



2015 Addendum to Quality Assurance Monitoring Plan

Long-Term Marine Waters Monitoring, Water Column Program



January 2015

Publication No. 15-03-102

Publication Information

Addendum

This addendum is on the Department of Ecology's website at <https://fortress.wa.gov/ecy/publications/SummaryPages/1503102.html>

This addendum is an addition to an original Quality Assurance Monitoring Plan. It is not a correction (errata) to the original plan.

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. For all reviewed and finalized data since 1999, the EIM study ID is: MarineWater.

Provisional data currently in collection status can be found under EIM study ID: MarineWater-2. This is transitional data that have not yet been through a documented data review process.

Historical data are grouped into logical periods based on primary methods used for collection and analyses. These studies are:
MarineWaterColumn1973-1989 and MarineWaterColumn1989-1998.

Activity Tracker code

Ecology's Activity Tracker code for this addendum is 01-800.

Original Publication

Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program. <https://fortress.wa.gov/ecy/publications/SummaryPages/1503101.html>

Cover photo: Bainbridge Island, July 28, 2014 (by Mya Keyzers)

Authors and Contact Information

Mya Keyzers and Julia Bos
mkey461@ecy.wa.gov and jbos461@ecy.wa.gov
Washington State Department of Ecology
Olympia, Washington 98504-7710

For more information contact: Communications Consultant, phone 360-407-6834.

Any use of product or firm names in this publication is for descriptive purposes only and does not imply endorsement by the author or the Department of Ecology.

Accommodation Requests: To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 360-407-6834. Persons with impaired hearing may call Washington Relay Service at 711. Persons with speech disability may call TTY at 877-833-6341.

2015 Addendum to Quality Assurance Monitoring Plan

Long-Term Marine Waters Monitoring, Water Column Program

January 2015

Approved by:

Signature: _____	Date: January 2015 _____
Mya Keyzers, Author / Marine Flight Lead Technician, EAP	

Signature: _____	Date: January 2015 _____
Julia Bos, Author / Marine Monitoring Coordinator, EAP	

Signature: _____	Date: January 2015 _____
Christopher Krembs, Senior Oceanographer, EAP	

Signature: _____	Date: January 2015 _____
Carol Maloy, Authors' Unit Supervisor, EAP	

Signature: _____	Date: January 2015 _____
Jessica Archer, Authors' Section Manager, EAP	

Signature: _____	Date: January 2015 _____
Bill Kammin, Ecology Quality Assurance Officer	

Signatures are not available on the Internet version.
EAP: Environmental Assessment Program

3.0 Background¹

This document describes the 2015 sampling effort for Ecology's Long-Term Marine Flights Monitoring Program. It is an addendum to *Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program* (Bos, 2015). In 2015, only core stations, and no rotational stations, will be sampled. Additional sampling will be added for total alkalinity and dissolved inorganic carbon samples (Keyzers, 2014), isotopic nitrogen sampling collaboration, and integrating a new instrument. This QAMP addendum specifies which stations and parameters will be sampled in 2015 and also describes isotopic nitrogen sampling collection at a subset of stations.

The purpose of the program is to examine and report marine water quality on a regular, long-term basis. Its objectives are to understand current existing conditions in the context of environmental factors, identify spatial and temporal trends, and provide high-quality information from sensor and lab sample collection.

All required sections not mentioned in this addendum are discussed in the original QAMP and referenced SOPs.

¹ The heading numbers in this Addendum relate back to the original QAMP.

5.4 Project schedule

Table 1. Proposed schedule for completing field and laboratory work, data processing, review, QC, storage in data repository, and reports.

Activity	Due date	Lead staff
Field and laboratory work		
Field work (sample collection) completed	Monthly	Mya Keyzers
Internal (Ecology) laboratory analyses completed	3 days post-collection (dissolved oxygen samples)	Laura Hermanson
Internal (Ecology) laboratory analyses completed	1 month post-collection (chlorophyll a samples)	Laura Hermanson
External (UW) laboratory analyses completed	3 months post-collection (nutrient samples)	Mya Keyzers
Data receipt or processing and upload to EAPMW (Marine Waters) database		
Instrument and sensor data	Same month as collection	Julia Bos
Internal laboratory data	1 month post-analyses	Laura Hermanson
External laboratory data	1 month post-analyses	Mya Keyzers
Data review and QAQC		
Instrument & sensor data	1 month post-collection	Julia Bos, Christopher Krembs, Skip Albertson, Mya Keyzers, Laura Hermanson
Internal laboratory data	1 month post-analyses	Laura Hermanson
External laboratory data	Quarterly, one quarter post-collection	Mya Keyzers
Environmental Information System (EIM) database		
EIM data loaded	Same month as collection	Julia Bos
EIM QA	4 months after sampling year complete	Julia Bos
EIM complete	4 months after sampling year complete	Julia Bos
Monthly reports		
Monthly condition summary generated	1 month post-collection	Julia Bos
Monthly summary posted to web	1 month post-collection	Christopher Krembs
Annual assessment - data products & written summary		
Draft assessments and products due	3 months after sampling year complete	Christopher Krembs, Julia Bos, Skip Albertson, Mya Keyzers, Laura Hermanson
Final reviews and QA/QC summarized	4 months after sampling year complete	Christopher Krembs, Julia Bos

Activity	Due date	Lead staff
Final summary due on web	4 months after sampling year complete	Christopher Krembs
Final data posted and performance measures reported		
Final data and analytical plots due on web	4 months after sampling year complete	Christopher Krembs, Skip Albertson
Final Performance calculated and submitted to OFM	Annually in July	Julia Bos

5.6 Budget and funding

This budget does not include the full cost of the monitoring program. It is limited to direct expenses for the specific elements below.

