to be based on collected data and other science-based documentation. These reports will provide context and explanations for the results presented, as well as include any additional analyses that may result from initial investigations. The ‘analysis log’ files will serve as the basis for most of the reporting results. The Biological Technician for this vital sign is identified as the primary individual responsible for updating the analysis log file and will also be pivotal in preparation of subsequent reports. It is anticipated that the Principal Investigator or another statistically trained individual will be responsible for the statistical analyses.

Drafts of the reporting products will be organized according to the categories outlined above, with key versions and review comments archived, and final versions clearly communicated to ARCN network staff to ensure distribution via websites and other channels.

Specific Instructions for Reports and Publications

Annual reports and trend analysis reports will use the [NPS Natural Resource Publications](#) template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Annual reports will use the [Natural Resource Report](#) template, and trend analysis and other peer-reviewed technical reports will use the [Natural Resource Technical Report](#) template. Instructions for acquiring a series number and other information about NPS publication standards

can be found at: <http://www.nature.nps.gov/publications/NRPM/index.cfm>. In general, the procedures for reports and publications are as follows:

1. The document should be formatted using the NPS Natural Resource Publications template. Formatting according to NPS standards is easiest when using the template from the very beginning, as opposed to reformatting an existing document.
2. The document should be peer reviewed at the appropriate level. For example, I&M Annual Reports should be reviewed by other members of the appropriate project work group. The Program Manager will also review all annual reports for completeness and compliance with I&M standards and expectations.
3. Upon completing the peer review, acquire a publication series number from the NPS Technical Information Center or the appropriate local or regional key official (currently the Regional I&M Coordinator).
4. Upload the file in PDF and MS Word formats to the ARCN Digital Library submissions folder.
5. Send a printout to each Park Curator.
6. The Data Manager or a designee will create a bibliographic record and upload the PDF document to NatureBib according to document sensitivity.

Table 16.2. Schedule for recurring reporting to NPS management.

Briefing Type	Purpose	Primary Audience	Frequency
Protected area managers briefing	Communicate highlights and potential management action items, with 1–2 page briefing statements for each protocol	Park resource staff; Network staff; agency and academic scientists; other Federal and State resource managers, discipline specialists, interpretive staff	Annually
Executive briefings (results synthesis)	Update Superintendents and other VIPs on park-specific findings and potential resource issues; suggest action items where appropriate	Individual Superintendents and other VIPs	As needed
Vital signs monitoring protocol report	Update park, regional, and national resource managers on network and park-specific findings and potential resource issues	Park resource managers, superintendents, regional ecologists, NPS Water Resources Division managers	Annually

References

- Cleveland, W.S. 1993. *Visualizing Data*. Hobart Press, New Jersey.
- Cleveland, W.S. 1994. *The Elements of Graphing Data*. Hobart Press, New Jersey.
- McBride, G.B. 2005. *Using Statistical Methods of Water Quality Management*. Wiley Interscience, Wiley, New York. 313p.

Shannon, C.E., and W. Weaver. 1949. The mathematical theory of communication. University of Illinois Press, Urbana.

Simpson, E.H. 1949. Measurement of Diversity. *Nature*. 163: 688.

Tufte, E.R. 1983. *The Visual Display of Quantitative Information*. Graphics Press, Connecticut.

Tufte, E.R. 1990. *Envisioning Information*. Graphics Press, Connecticut.

Tufte, E.R. 1997. *Visual Explanations. Images and Quantities, Evidence and Narrative*. Graphics Press, Connecticut.

SOP 17: Standard Directory Structure for Data Deliverables

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Tables

Table S17.1. Standardized naming conventions for all Coastal Lagoon Vital Signs Monitoring Program deliverables.....	120
Table S17. 2. Standardized abbreviations for Coastal Lagoons Vital Signs Monitoring Program.	121

Figures

Figure S17.1. Example of the standard data management directory structure for the lagoons monitoring program.....	119
---	-----

Purpose

Seasonally collected data deliverables (Appendix A) are important resources for the lagoons monitoring program and must be meticulously organized to sustain their value to future scientists. The lagoons monitoring program has a standard directory structure for managing raw and processed field data deliverables. This SOP outlines standard procedures for organizing and naming deliverable files in the master lagoons shared drive.

Master Lagoons Monitoring Directory

ARCN provides a master directory for all materials related to the lagoons monitoring program. The convention is to map the ARCN drive as O:\. The lagoons directory path is O:\Monitoring\Vital Signs\Lagoon Communities and Ecosystems.

Contact the Network data manager for a machine path and permissions.

Scope

While all materials related to lagoons monitoring are stored in the lagoons master directory, for simplicity only directories and files related to data deliverables management are discussed in this SOP.

Standard Directory Structure

Error! Reference source not found. shows an example of the standard data deliverables directory structure. This structure should be used when downloading loggers, digitizing data sheets, copying images off of cameras, etc.

Procedure

1. At the first opportunity to build deliverables during a sampling campaign create a top level directory and name it according to the scheme presented in **Error! Reference source not found.**
2. Create a \Data directory and deliverables subdirectories according to the scheme in Figure S17.1.
3. to hold the deliverables subdirectories.
4. Name any files you download or create according to the specifications of the deliverables schedule and file them in the appropriate directory.

