Continuation of Arctic Nearshore Impact Monitoring in the Development Area (cANIMIDA)

Summer 2004 Field Survey Report

Report to

Minerals Management Service
Anchorage, AK

Report by

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1.0 Introduction

MMS Vessel 1273

As part of the Minerals Management Service (MMS) program entitled "Continuation of Arctic Nearshore Impact Monitoring in the Development Area" (cANIMIDA), the first summer-season field survey of this program (fifth summer survey overall, including ANIMIDA) was conducted from July 28, 2004 to August 17, 2004. The scientific crew, on board the MMS Vessel 1273, collected water, sediment, and tissue samples for physical and chemical analyses. Work also included deployment and retrieval of moorings with caged mussels and semi-permeable membrane devices (SPMDs), setting fish traps, trawling, and collection of shoreline coordinates from the program study area. This report summarizes the field activities and samples collected during the 2004 cANIMIDA summer field survey.

The following bulleted items describe components successfully completed during the 2004 cANIMIDA summer sampling survey:

- Collected 51 surface sediment samples (0 to 1 cm) for hydrocarbon and metals chemistry from 47 offshore stations. Stations were comprised of 16 historic Beaufort Sea Monitoring Program (BSMP) stations, 22 historic Northstar island and Northstar pipeline stations, seven historic Liberty stations, and two new Liberty locations. Samples included triplicates at 2 stations, and additional samples at two stations with coordinate location discrepancies.
- Collected current and turbidity profiles at 20 stations (18 offshore and 2 river locations). Collected 109 suspended sediment samples from one to eight depth strata at the same 20 locations.
- Collected six large volume water samples for organic contaminant analysis; three from Northstar, two from the BSMP, and one from the Liberty area.
- Deployed and retrieved six moorings, three adjacent to Northstar, one in the Liberty area, and two in the BSMP area. Each mooring had single mussel cages and paired semi-permeable membrane device (SPMD) systems.
- Collected 19 bivalve/amphipod/isopod samples. For amphipods, six samples were collected from the Northstar area, four from the BSMP (includes two replicates at one location), and two from the Liberty area. For bivalves, three samples were collected from the BSMP and two from the Liberty area. For isopods, one sample was collected from the BSMP and one from the Northstar area.
- Collected one crude oil source sample from Northstar.
- Delivered all field samples to analytical laboratories for appropriate analyses.

2.0 Schedule

The summer 2004 cruise was conducted from July 28 to August 17, 2002. There were three days lost in the first week, and a half day lost in the final week, due to high winds and seas causing unsafe working conditions. Ice conditions during the survey were favorable, and did not impact sampling efforts. Members of the field team arrived in Prudhoe Bay, Alaska during July 26-28. Initial "check-out" of MMS Vessel 1273 was performed on July 26 and 27 by ship captain Mark Mertz of TEG Oceanographic Services (TEG). Field sampling personnel was comprised of seven staff from three organizations; two staff from Battelle, four from the Florida Institute of Technology (FIT), and one from Kinnetic Laboratories (KLI). The scientific team and ship's captain conducted the work on a 12 to 20 hours/day basis, depending on operating conditions and logistic considerations.

3.0 Cruise Operations and Samples Collected

The MMS Vessel 1273 served as the survey platform for the summer 2004 field work. The MMS Vessel 1273 underwent extensive maintenance and retrofit of electronic equipment during the winter of 2003-2004. The vessel was delivered to Prudhoe Bay, Alaska by MMS prior to the survey and launched after inspection by MMS and TEG representatives. The MMS Vessel 1273 was also used to retrieve current meters for the MMS University of Alaska Coastal Marine Institute (CMI) program at the end of the cANIMIDA survey. A complete list of the sampling stations that were targeted and sampled in the study area is included in Table 1. Table 1 also provides the station type, latitude and longitude, depth, date and time of sampling, and the type of sample (sample matrix). Figure 1 shows the locations of the 2004 sampling stations in the cANIMIDA study area on a series of maps. Additional daily survey and sampling station information is included in the Daily Operations Logs (Attachment 1), Station Logs (Attachment 2), and Fish Sampling Logs (Attachment 3). The following narrative summarizes the field survey timeline.

Mussels in holding container with aeration prior to deployment

July 26 (Monday)

The ship's Captain (Mark Mertz) arrives at Deadhorse, AK, inspects MMS Vessel 1273, and takes custody of the vessel after inspection.

July 27 (Tuesday)

Vessel 1273 maintenance and shakedown cruise is performed in Prudhoe Bay. The captain familiarizes himself with the new electronic equipment, and remedied several minor issues remaining from the winter repairs and truck transport to Prudhoe Bay.