Table 2. Projected budget for 2015 Marine Flight operations.

UW Marine Chemistry Lab Analyses			
Type	Cost/unit	Qty.	Cost
Seawater Nutrient Analysis	\$ 16.80	1416	\$ 23,788.80
Salinity Analysis	\$ 19.65	156	\$ 3,065.40
Dissolved Oxygen Regents	\$532.00	1	\$ 532.00
Subtotal			\$ 27,386.20
Sensor Cost			
Company			Cost
Seabird Inc.			\$ 4,000.00
WET Labs Inc.			\$ 3,000.00
Biospherical Instruments Inc.			\$ 200.00
Subtotal			\$ 34,386.20
Transportation Cost			
Company			Cost
Kenmore Air Seaplanes	\$634.00	205	\$ 130,000.00
Port of Olympia	\$50.00	12	\$ 600.00
Subtotal			\$ 130,600.00
Shannon Point Marine Science Center			
Research Vessel	\$110.00	96	\$ 10,560.00
Lab fee	\$295.00	12	\$ 3,540.00
Subtotal			\$ 14,100.00
		Total	\$ 206,472.40

7.1.2.2 Sampling Schedule

Core long-term monitoring stations are visited once a month, year- round, to ensure that all major seasonal hydrographic conditions are observed. Since not all stations can be visited in 1 day, stations are aligned by region and separated into 6 regional surveys a month for the most efficient operations. This year the stations are divided into 6 regional surveys per month instead of 5, as previously. Fewer stations per flight allow greater flexibility to adapt to weather delays, seasonally limited daylight hours, and scheduling for additional activities such as the *Eyes Over Puget Sound* aerial surveys.

For 2015, the stations WPA001 and GYS004 were changed from core to rotational, as these stations are in rivers and exhibit freshwater rather than marine characteristics. These 2 stations will not be sampled in 2015. This results in a total of 37 core stations. This year the regions will be grouped as:

- Strait of Juan de Fuca (Straits)
- Coastal Bays (MF1)
- San Juans/North Sound/Whidbey Basin (MF2)
- Admiralty Inlet/Central Sound (MF3)
- South Sound (MF4)
- Hood Canal (MF5)

See Table 3 and Figures 1-6.

Stations are sampled at intervals of no less than 3 weeks apart to ensure reasonable adherence to a monthly sampling scheme.

Table 3. 2015 station list for Ecology long-term marine water column monitoring.

Flight	Station ID	Location	Lat. N NAD83 (deg/dec_min)	Long. W (NAD83) (deg/dec_min)	Depth (m)	Record	Record Length (yrs)	Justification
Marine Flight 1: Coast	GYS008	Mid-S. Channel	46 56.2388	123 54.7934	6	1974 - 76, 1983 - present	35	represents mid Grays Harbor, south
	GYS016	Damon Point	46 57.2053	124 05.5770	11	1982 - 1987, 1991 - present	29	represents outer Grays Harbor, north
	WPA004	Toke Point	46 41.9800	123 58.1240	14	1973-1975, 1977-present	41	represents north Willapa Bay
	WPA113	Bay Center	46 38.6400	123 59.5800	11	1997-2000, 2006-present	12	represents mouth of (NW) Willapa Bay
	WPA006	Nahcotta Channel	46 32.7226	123 58.8097	21	1991-present	24	represents central Willapa Bay
	WPA007	Long Island, S. Jensen Pt.	46 27.1893	124 00.5672	14	1991-2008, 2013-present	19	represents SW Willapa Bay
	WPA008	Naselle River mouth	46 27.7890	123 56.4760	14	1996-2008, 2013-present	14	represents SE Willapa Bay, off Naselle R.
	WPA003	Willapa River, John. Slough	46 42.2392	123 50.2431	10	1973-present	42	represents north Willapa Bay, off Willapa R.
Marine Flight 2: North	PTH005	Port Townsend	48 04.9889	122 45.8767	26	1977-1978, 1991-2002, 2005-present	24	represents waters off city of Port Townsend