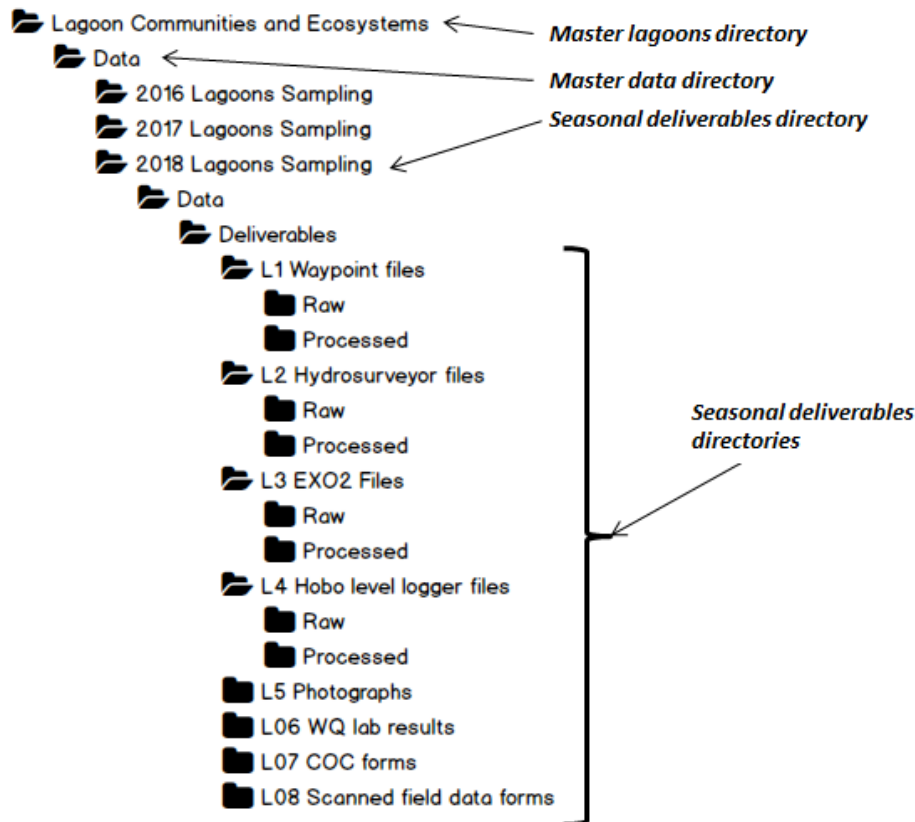


Figure S17.1. Example of the standard data management directory structure for the lagoons monitoring program.

Standard Directory Structure Creation Script

The following Windows batch script will automatically create a directory structure skeleton.

1. Copy the script text below into a text file and change its extension to .bat.
2. Put the batch (.bat) file into the directory where you would like the directory structure to be created.
3. Double click the file to execute.

```
REM ARCN lagoons standard directory structure creation batch file
md "[YEAR] Lagoons Sampling"
md "[YEAR] Lagoons Sampling"\Data
md "[YEAR] Lagoons Sampling"\Data\Deliverables
md "[YEAR] Lagoons Sampling"\Data\Deliverables\"L01 GPS waypoint files"
md "[YEAR] Lagoons Sampling"\Data\Deliverables\"L02 Hydrosurveyor files"
md "[YEAR] Lagoons Sampling"\Data\Deliverables\"L03 EXO2 Sonde Probe data"
md "[YEAR] Lagoons Sampling"\Data\Deliverables\"L04 HOBO Level Logger files"
md "[YEAR] Lagoons Sampling"\Data\Deliverables\"L05 Digital Photographs"
md "[YEAR] Lagoons Sampling"\Data\Deliverables\"L06 WQ lab results"
md "[YEAR] Lagoons Sampling"\Data\Deliverables\"L07 Chain of custody forms"
md "[YEAR] Lagoons Sampling"\Data\Deliverables\"L08 Scanned field data forms"
```

Standard Naming Conventions for Files

All file naming should follow the same general format. For example, a scanned fish field data form from BELA in June 2017 would be given the following name:

L08_BELA_201706_FISH_01

See Table S17.1 for more standardized naming conventions and Table S17.2 for standardized site abbreviations.

Table S17.1. Standardized naming conventions for all Coastal Lagoon Vital Signs Monitoring Program deliverables.

Deliverable	Name Convention	SOP
Waypoint L01	L01 “GPS name” “projection+datum” ”YYYYMMDD” Example: L01_GPS76c_waypt_UTMWGS84_20051225	4
Hydrosurveyor L02	L02 “Park unit” “YYYYMMDD” “Lagoon” “Site Name” Example: L02_BELA_20051225_AQ_OF	10
EXO2 L03	L03 “Park Unit” “Lagoon” “Site Name” “YYYYMMDD” Example: L03_CAKR_KO_R1_20051225	7
HOBO Logger L04	L04 “Park Unit” “Lagoon” “Site Name” “YYYYMMDD” Example: L04_BLEA_KU_ME_20051225	9
Photographs L05	L05 “Park Unit” “Lagoon” “Site Name” “YYYYMMDD” Example: L05_CAKR_KR_TE_20051225	14
WQ Lab Results L06	L06 “Park Unit” “Lagoon” “Site Name” YYYYMMDD_WQ Example: L06_BELA_KU_IF_20051225_WQ	6, 12
Chain of Custody (COC) L07	L07 “Park Unit” “Lagoon” “Site Name” YYYYMMDD_CO C Example: L07_CAKR_KR_R1_20051225_CO C	12
Field Data Forms L08	L08 “Park Unit” “Lagoon” “Site Name”_ “GearType” YYYYMMDD “Data Type” L08_BELA_KU_IF_FYKE_20051225_FISH	11
Original Field Data Sheets L09	Hard copies to be stored in designated filing cabinet for 3 years	12, 11

Table S17. 2. Standardized abbreviations for Coastal Lagoons Vital Signs Monitoring Program.