Field team members John Trefry, Bob Trocine, Matt Alkire (FIT) and Gary Lawley (KLI) arrive at Deadhorse, AK. The team mobilizes field and laboratory equipment/supplies at the British Petroleum (BP) Seawater Treatment Plant (STP) Facility.

Field team members John Hardin, Mike Walsh (Battelle) and Greg Delfosse (FIT) receive North Slope safety training in Anchorage.

July 28 (Wednesday)

Field team members Hardin, Walsh and Delfosse acquire BP badges in the morning, and travel to Deadhorse in the afternoon.

The field team at STP mobilizes the vessels (1273 and two inflatables) and sets up water processing laboratory at STP.

July 29 (Thursday)

Amphipod traps are deployed and retrieved at three locations within the Northstar area. Three subsurface moorings are deployed at Northstar. Each mooring is comprised of one mussel cage with ~40 mussels in a Nytex tube, two SPMD cages (four SPMDs, two in each cage), and an acoustic pinger (Figure 2).

Deploying mussel/SPMD mooring w/acoustic pinger

July 30 (Friday)

Three moorings are deployed (one at Liberty, two at BSMP locations). "Zero time" (not deployed) mussels (three samples), one SPMD field blank, and one hydraulic fluid QC sample are collected. Hydraulic fluid leak at the remote steering station (where equipment and supplies were stored) was repaired during the day. Sediment samples are collected at two BSMP locations. Anchor 1273 at West Dock.

July 31 - August 1 (Saturday – Sunday)

Winds of 25 – 50 kts prevail. Sea conditions are unsafe for sampling. Attempt was made to sample on 1 August, but team abandons attempt. River shoreline mapping for erosion studies is completed along the Sagavanirktok ('Sag') River.

August 2 (Monday)

Sediment samples are collected from seven locations within the Liberty and BSMP areas. Water is collected from two Liberty locations and one transect location (E0). One amphipod and three clam samples are collected from Liberty and BSMP areas.

August 3 (Tuesday)

Sediment samples are collected from seven locations within Liberty and BSMP areas. Water is collected from two locations (one Liberty, one BSMP). Amphipods are collected from two BSMP stations. Anchor is lost under moving iceberg during water sampling. The anchor was replaced the same day by John Tremont of MMS and shipped via airfreight from Anchorage to Deadhorse.

August 4 (Wednesday)

Winds of 25 – 40 kts and rough seas prevail; conditions are again unsafe for sampling. Sediment and tissue samples are shipped to the Battelle Duxbury laboratory.

August 5 (Thursday)

Sampling team split into two groups.

The water/sediment team collects water from seven locations (six transect and one BSMP location). Sediment is collected from one BSMP location.

The fish team deploys fyke net at Point Brower.

Van Veen grab with sediment sample

August 6 (Friday)

The water/sediment team collects sediment samples from 11 Northstar locations, and samples water at four locations (three on transect K and one at Northstar).

The fish team collects fish from the fyke net set at Point Brower. Fish are processed for tissue chemistry, estrogen-mediated suppression of cytochrome P4501A (CYP1A), and bile is removed for metabolites of fluorescent aromatic compounds (FACs) at the STP Conex building.

Dick Prentki, MMS' Contracting Officer's Technical Representative (COTR), arrives at Deadhorse.

August 7 (Sunday)

The water/sediment team collects water from two transect locations and sediment from five Northstar locations.

The fish team collects fish from Point Brower, removes net from Point Brower, and processes fish at STP. The fyke net is set at Stump Island in the afternoon.

August 8 (Monday)

The water/sediment team sets two minnow traps baited with sardines close to Northstar Island to test an alternative fish collection method. Water is collected from one BSMP, one transect, and two Northstar locations. Sediment is collected from one Northstar and three BSMP locations. Amphipods are collected from one Northstar location.

The FIT team completes their water sampling, processes their final samples, and begins packing samples and equipment.

The fish team collects fish in the morning from Stump Island net, re-sets the net, and processes samples at STP. Fish are then collected in the afternoon, the net is re-set, and the second batch of fish is processed in the evening.

August 9 (Tuesday)

The water/sediment team retrieves minnow traps from Northstar. No fish were caught, only isopods and a few amphipods. Larger traps than the minnow traps with live bait, such as isopods, might be more suitable to catch small bottom fish such as sculpin and flatfish/sand dabs and could be considered for future surveys.

Surface water sample collection near flow ice

The water/sediment team collects sediment from five Northstar locations and five BSMP locations. Amphipods are collected from one Northstar location, and clams from one BSMP location. One large volume water sample is collected from Northstar and filtered using the Infiltrex unit at STP in the evening.

The fish team collects fish from Stump Island, removes fyke net, and processes fish samples at STP.