	RSR837	Rosario Strait	48 36.9896	122 45.7775	56	2009-present	6	represents waters in Rosario Strait
	GRG002	Strait of Georgia	48 48.4896	122 57.2446	190	1988-present	27	represents Strait of Georgia end member
	BLI009	Bellingham Bay	48 41.1564	122 35.9771	16	1977-present	38	represents waters off city of Bellingham
	SKG003	Skagit Bay	48 17.7893	122 29.3763	24	1990-1991, 1994-1998, 2007-present	15	represents Whidbey Basin
	SAR003	Saratoga Passage	48 06.4557	122 29.4925	149	1977-present	38	represents Whidbey Basin
	PSS019	Possession Sound	48 00.6556	122 18.0750	101	1980-present	35	represents waters off city of Everett
Marine Flight 3: Central	ADM001	Admiralty Inlet	48 01.7888	122 37.0760	148	1975-1987, 1992-present	35	represents waters within Admiralty Inlet
	ADM003	S. of Admiralty Inlet	47 52.7390	122 28.9917	210	1988-1991, 1996-present	21	represents waters S. of Admiralty sills
	PSB003	Puget Snd. Main Basin	47 39.5891	122 26.5745	40-50	1976-present	39	represents Puget Sound Main Basin
	ELB015	Elliott Bay	47 35.7892	122 22.1743	82	1991-present	24	represents waters off city of Seattle
	EAP001	East Passage	47 25.0226	122 22.8241	200	1988-1991, 94-95, 1997-present	23	represents S. Puget Sound main axis
	CMB003	Commencement Bay	47 17.4226	122 27.0074	150	1976-present	39	represents waters off city of Tacoma
Marine Flight 4: South	BUD005	Budd Inlet	47 05.5224	122 55.0918	15	1973-present	42	represents waters off city of Olympia
	DNA001	Dana Passage	47 09.6890	122 52.3083	40	1984-85, 1989-present	28	represents south reach of Southern Puget Sound
	NSQ002	Devil's Head	47 10.0390	122 47.2914	100	1984-85, 1996-present	21	represents S. Puget Sound near Nisqually
	GOR001	Gordon Point	47 10.9891	122 38.0743	160-170	1996-present	18	represents S. Puget Sound south of Narrows
	CRR001	Carr Inlet	47 16.5891	122 42.5745	95	1977-93, 95-96, 1998-2003, 2006, 09-present	31	represents waters within Carr Inlet
	CSE001	Case Inlet	47 15.8724	122 50.6583	55	1978-1993, 95-96, 1998-99, 2009-present	26	represents waters within Case Inlet
	OAK004	Oakland Bay	47 12.8056	123 04.6590	15	1974-75, 1977-present	40	represents waters off city of Shelton
Marine Flight 5: Hood Canal	HCB007	Hood Canal, Lynch Cv.	47 23.8889	122 55.7755	21	1990-1996, 1998-2007, 2011-present	21	very low DO, assess duration & coverage
	HCB004	Hood Canal, Sisters Pt.	47 21.3723	123 01.4924	55	1975-1987, 1990-present	38	represents southern Hood Canal
	HCB003	Hood Canal, Eldon	47 32.2722	123 00.5760	144	1976-92, 1994-96, 1998-2007, 2010-present	34	very low DO, assess duration & coverage
	HCB010	Hood Canal, S of Bangor	47 40.2000	122 49.2000	100	2005-present	10	represents northern Hood Canal
	SIN001	Sinclair Inlet	47 32.9557	122 38.6083	16	1973-1987, 1991-present	38	represents waters off city of Bremerton
JEMS	SJF000	Strait of Juan de Fuca - S. of San Juan Island	48 25.0000	123 01.5000	180	2000 - present	15	represents northern Strait of Juan de Fuca
	SJF001	Strait of Juan de Fuca - SE of Hein Bank	48 20.0000	123 01.5000	160	2000 - present	15	represents central Strait of Juan de Fuca
	SJF002	Strait of Juan de Fuca - SW of Eastern Bank	48 15.0000	123 01.5000	145	2000 - present	15	represents southern Strait of Juan de Fuca
	ADM002	N. of Admiralty Inlet	48 11.2391	122 50.5770	82	1980-present	34	represents waters entering Admiralty Inlet