Lagoon Abbreviation	Full Name, Location
KO	Kotlik Lagoon, northern most lagoon in CAKR
AQ	Aukulak Lagoon, southern most lagoon in CAKR
KR	Krusenstern Lagoon, CAKR
KU	Kupick “Cowpack” Lagoon, BELA
IK	Ikpek Lagoon, BELA
Site Abbreviation	Full Name
IF	Inflow
OF	Outflow
ME	Marine Edge
TE	Terrestrial Edge
R1	Random 1
R2	Random 2
R3	Random 3
NS	Not specified
Fish Gear Type Abbreviation	Full Name
FYKE	Fyke net
GN	Gill net (use GN1, GN2,...GN# if multiples are used within a single sampling event/day/site)
BS	Beach seine (use BS# if multiples are used)
OTHER	Other fish sampling types (e.g., minnow trap, hook and line)

SOP 18: Metadata Development

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This Standard Operating Procedure document describes the guidelines for documenting data and how it should be accomplished.

Metadata Documentation

Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition and other characteristics of a given data set. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all ARCN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed and synthesized

Updated metadata is a required deliverable that should accompany each season's certified data. For long-term projects such as this one, metadata creation is most time consuming the first time it is developed – after which most information remains static from one year to the next. Metadata records in subsequent years only need to be updated to reflect changes in contact information, taxonomic conventions, publication listings, data disposition, quality descriptions, collection methods, analysis approaches or quality assurance for the project. The NPS Metadata Tool and Editor (<https://science.nature.nps.gov/im/gis/metadata.cfm>, accessed April 2017) integrates with the NPS Data Store and is a suggested tool.

Specific procedures for creating, parsing, and posting the metadata record are found in ARCN Data and Information Management Plan, Chapter 7: Data Documentation (NPS 2008).

General procedures:

- 1) The PI reviews data quality annually for certification.
- 2) The PI notates and flags data as appropriate and indicates such in the metadata.
- 3) The PI then notifies the data manger that data verification is complete and the data can be certified for distribution and analytical use.
- 4) The PI should update the metadata interview content as changes to the protocol are made, and each year as additional data are accumulated.

References

National Park Service (NPS). 2008. Data and information management plan: Arctic Network Inventory and Monitoring Program. Natural Resource Report NPS/ARCN/NNR-2008/053. National Park Service, Fort Collins, Colorado.

SOP 19: Vital Sign Products Management in the IRMA Data Store

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Tables

Table S19.1. ARCN/CAKN Vital Signs mater project reference links.	127
--	-----

Figures

Figure S19.1. Vital Sign Project reference architecture in the IRMA Data Store.	126
Figure S19.2. Deliverable schedule example.	Error! Bookmark not defined.
Figure S19.3. Example of use of subdirectory.	129
Figure S19.4. Screenshot of Data Store.	Error! Bookmark not defined.
Figure S19.5. ARCN webpage	Error! Bookmark not defined.

Purpose

ARCN/CAKN Data Management Standard Operating Procedure DMSOP-1:

The IRMA Data Store is the authoritative archive for Inventory and Monitoring products. Each Vital Sign in the ARCN and CAKN has a master Project reference (Figure S19.1, Table S19.1) that describes the program. Monitoring products such as reports, journal articles, raw data deliverables and certified data products are linked to this master Project reference. Future scientists will rely on a well-organized archive of digital resources in order to continue the monitoring and assure the longevity of high quality data products.