FIT team completes de-mobilization of equipment and supplies. Three FIT staff depart Deadhorse, John Trefry remains.

August 10 (Wednesday)

Sediment, tissue and fish samples are shipped to Battelle Duxbury in the morning. Re-fueled 1273 with 200 gallons of diesel fuel and fill water tanks.

One large volume water sample was collected in the afternoon from Northstar and the sample was filtered in the evening.

August 11 (Thursday)

The single water/sediment/fish team transits to Tigvariak Island. One large volume water sample was collected from a BSMP station on the way to Tigvariak. The water sample was filtered on the 1273. Fyke net was deployed at Tigvariak. A second large volume water sample was collected from a BSMP station, and the sample was filtered while anchored at Tigvariak Island.

John Trefry departs Deadhorse.

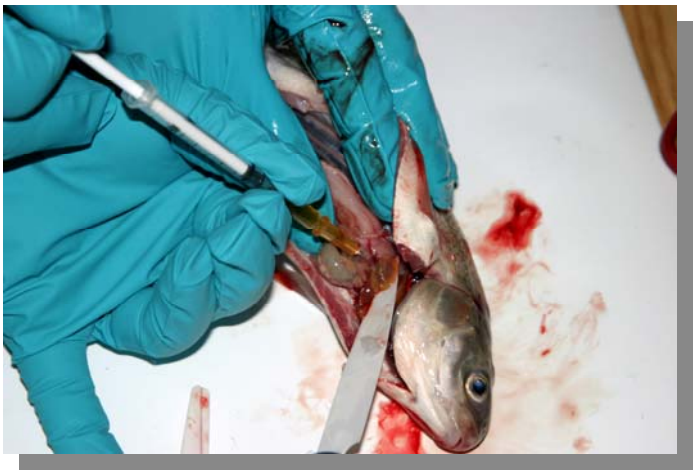
Collecting fish from fyke net at Tigvariak

August 12 (Friday)

Fish were collected from the fyke net in the morning, the net was re-set, and the samples were process on the 1273. Clams were collected from a BSMP location in the afternoon. The fyke net was re-sampled in the evening and removed, and the samples were processed. Returned to anchor at Tigvariak Island.

August 13 (Saturday)

Two mussel/SPMD moorings (one Liberty and one BSMP location) were retrieved. Amphipod traps were set at two Liberty locations and fish were collected by trawling at Liberty. Amphipods were retrieved from one location. One large volume water sample was collected from Liberty and processed. Returned early to Endicott Island due to building winds and seas.



Collecting bile sample for FACS analysis

August 14 (Sunday)

Mussel/SPMD mooring was retrieved from a BSMP location. The amphipod trap set on 13 August was retrieved, but there were not enough organisms to keep the sample. A too long of a deployment appears to cause amphipods to lose interest in the Nytex™ wrapped bait (i.e., the bait is not available to eat, so the amphipods leave). Returned to West Dock.

August 15 (Monday)

Moorings were retrieved from three Northstar locations. Fish were collected by trawling at Northstar. A large volume water sample was collected from Northstar and the sample was filtered at STP in the evening.

The field sampling was completed for the 2004 cANIMIDA summer season.

August 16 (Tuesday)

De-mobilized equipment and supplies, and shipped samples.
Re-fueled 1273 with 200 gallons of diesel, and re-filled the water tanks.

August 17 (Wednesday)

Equipment and gear were shipped in the morning.

A Northstar crude sample was received and shipped in the evening. This is the one source sample that was collected on this trip.

Battelle and KLI staff depart Deadhorse. Mark Mertz remains to captain 1273 for the University of Alaska (UA) survey.

August 18 (Thursday) – 2 September (Thursday)

UA staff arrived on 19 August. UA equipment arrives by 21 August. The UA mooring deployment efforts were affected by several weather days, but the work was successfully completed. Mark Mertz supervises the removing of the 1273 from the water and prepares the vessel for the winter. Mertz returns to California on 2 September.

4.0 Sampling Procedures

The sampling procedures that were used were consistent with those used during the Summer 2002 program (MMS 2002), and were described in the Summer 2004 Field Logistics and Sampling Plan for the Minerals Management Service ANIMIDA Program (MMS, 2004). One additional sample type, filtered large volume (100L) water samples for organic analytes, was added to the cANIMIDA 2004 survey, and such water samples were collected from six locations.