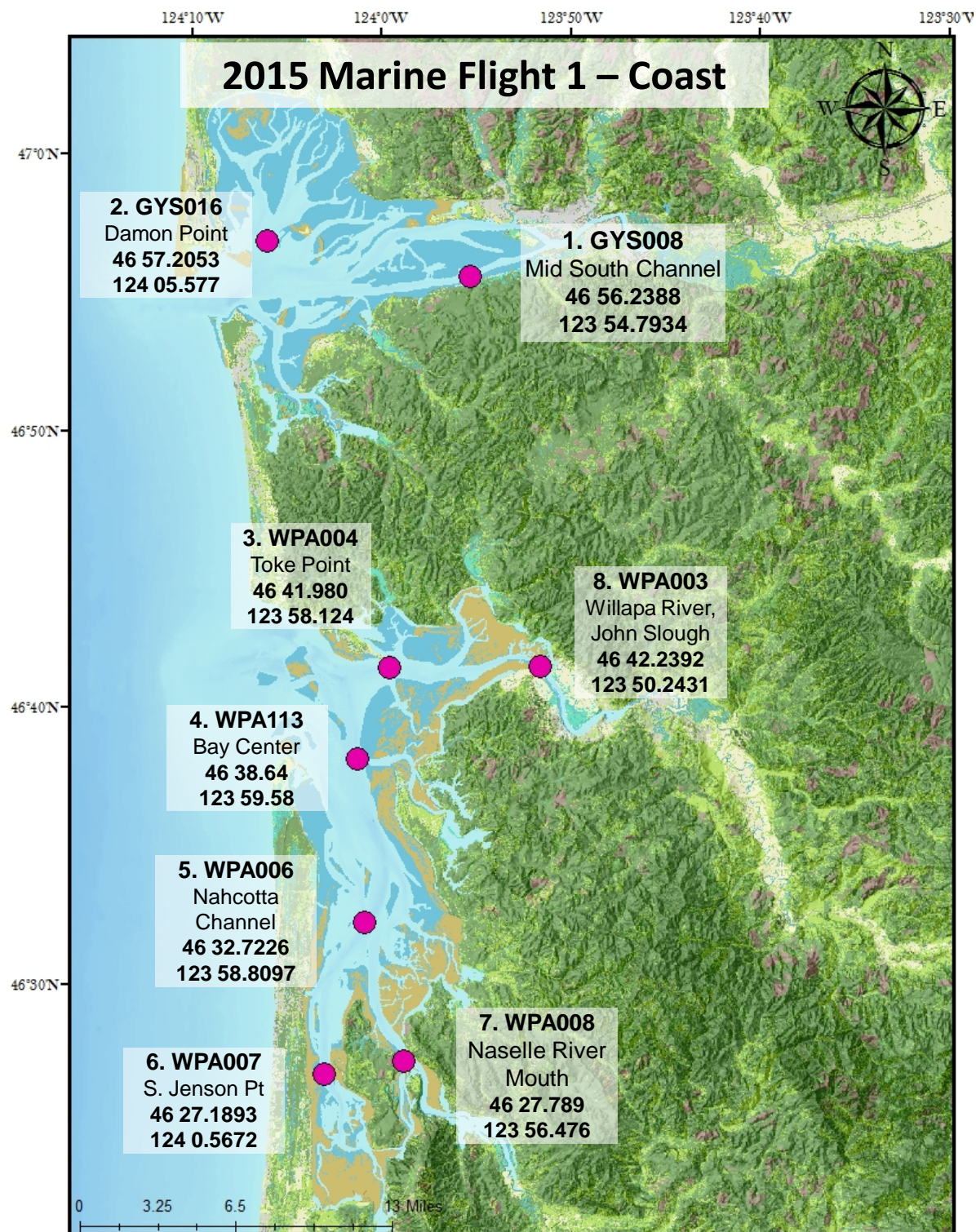


Figure 2. 2015 Marine Flight 1 (MF1) Coast sampling stations.

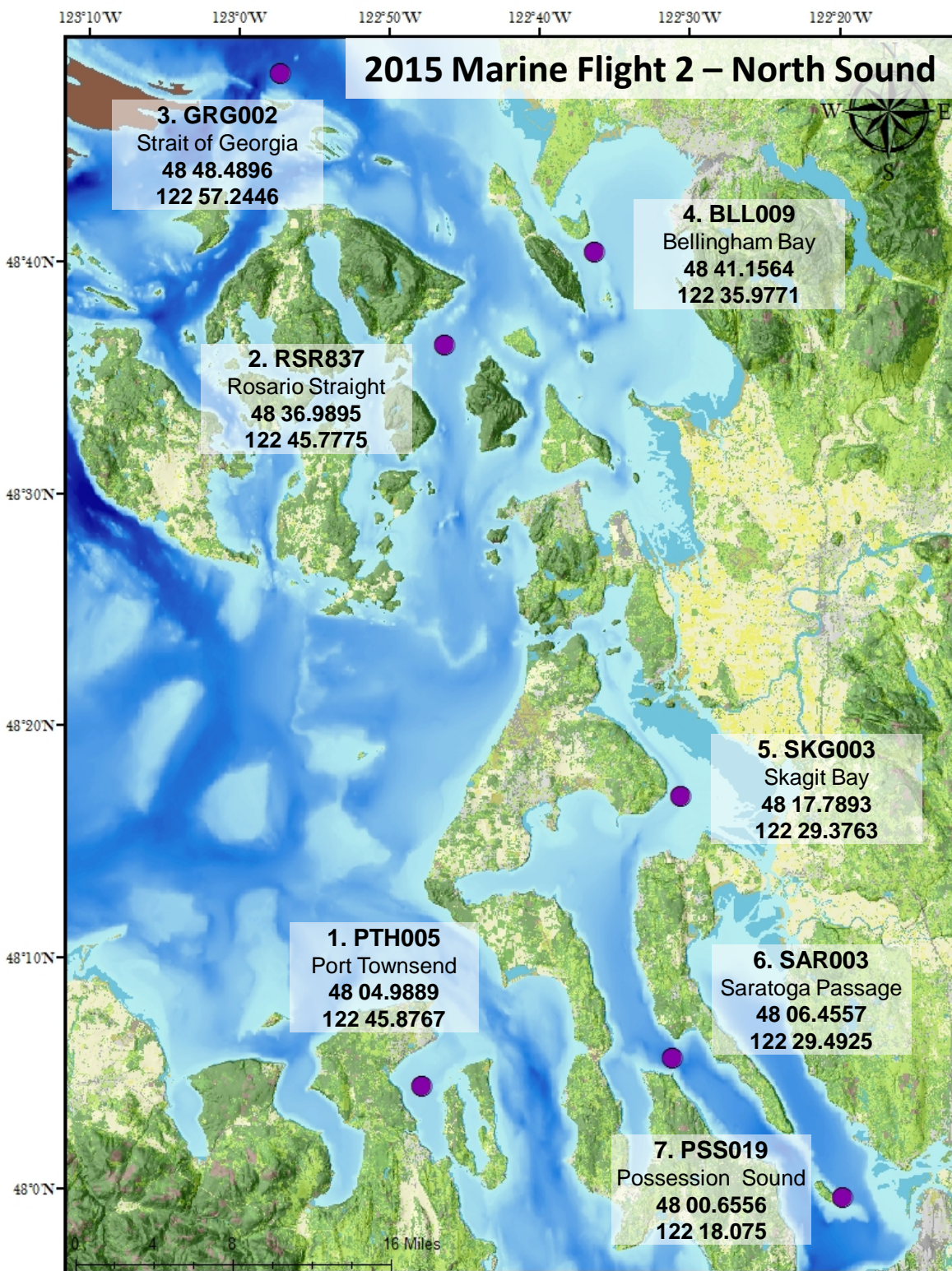


Figure 3. 2015 Marine Flight 2 (MF2) North Sound sampling stations.