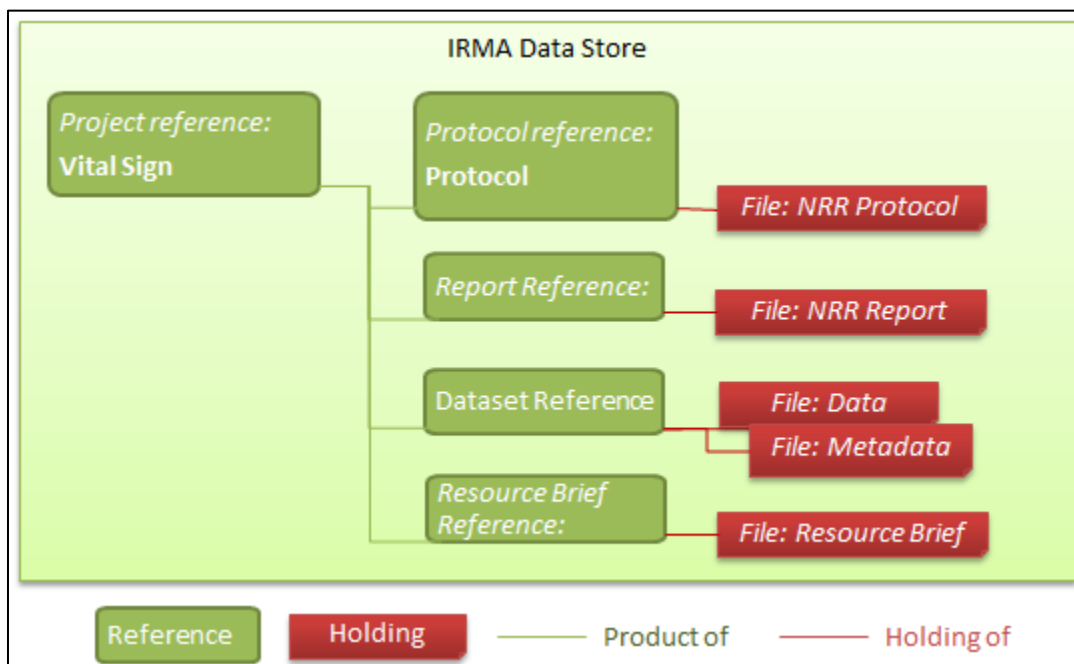


Figure S19.1. Vital Sign Project reference architecture in the IRMA Data Store.

In the Data Store files are known as holdings (red boxes) and descriptors are known as references (green boxes). **Error! Reference source not found.** shows how references may have a 'product of' relationship with a master reference. Each ARCN/CAKN Vital Sign Project reference can have zero or more products related to it. This hierarchy of related digital resources and descriptors provides rich context to the monitoring efforts and maintains the value of informational products over time.

This standard operating procedure describes how project leaders and authorized personnel can document and upload documents to the Data Store. These tasks are elemental to the standard ARCN/CAKN closeout procedure.

Prerequisites

Data Store manages privileges. Some records are not visible to the public. Others are visible only to the NPS as a whole, or individuals within the NPS. In order to edit records you must have editing privileges. If you need editing permissions examine the reference profile for a list of reference owners, any of which can grant you permissions.

Locating a Monitoring Project's Master Project Reference

Method 1: Direct link

Table S19.1 lists IRMA Project references for each Vital Sign in the ARCN and CAKN.

Table S19.1. ARCN/CAKN Vital Signs mater project reference links.

Acronym	Vital Sign	IRMA Project Reference
ARCN	Air Quality	https://irma.nps.gov/DataStore/Reference/Profile/2208372
ARCN	Brown Bears	https://irma.nps.gov/DataStore/Reference/Profile/2210687
ARCN	Caribou	https://irma.nps.gov/DataStore/Reference/Profile/2216435
ARCN	Climate	https://irma.nps.gov/DataStore/Reference/Profile/2210690
ARCN	Coastal Erosion	https://irma.nps.gov/DataStore/Reference/Profile/2210650
ARCN	Dall's Sheep	https://irma.nps.gov/DataStore/Reference/Profile/2214983
ARCN	Fire Extent and Severity	https://irma.nps.gov/DataStore/Reference/Profile/2219489
ARCN	Lagoon Communities and Ecosystems	https://irma.nps.gov/DataStore/Reference/Profile/2216893
ARCN	Lake Communities and Ecosystems	https://irma.nps.gov/DataStore/Reference/Profile/2219173
ARCN	Landbird Monitoring	https://irma.nps.gov/DataStore/Reference/Profile/2219895
ARCN	Moose	https://irma.nps.gov/DataStore/Reference/Profile/2222140
ARCN	Muskox	https://irma.nps.gov/DataStore/Reference/Profile/2219896
ARCN	Permafrost	https://irma.nps.gov/DataStore/Reference/Profile/2220038
ARCN	Shallow Lakes	https://irma.nps.gov/DataStore/Reference/Profile/2215910
ARCN	Snowpack	https://irma.nps.gov/DataStore/Reference/Profile/2221415
ARCN	Stream Communities and Ecosystems	https://irma.nps.gov/DataStore/Reference/Profile/2219172
ARCN	Terrestrial Landscape Patterns and Dynamics	https://irma.nps.gov/DataStore/Reference/Profile/2211095
ARCN	Terrestrial Vegetation and Soils	https://irma.nps.gov/DataStore/Reference/Profile/2220078
ARCN	Western Yellow-billed Loons	https://irma.nps.gov/DataStore/Reference/Profile/2216938
ARCN	Wet and Dry Deposition	https://irma.nps.gov/DataStore/Reference/Profile/2217416
CAKN	Air Quality	https://irma.nps.gov/DataStore/Reference/Profile/2220069
CAKN	Bald Eagle	https://irma.nps.gov/DataStore/Reference/Profile/2216071
CAKN	Caribou - DENA	https://irma.nps.gov/DataStore/Reference/Profile/2221183
CAKN	Caribou - WRST	https://irma.nps.gov/DataStore/Reference/Profile/2217176
CAKN	Climate	https://irma.nps.gov/DataStore/Reference/Profile/2218183
CAKN	Dall's Sheep	https://irma.nps.gov/DataStore/Reference/Profile/2214983
CAKN	Glaciers	https://irma.nps.gov/DataStore/Reference/Profile/2216228
CAKN	Golden Eagles	https://irma.nps.gov/DataStore/Reference/Profile/2220073
CAKN	Moose	https://irma.nps.gov/DataStore/Reference/Profile/2220369
CAKN	Passerines	https://irma.nps.gov/DataStore/Reference/Profile/2220325
CAKN	Peregrine Falcons	https://irma.nps.gov/DataStore/Reference/Profile/2218300
CAKN	Permafrost	https://irma.nps.gov/DataStore/Reference/Profile/2216593