2015 Marine Flight 3 - Central Sound

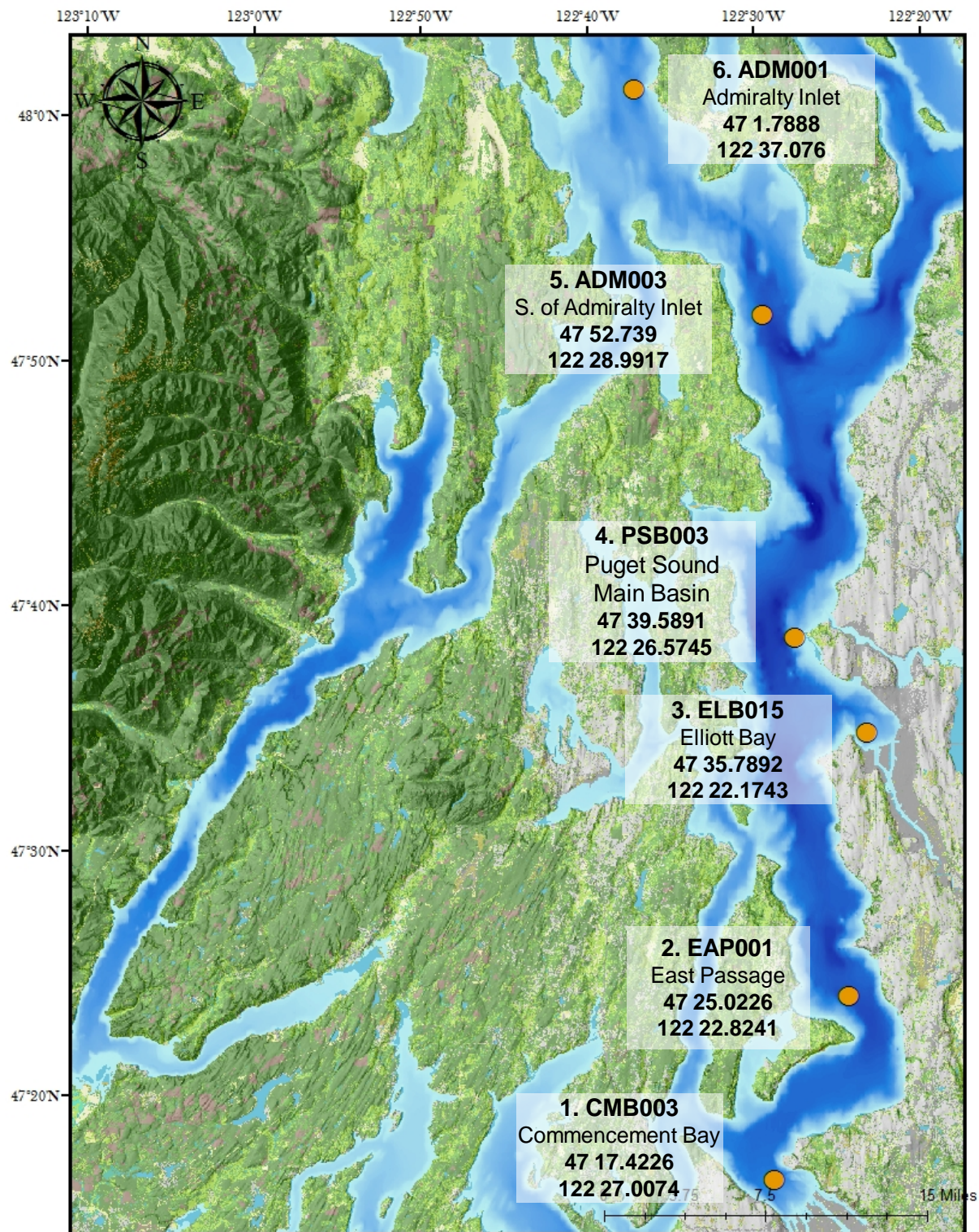


Figure 4. 2015 Marine Flight 3 (MF3) Central Sound sampling stations.

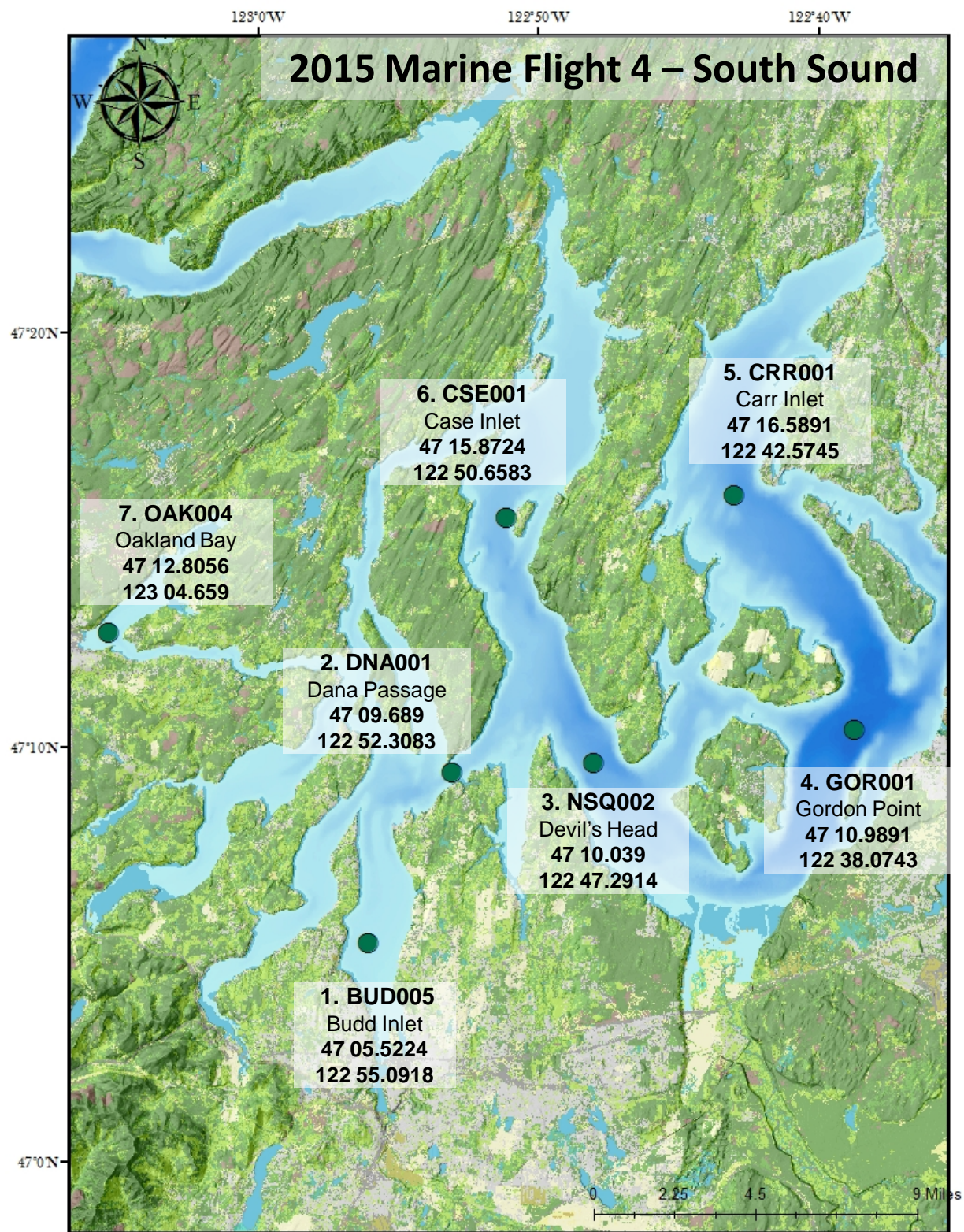


Figure 5. 2015 Marine Flight 4 (MF4) South Sound sampling stations.

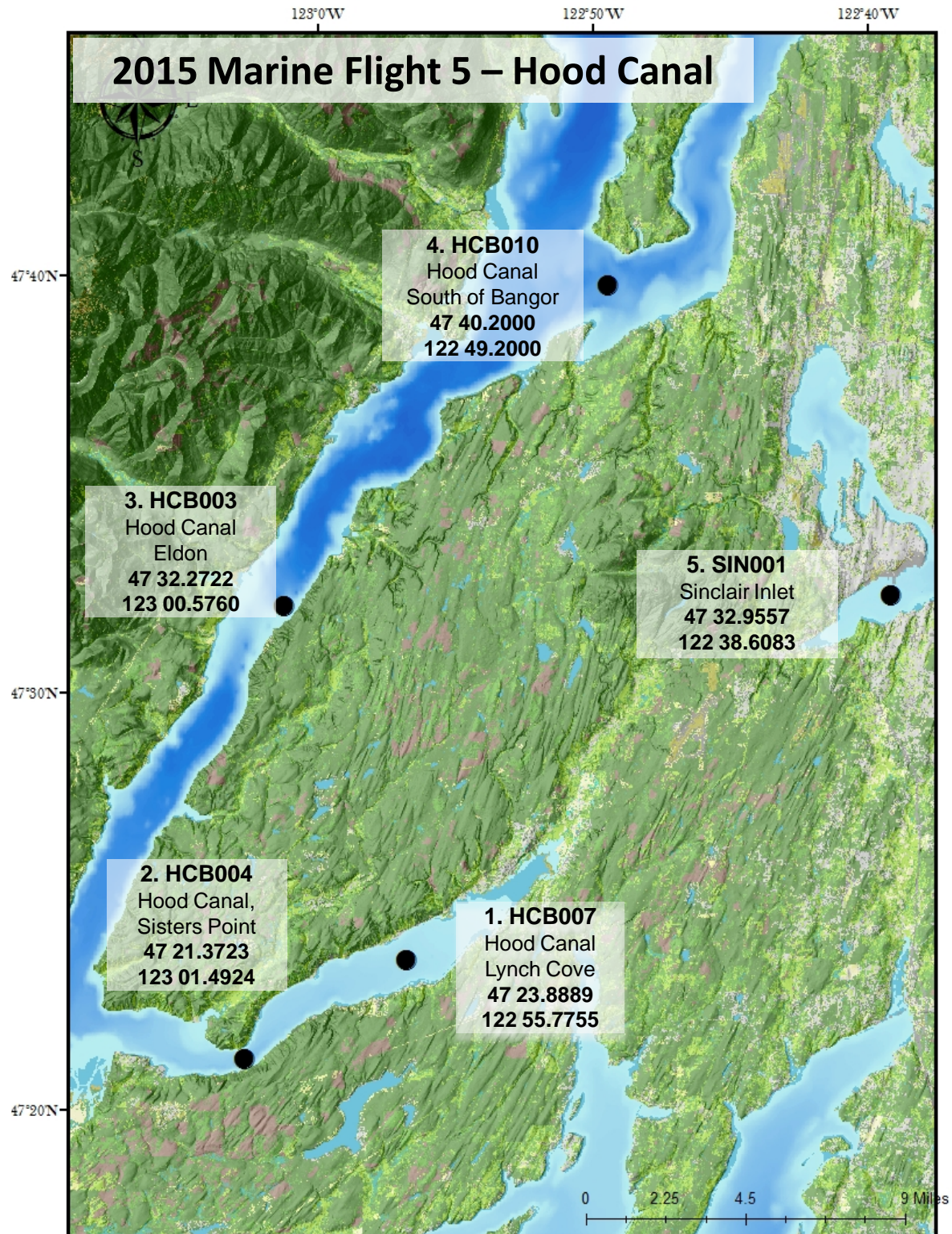


Figure 6. 2015 Marine Flight 5 (MF5) Hood Canal sampling stations.