Acronym	Vital Sign	IRMA Project Reference
CAKN	Plant Phenology	https://irma.nps.gov/DataStore/Reference/Profile/2220373
CAKN	Shallow Lakes	https://irma.nps.gov/DataStore/Reference/Profile/2215910
CAKN	Small Mammals	https://irma.nps.gov/DataStore/Reference/Profile/2219630
CAKN	Snow Pack	https://irma.nps.gov/DataStore/Reference/Profile/2210839
CAKN	Soundscape	https://irma.nps.gov/DataStore/Reference/Profile/2220378
CAKN	Streams and Rivers	https://irma.nps.gov/DataStore/Reference/Profile/2215908
CAKN	Vegetation Structure and Composition	https://irma.nps.gov/DataStore/Reference/Profile/2210855
CAKN	Wolves	https://irma.nps.gov/DataStore/Reference/Profile/2218298

Method 2: Locate a monitoring project’s master Project reference from a Network web site:

1. Using a browser, navigate to the ARCN or CAKN website
2. Select a Vital Sign profile by clicking on it
3. Locate the master IRMA Project reference link at the bottom of the page and click on it.

Method 3: Search for a monitoring project’s master Project reference

1. Search for the required Project reference using the Data Store’s search tools.
2. Alternatively, using a browser navigate to the Network Program reference:
 - a. ARCN: <https://irma.nps.gov/DataStore/Reference/Profile/2208369>
 - b. CAKN: <https://irma.nps.gov/DataStore/Reference/Profile/2210836>
3. Select a Vital Sign Project reference and click on it

Adding a Product to a Vital Sign’s Master Project Reference in Data Store

1. Navigate to the IRMA Data Store using a browser.
2. Ensure your Active Directory username appears in the upper right corner indicated that IRMA has authenticated you. Contact your data manager if you need editor permissions.
3. Add the new product to the Data Store. Consult the IRMA help documents if needed.
4. Activate the new reference.

Linking a Reference as a ‘Product of’ a Vital Sign Project Reference

The procedure below assumes you have editor privileges on the master Vital Sign’s Project reference to which you would like to add a product.

1. Navigate to the product reference using a browser.
2. Copy the reference code to your clipboard.
3. Navigate to the Vital Sign master Project reference to which you would like to add the reference from above as a product.
4. Enter editing mode.

5. Click the Products tab.
6. Use the tools provided to search for the new product's reference code.
7. Add the reference code to the list of products associated with the Vital Sign's Project reference.
8. Activate the reference
9. Verify the product
10. Navigate to the Vital Sign's web profile on the ARCN/CAKN website and verify the product.

Seasonal Closeout

In order to better communicate the purpose of the deliverables schedule in monitoring protocols I put together an example of how the schedule is used throughout the data management life cycle. The example is from the draft ARCN Brown Bears protocol but should be similar for other Vital Signs.

About the deliverables schedule

Each Vital Sign protocol ideally has a deliverables schedule. The deliverables schedule may appear in the narrative or in an appendix or other location. The DS describes what data items are collected, their specifications, when they are collected and archived, who is responsible, etc. Here is an example data deliverables schedule:

Realized deliverables management in working directories

The deliverables schedule is realized on a re-measurement cycle and aids in the organization of files as they come in. In the example below a master directory was created in the field for the 2008 Noatak Brown Bear Survey. A `\Data` subdirectory was created to hold the field data deliverables. Deliverable files were named according to the identifier in the deliverables schedule (red box). This example is overly simplified to convey the idea. You will probably need to create more subdirectories and/or file naming schemes to isolate raw data files from processed data files, or to better adapt the process to your needs (Figure S19.3).

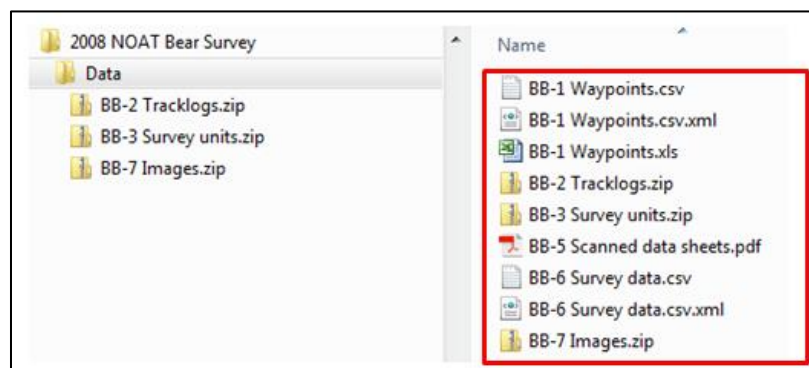


Figure S19.2. Figure S19.3. Example showing well organized and labeled directory structure.

Deliverables management during seasonal closeout

Seasonal closeout is easy when deliverables are well organized in working directories. A private Dataset reference is created for the survey and the various deliverables are uploaded as holdings. When the holdings reconcile with the deliverables schedule then seasonal closeout is complete.

Important note: *Deliverables are not certified datasets and should not be publicly available.* You can't see from the screenshot but the deliverables Dataset reference has been configured to show metadata but not allow file downloads (i.e., NPS Only). Analytical quality data should only be published through a certified, public Dataset reference.