7.3.1 Changes to the Sampling Process Design

Total Alkalinity and Dissolved Inorganic Carbon

The Marine Flight Program is conducting a pilot study to test whether total alkalinity and dissolved inorganic carbon water sampling can be incorporated into the existing Marine Flight Program. The field work is scheduled to end in May 2015, and the final report is due on the web in November 2015. Nothing has changed from the original QAMP, but collecting these samples is a change to the usual MF sampling design. For more information, see *Quality Assurance Project Plan: Puget Sound Total Alkalinity and Dissolved Inorganic Carbon* (Keyzers, 2014.)

Isotopic Nitrogen Sampling Puget Sound

The Washington State Department of Ecology's Marine Waters Monitoring Program and Freshwater Ambient Monitoring Program are collaborating with the University of Washington (UW) Fishery Sciences Department on a cost-effective feasibility pilot study. The goal of this study is to understand the integration of nitrogen transport and processing between terrestrial, river, and estuarine ecosystems. The primary goal is to identify sources and potential sinks of nutrients in river systems connected to Puget Sound.

The key goals of this feasibility study are:

- Identify and track sources of nitrate within 24 river systems of the Puget Sound watershed and determine the degree that these sources vary with land-use patterns (e.g., urban, agricultural) and atmospheric deposition (snowpack) within these watersheds.
- Quantitatively differentiate between baseline and anthropogenic nitrogen sources (e.g., natural glacial base flow vs. agricultural runoff and urban stormwater).
- Determine if source-related changes are associated with episodic events or seasons (e.g., high flow runoff from storm events).
- Determine if nitrogen sources are mixing conservatively along salinity gradients within freshwater and estuarine surface water environments connected to the Nooksack, Snohomish, and Stillaguamish river systems.

For this collaboration, marine flight technicians will collect additional samples at 6 stations. This sampling is not extensive. It does not burden routine operations, but it leverages existing infrastructure by collecting water at stations and depths already sampled. There is no additional cost since UW Fisheries will provide all equipment for data collection. Samples are transferred for no additional effort as part of our routine monthly sample delivery to the UW Marine Chemistry Lab. Ecology's contribution is to collect and deliver the samples to UW Fisheries. The UW project is independent and exploratory, and Ecology will not be evaluating the results as part of the ambient monitoring program data analysis steps.

Table 4. Projected water sample collection plan for 2015 listing depths (in meters) for each sample type collected at each station. Near bottom (NB).

Station	Nutrients	Chlorophyll	Dissolved Oxygen	Salinity	Alkalinity	Isotopic Nitrogen	Method Blank	Field Splits	Approximate Water Depth (m)
Marine Flight 1									
GYS008	0	0							6
GYS016	0, 10	0, 10	NB						11
WPA004	0, 10, 10, 10	0, 10, 10, 10		10			1		14
WPA113	0, 10	0, 10	NB						11
WPA006	0, 10	0, 10	NB	10					21
WPA007	0, 10	0, 10							14
WPA008	0, 10	0, 10							14
WPA003	0, 10	0, 10							10
Total Samples:									
8	17	17	3	2			1		
Marine Flight 2									
PTH005	0, 10, 10, 10	0, 10, 10, 10	NB				1		26
RSR837	0, 10, 30	0, 10, 30							56
GRG002	0, 10, 30	0, 10, 30		30					190
BLL009	0, 10	0, 10	NB			0,10			16
SKG003	0, 10	0, 10		10					24
SAR003	0, 10, 30	0, 10, 30	NB		5,5,5	0,30			149
PSS019	0, 10, 30	0, 10, 30			5,5,5	0,30			101
Total Samples:									
7	20	20	3	2	6	6	1		
Marine Flight 3									
ADM001	0, 10, 30	0, 10, 30			5,5,5				148
ADM003	0, 10, 30	0, 10, 30	NB			0,30			210
PSB003	0, 10, 30	0, 10, 30				0,30			40-50
ELB015	0, 10, 30	0, 10, 30		10		0,30			82
EAP001	0, 10, 30	0, 10, 30	NB						200
CMB003	0, 10, 10, 10, 30	0, 10, 10, 10, 30	NB	30			1		150
Total Samples:									
6	20	20	3	2	3	4	1		
Marine Flight 4									
HCB007	0, 10	0, 10		10					21
HCB004	0, 10, 30	0, 10, 30	30						55
HCB003	0, 10, 30	0, 10, 30							144
HCB010	0, 10, 30	0, 10, 30	NB	30	5,5,5				100
SIN001	0, 0, 0, 10	0, 0, 0, 10	NB				1		16
Total Samples:									
5	15	15	3	2	3		1		
Marine Flight 5									
BUD005	0,10, 10, 10	0, 10, 10, 10	NB	10			1	1	15
DNA001	0, 10, 30	0, 10, 30	NB, NB						40
NSQ002	0, 10, 30	0, 10, 30							100
GOR001	0, 10, 30	0, 10, 30	NB	30					160-170
CRR001	0, 10, 30	0, 10, 30	NB						95
CSE001	0, 10, 30	0, 10, 30							55
OAK004	0, 10	0, 10			5,5,5				15
Total Samples:									
7	21	21	5	2	3		1	1	
Straits									
SJF000	0, 30, 80, 140	0, 30, 80, 140	0, 30, 80, 140						161
SJF001	0, 30, 80, 140	0, 0, 0, 30, 80, 140	0, 30, 80, 140						144
SJF002	0, 30, 80, 140, 140, 140	0, 30, 80, 140	0, 30, 80, 140, 140, 140	0, 140					142
ADM002	0, 10, 30, 80	0, 10, 30, 80	80	80					82
Total Samples:									
4	18	19	15	3					
Annual Total:									
Station	Nutrients	Chlorophyll	Dissolved Oxygen	Salinity	Alkalinity	Isotopic	Method Blank	Field Splits	
37	111	112	32	13	15	10	5	1	