Deliverables publication

The ARCN website pulls data from the IRMA Data Store. Once the reference above is activated and linked to the master bear monitoring Project reference it automatically appears on the ARCN lagoons web page.

Summary

The deliverables management scheme presented above ensures future project leaders have access to past data deliverables, the Networks have highly visible accountability for funding expenditures and data is preserved for posterity.

SOP 20: Revising the Protocol

Version 1.0 (April 2017)

Revision Log

Only changes in this specific Standard Operating Procedure (SOP) will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Purpose

This Standard Operating Procedure explains how to make and document changes to the Coastal Lagoon Vital Signs Monitoring Protocol narrative and associated SOPs for the Arctic Network. Anyone editing the protocol narrative or any one of the SOPs needs to follow this outlined procedure in order to eliminate confusion in how data is collected, managed, analyzed, or reported. All observers should be familiar with this SOP in order to identify and use the most current methodologies.

A master equipment list for the entire Coastal Lagoon Vital Signs Monitoring Protocol can be found in Appendix S1.A of SOP 1: Before the Field Season. The master equipment list should be updated simultaneously if this or any SOP requiring an equipment list is revised.

Rationale

The Coastal Lagoon Vital Signs Monitoring Protocol narrative and associated SOPs for the Arctic Network represents an effort to document and employ scientifically rigorous methodologies for collecting, managing, analyzing, and reporting water quality monitoring data and information. However, all protocols regardless of initial rigor require editing as new and different information becomes available. Required edits should be made in a timely manner and appropriate reviews undertaken. Careful documentation of changes to the protocol, and a library of previous protocol versions are essential for maintaining consistency in data collection and for appropriate treatment of the data during data summary and analysis. The MS Access database for each monitoring component contains a field that identifies which version of the protocol was used when the data were collected.

In this context of revising the protocol, the rationale for dividing this into a protocol narrative with supporting SOPs is based on the following:

- The protocol narrative is a general overview of the protocol that gives the history and justification for monitoring and an overview of the sampling methods, but does not provide all of the methodological details. The protocol narrative will only be revised if major changes are made to the protocol.
- The SOPs, in contrast, are very specific step-by-step instructions for performing a given task. They are expected to be revised more frequently than the protocol narrative.
- When a SOP is revised, in most cases, it is not necessary to revise the protocol narrative to reflect the specific changes made to the SOP.
- All versions of the protocol narrative and SOPs will be archived in a Protocol Library.

Procedure

All edits require review for clarity and technical soundness. Small changes or additions to existing methods should be reviewed in-house by Arctic Network staff (e.g., version changes by hundredths). However, if there is a complete or major change in methods, then an outside review may be required (e.g., version changes by whole numbers). If there is a major change in

methodology, either to the entire protocol or individual SOP or narrative components, the Arctic Network Inventory and Monitoring Program coordinator should be consulted to determine the appropriate level of peer review required. Typically, regional and national staff of the NPS, and outside experts in government, private sector, and academia with familiarity in coastal lagoon monitoring in the Arctic will be utilized as reviewers.

Revision Log

Edits and revisions to the protocol narrative and associated SOPs will be documented by version in the Revision History Log that is found on the first page of each SOP. Log changes only in the protocol narrative or SOP being edited. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02...) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 ...). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Metadata

Any changes to associated database design and organization are documented in the Metadata of the project database(s).

Notification

The Data Manager should be informed about changes to the protocol narrative or SOP so the new version number can be incorporated in the Metadata of the project database. The database may have to be edited by the Data Manager to accompany changes in the protocol narrative and SOPs.

The appropriate ARCN staff should be notified of the changes and appropriate level review process initiated as determined in collaboration between the network staff and protocol principal investigator.

Once review comments are received and incorporated, post revised versions on the internet. Forward copies to all individuals with a previous version of the effected protocol narrative or SOP, and include the ARCN Data Manager in the network's protocol library.

SOP 21: Additional Research Ideas

Version 1.0 (April 2017)

Revision Log

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

New Version Number	Revision Date	Author	Changes Made	Reasons for Change	Network Regional Reviewer Approval	Previous Version Number

Tables

Table S21.1. Twelve recommended variables to be included in coastal lagoon monitoring from Robards et al. 2014.	136
--	-----

Figures

Figure S21.1.. Using gastric lavage technique to collect stomach samples from lagoon fishes. (Photo Credit: WCS)	138
--	-----

Figure S21.2. Cragonid shrimp collected in a coastal lagoon. (Photo Credit: WCS) ...	140
--	-----

Purpose

The purpose of this Standard Operating Procedure is to outline and prioritize additional research needs associated with the Coastal Lagoons Monitoring Protocol. Additional research needs have been identified as important to increasing our understanding of coastal lagoon ecosystems, but are not necessarily essential for long term monitoring.

Overview

Robards et al. (2014) recommended twelve variables to be considered for the Coastal Lagoons Monitoring Protocol. These are listed in Table S22.1. Due to personnel, logistical, and budgetary restrictions, only a subset of these variables were included in protocol development. If funding or personnel become available, the PI will refer to this SOP for additional research needs. As new research ideas arise, they may be added to this SOP following the revision log instructions outlined above.

Table S22.2. Twelve recommended variables to be included in coastal lagoon monitoring from Robards et al. 2014.

Type	Description
Abiotic	Dynamics of connectivity with marine environment
	Physical lagoon dynamics
	Overwintering habitat
	Timing of break-up
	Seasonal water chemistry and chlorophyll
Biotic	Seasonal phytoplankton composition and abundance
	Seasonal zooplankton composition and abundance
	Seasonal epifaunal composition and relative abundance
	Seasonal fish composition and patterns of use
	Fish growth rates from otoliths
	Seasonal fish diet sampling
	PolyAromatic Hydrocarbons (PAHs)

Additional research needs are divided into first and second priority needs. When deciding on what additional research activities to add to the protocol, first priority needs should be considered first.

First Priority

- Fish growth: Otoliths
- Contaminants
- Food web: Fish Diet; Stable Isotopes
- Plankton Community: Phytoplankton; Zooplankton

Second Priority

- Migration and Movement : Fish tagging; Otolith microchemistry
- Invertebrate Community

Descriptions of Additional Research

Otoliths

Otoliths, or fish ear bones, provide information on a fish's age and growth. Similar to how a tree can be aged by the number of rings in a cross section of its trunk, rings on a fish otolith can be enumerated by a trained individual to infer a fish's age. Information such age classes, length at age, and average, minimum, and maximum age of a stock can be attained using otolith analyses.

Otolith collection requires lethal take of a fish, so a study must be conservatively designed to provide statistically robust information while minimizing fish mortality. Collection of otoliths require additional training for field technicians to be able to locate and properly store otoliths. Lastly, otoliths can only be aged by trained individual(s). Contracting with an outside lab may be required for otolith aging.

Contaminants

Increasing contaminant levels have been observed in Arctic fish species in recent years (Carrie et al. 2010). Contaminants include mercury (Hg), historic use or banned pesticides such as Dieldrin, Endrin, Chlordane, polycarbonated biphenyls (PCBs), and polyaromatic hydrocarbons (PAHs), among others. Contaminants require collection of fish tissue (lethal take of fish) and analysis in an analytical laboratory. Fish may be obtained both by subsistence users and in the course of vital sign sampling. Analysis has frequently been provided as a free public service by the State of Alaska, and by other cooperative programs. Because of their high expense, samples of organic chemicals are anticipated to occur only via such external partnerships.

Methylmercury is considerably cheaper and may occur both internally as funding permits and externally via partnerships. Sample preservation, shipping and chain of custody protocols will follow those designated by the analytical labs used by partnership arrangements.

Food web

Fish Diet

Analysis of fish diet can provide insight into a fishes role in a food web. There are a number of ways to examine diet, each having advantages and disadvantages (Hyslop 1980). Haynes et al. (2017) used gastric lavage to collect stomach samples from fishes in a non-lethal manner (Figure S22.2).

Non-lethal methods are recommended for diet collection. Diet collection required additional tools for the field. Diet content identification requires a trained individual and is labor and time intensive.



Figure S22.6. Using gastric lavage technique to collect stomach samples from lagoon fishes. (Photo Credit: WCS)

Stable Isotopes

Stable isotopes, most notably carbon and nitrogen, are increasingly used to make inference on carbon sources and structure of marine food webs. A stable isotopes of an element has at least one additional neutron in an atom. Unlike radioactive isotopes, stable isotopes do not decay, and are heavier than their non-isotope equivalent. Certain isotopes are incorporated into an organisms tissue in a predictable and measureable way based on certain variables (e.g., position in a food web, location) (Zanden and Rasmussen 2001). The ratio of the heavier stable isotope to the more common non-isotope form of an element can be measured using specialized equipment and is expressed in delta notation (e.g., $\delta^{15}\text{N}$).

Nitrogen stable isotopes ($\delta^{15}\text{N}$) is a strong signal of an organism's trophic position within a food web (Post 2002). Primary consumers have very low $\delta^{15}\text{N}$ values, while top predators have high (more enriched in the heavier stable isotope) $\delta^{15}\text{N}$ values. The step in $\delta^{15}\text{N}$ between trophic levels is predictable (for the most part), and can be calculated using a simple equation. Looking at $\delta^{15}\text{N}$ can provide information on an organisms role in a food web when stomach samples are empty, compromised (e.g., burst or decayed stomachs), or simply not available.

Fish tissue can also be used to look at $\delta^{13}\text{C}$ values. Different carbon sources (e.g., marine phytoplankton vs. terrestrial plants) have different $\delta^{13}\text{C}$ signatures. Analysis of fish tissue for

$\delta^{13}\text{C}$ signatures could inform researchers about the base of the food web and relative importance of marine vs. terrestrial derived carbon sources for fishes that use the lagoon habitats.

Collection of fish tissue for stable isotopes requires additional steps. Most methods require tissue like muscle or liver, and therefore require lethal take of fishes. Similar to otoliths, studies involving tissue collection for stable isotope analyses should be designed to take a conservative number of fish to avoid undue waste, but provide enough samples to produce statistically robust results. Similarly, a technician must be trained in proper tissue collection, tissue storage, and shipping. Specialized equipment is required for processing tissue samples for SI is necessary. Additionally, sample processing can be expensive. However, a stable isotope study would be informative of lagoon food webs, and would complement a fish diet study.

Migration and Movement

Many of the fishes that occupy coastal lagoons are migratory. Some fishes, like Humpback Whitefish, have complex migration patterns and move between lower reaches and upper reaches of rivers and streams to spawn (Brown et al. 2012). Understanding the movement of these fishes at different stages of their life history is important for determining the importance of different habitats, and the role of lagoons for these populations.