8.1.1 CTD Data Collection

Beginning in 2015, the CTD instrument package will be upgraded from a Seabird Electronics SBE25 to a SBE25*plus*. The SBE25*plus* has an internal pressure sensor. This upgrade does not change field operations or methods. Principles of CTD and sensor operations are described in manufacturer operating manuals. Instructions for optimum CTD data collection are outlined in these manuals.

10.0 Quality Control Procedures

Ecology will adhere to all quality control procedures outlined in the original QAMP (Bos, 2015). Likewise, Ecology will use the measurement quality objectives defined in the original QAMP to assess quality/usability of the collected data. The sections below discuss specific modifications to our quality assessment and quality control procedures for the 2015 sampling year.

10.5.2.1 Replicate Sample Collection

Triplicate samples will be collected during every field event to help determine field and sampling variability. Three samples taken in succession from the same niskin will be collected from one station in order to conduct a quantitative determination of homogeneity of conditions, along with precision and bias of sampling methods. Parameters to be replicated include dissolved oxygen (monthly), nutrients (every survey), and chlorophyll *a* (every survey).

10.5.2.2 Independent Analytical Lab Samples

Field Split Sample Collection

A nutrient field sample will be collected and split into 2 independent replicates once a month by King County and then analyzed by two laboratories. One split will be analyzed by (UW-MCL) and the other by King County Environmental Labs. These split samples will serve as independent verification of lab results generated by UW-MCL for Ecology's Marine Monitoring Program.

10.5.2.3 Certified Reference Materials

A certified seawater nutrient standard will be commercially available sometime in 2015, sources are currently being vetted. Once this resource is available, this lab control will be added to sample batches to validate analytical lab performance, enhancing field split sample collection.

10.5.2.4 Laboratory Blanks

Method Blanks

Blanks of low nutrient seawater will be taken 5 times a month with each flight. These blanks will be handled like field samples to determine if contamination occurs during any stage of the sampling process.

An additional unfiltered blank of low nutrient seawater (LNSW) will be included with each sample batch. These blanks test potential effects of handling and filtration effects. These blanks serve to determine if samples could be contaminated during processing and analysis.

10.5.2.3 Laboratory Control Samples

These will be omitted from the 2015 sampling plan due to the addition of field split samples. These samples are commonly called nutrient standards.

References

- Bos, J., 2007. Standard Operating Procedure for Seawater Dissolved Oxygen Analysis. Washington State Department of Ecology, Olympia, WA. SOP No. EAP027. http://www.ecy.wa.gov/programs/eap/qa/docs/ECY_EAP_SOP_SeawaterDissolvedOxygenAnalysis_v2_1EAP027.pdf
- Bos, J., 2008. Standard Operating Procedure for Chlorophyll *a* Analysis. Washington State Department of Ecology, Olympia, WA. SOP No. EAP026. http://www.ecy.wa.gov/programs/eap/qa/docs/ECY_EAP_SOP_ChlorophyllAnalysis_v_3_0EAP026.pdf
- Bos, J., 2010a. Standard Operating Procedure for Seawater Sampling. Washington State Department of Ecology, Olympia, WA. SOP No. EAP025. http://www.ecy.wa.gov/programs/eap/qa/docs/ECY_EAP_SOP_SeawaterSampling_v_2_0EAP025.pdf
- Bos, J., 2010b. Standard Operating Procedure for Reagent Preparation. Washington State Department of Ecology, Olympia, WA. SOP No. EAP028. http://www.ecy.wa.gov/programs/eap/qa/docs/ECY_EAP_SOP_Reagent%20Preparation_v2_2EAP028.pdf
- Bos, J., 2015. Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program. Washington State Department of Ecology, Olympia, WA. Publication No. 15-03-101. <https://fortress.wa.gov/ecy/publications/SummaryPages/1503101.html>
- Bos, J. and S. Albertson, in draft, a. Standard Operating Procedure for Marine Waters Data Processing. Washington State Department of Ecology, Olympia, WA. SOP No. EAP089.
- Bos, J. and S. Albertson, in draft, b. Standard Operating Procedure for Marine Waters Data Quality Assurance and Quality Control. Washington State Department of Ecology, Olympia, WA. SOP No. EAP088.
- Keyzers, M., 2014. Quality Assurance Project Plan: Puget Sound Total Alkalinity and Dissolved Inorganic Carbon. Washington State Department of Ecology, Olympia, WA. Publication No. 14-03-116. <https://fortress.wa.gov/ecy/publications/SummaryPages/1403116.html>
- King County, 2014. Interim Report on An Inter-Laboratory Nutrient Comparison Study Between The King County Environmental Laboratory and University of Washington Marine Chemistry Laboratory. Prepared by Scott Mickelson, King County Water and Land Resources Division, Seattle, Washington; and Julia Bos, Washington State Department of Ecology Marine Monitoring Unit, Olympia, Washington.