A number of methods are commonly used to track fish movements. These include various tags, sonar, and otolith microchemistry. The appropriate method will depend on the nature of the hypothesis being tested, personnel skill, and budget.

Tagging fish requires handling of fish, as well as having someone experienced in attaching tags to fishes. Depending on the type of tag used, receivers and other additional tracking equipment may be required. Otolith microchemistry requires the lethal take of fish.

Invertebrate Community

Lagoons support diverse macroinvertebrate communities. Lagoon fishes feed on invertebrates like mysid shrimp (Haynes et al. 2017). Invertebrates provide food for fish, birds, and marine mammals. Success rates. Past lagoon sampling efforts have included sampling of lagoon communities, with mixed success.



Figure S21.7. Cragonid shrimp collected in a coastal lagoon. (Photo Credit: WCS)

Reynolds 2012 was able to sample epifauna communities using a petit ponar grab. Haynes et al. 2017 did not find this method suitable for CAKR and BELA lagoons. Successful sampling of invertebrate communities in coastal lagoons will require development of suitable sampling techniques.

New Research Methods

Environmental DNA (eDNA) is an example of a quickly developing technology that could be used for lagoon monitoring in the future. eDNA has been proven a useful tool in large riverine systems where sampling the entire system is logistically challenging (Laramie et al. 2015). This technique has been used for detection of rare and cryptic species (Thomsen and Willerslev 2015). Both fish and other organisms (e.g., invertebrates, birds) can be detected using eDNA. Collecting eDNA generally involves collecting water or sediments from an environment, eliminating the need to directly handle animals. Eliminating handling reduces stress, and eliminates potential mortality events. No nets are required. Collection tools usually only involve containers for the water samples and a cooler to keep samples cool. Therefore, only a small team of field personnel is needed to collect samples.

Current drawbacks for using eDNA include: increased expense for sample processing, transporting samples from the field to the lab in a timely manner, and difficulty keeping samples cool while in the field. Certain parameters like fish length cannot be collected with eDNA. In addition, the use of eDNA is not currently accepted as definitive method for indicating fish presence for the Anadromous Waters Catalog (Alaska Department of Fish and Game). As eDNA becomes more cost effective and widely accepted by regulatory agencies, it may become an effective method of monitoring species compositions of lagoon systems. Likewise, there is the potential for new technologies to be developed over the lifespan of this monitoring program that could radically change how we sample. This protocol was designed to be adaptable to potential changes by using a simple sampling design and limiting the number of parameters collected. For revising the protocol, see SOP 20: Revising the Protocol.

Adding an Additional Research Need

Adding an additional research objective to the Coastal Lagoons Vital Sign Monitoring program will require creation of all applicable SOPs. Additional gear list, field personnel training, and budget considerations must be recorded as well. The core objectives outlined in the Coastal Lagoons Vital Sign Monitoring program are always priority, and therefore the core of this protocol should not require additional modifications. If modifications or revisions are required, follow the steps outlined in SOP 23: Revising the Protocol.

Note: If lethal take of fish is required, minimize waste by designing the sampling plan to include multiple tissue collection and uses. For example, if collecting fish tissue for contaminants, include otolith collection as well.

References

- Brown, R.J., C. Brown, N.M. Braem, W.K. Carter III, N. Legere, L. Slayton. 2012. Whitefish biology, distribution, and fisheries in the Yukon and Kuskokwim River drainages in Alaska: a synthesis of available information. Alaska Fisheries Data Series Number 2012-4. U.S. Fish and Wildlife Service, Fairbanks, Alaska.
- Carrie, J., F. Wang, H. Sanei, R.W. Macdonald, P.M. Outridge, G.A. Stern. 2010. Increasing contaminant burdens in an Arctic fish, Burbot (*Lota Lota*), in a warming climate. *Environmental Science and Technology*. 44: 316-322.
- Haynes, T.B., M. Tibbles, M.D. Robards, T. Jones, A. Whiting, M. Wipfli. 2017. Coastal lagoon community and ecological monitoring in the southern Chukchi Sea National Park Units. 2015 field sampling report. Wildlife Conservation Society. Cooperative Ecosystems Studies Units Agreement #: P13AC01025.
- Hyslop, E.J. 1908. Stomach contents analysis – a review of methods and their application. *Journal of Fish Biology*. 17(4): 411-429.
- Laramie, M.B., D.S. Pillod, C.S. Goldberg. 2015. Characterizing the distribution of an endangered salmonid using environmental DNA analysis. *Biological Conservation*. 183: 29-37.
- Post, D.M. 2002. Using stable isotopes to estimate trophic position: models, methods, and assumptions. *Ecology*. Ecological Society of America. 83(3): 703-718.
- Reynolds, M.D. 2012. Coastal lagoon community and ecological monitoring in the Southern Chukchi Sea National Park Units over five decades. Status and 2012 field sampling report. Wildlife Conservation Society.
- Thompson, P.F., and E. Willerslev. 2015. Environmental DNA – An emerging tool in conservation for monitoring past and present biodiversity. *Biological Conservation*. 183: 4-18.
- Zanden, M.J.V., J.B. Rasmussen. 2001. Variation in $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ trophic fractionation: implications for aquatic food web studies. *Limnology and Oceanography*. 46(8): 2061 – 2066.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS XXX, Month 20XX

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

DRAFT