Sampling procedures included:

- water conductivity, temperature, and depth (CTD) measurements
- water current measurements with the CTD/Doppler current meter

Sieving sediment for clams

- water sample collection via pump system from offshore suspended sediment stations, and via hand at shoreline river stations
- surface sediment grab sample collection using a modified Van-Veen grab (for sediments and bivalves)
- deployment and retrieval of amphipod traps
- deployment and retrieval of mussel cages and SPMDs from six fixed moorings
- collection of fish samples by fyke net at three locations, and by trawling at two locations
- collection of large volume water samples at six locations
- DGPS measurements of shoreline sections

Photo documentation, station logs, and field notes were recorded during the field survey. The daily operations logs are included in Attachment 1, the station logs for each sampling station are included in Attachment 2, and the fish sampling logs are included in Attachment 3. The station logs include a description of the sampling location, observations, number and type(s) of samples collected, and comments.

5.0 Technical Issues

There were no significant technical difficulties during this survey. The sampling went smoothly, with a normal amount of weather days (3.5). As expected, collecting sufficient fish offshore with a small otter trawl was difficult and returned a minimal amount of fish for analysis. Other approaches for collecting fish should be considered for future surveys. There were no permit problems with mussel collection and transport, partly because of lessons learned as part of the 2002 survey.

6.0 References

Minerals Management Service. 2002. Summer 2002 Field Sampling and Logistics Plan. July 2002.

Minerals Management Service. 2004. Summer 2004 Field Sampling and Logistics Plan. July 22, 2004.

Table 1. cANIMIDA Stations Sampled in the Summer 2004 Survey

Station ID	Station Type	Latitude[1] (WGS84)	Longitude[1] (WGS84)	Date
3A	BSMP	70° 16.9327	147° 05.4570	30-Jul; 11,12,13-Aug
3B	BSMP	70° 17.9035	147° 02.5445	30-Jul
4A	BSMP	70° 18.4539	147° 40.2372	3-Aug
4B	BSMP	70° 21.0155	147° 40.0320	3-Aug
4C	BSMP	70° 26.0898	147° 42.9757	3-Aug
5(0)	BSMP	70° 22.7435	147° 00.3850	3-Aug
5(1)	BSMP	70° 25.0763	148° 03.5628	5-Aug
5(10)	BSMP	70° 27.3238	148° 30.0676	8-Aug
5(5)	BSMP	70° 26.0820	147° 18.0805	3-Aug
5(5) - L1	BSMP	-	-	
5(5a)	BSMP	70° 26.0079	148° 18.8205	8-Aug
5A	BSMP	70° 29.6986	148° 46.0600	9-Aug
5B	BSMP	70° 34.8745	148° 55.1429	9-Aug
5D	BSMP	70° 24.4578	148° 33.5676	8-Aug
5E	BSMP	70° 38.3621	149° 16.3576	9-Aug
5F	BSMP	70° 26.4946	148° 49.5346	9-Aug
5H	BSMP	70° 22.2280	147° 47.8581	2,11,14-Aug
E0	Other	70° 23.0036	148° 00.0271	2-Aug
E1	Other	70° 23.9972	148° 00.1264	5-Aug
E2	Other	70° 26.0057	148° 00.0680	5-Aug
E3	Other	70° 27.9779	148° 06.1030	5-Aug
K0	Other	70° 26.3959	148° 41.8500	7-Aug
K1	Other	70° 27.6797	148° 41.2676	6-Aug
K2	Other	70° 28.3053	148° 40.1109	6-Aug
K3	Other	70° 28.9968	148° 38.8059	6-Aug
K4	Other	-	-	
K5	Other	-	-	
L01	Liberty	70° 17.9321	148° 40.0906	2-Aug
L01A	Liberty	70° 18.9281	147° 33.9044	11-Aug
L04	Liberty	70° 17.0604	147° 40.0976	2-Aug
L06	Liberty	70° 16.9242	147° 34.0839	2,13-Aug
L07	Liberty	70° 16.7760	147° 32.0016	2-Aug
L08	Liberty	70° 16.7007	147° 30.3426	2-Aug
L09	Liberty	70° 16.5705	147° 27.2041	2-Aug
L14	Liberty	70° 17.0095	147° 34.744	13-Aug
L17	Liberty	70° 23.6088	147° 32.9282	3,13-Aug
L18	Liberty	70° 18.3738	147° 45.6664	3,13-Aug
MZ	QA/QC	NA	NA	30-Jul
N01	Northstar	70° 31.6679	148° 41.4653	8-Aug
N02	Northstar	70° 30.5390	148° 41.3394	7-Aug
N03	Northstar	70° 30.0202	148° 41.4901	7,8-Aug
N04	Northstar	70° 29.6787	148° 48.0977	9,15-Aug
N05	Northstar	70° 29.6337	148° 44.6996	7,10,15-Aug
N06	Northstar	70° 29.5591	148° 43.2685	7,9,15-Aug
N07	Northstar	70° 29.5703	148° 40.0925	6-Aug
N08	Northstar	70° 29.4281	148° 38.3250	6-Aug
N09	Northstar	70° 29.3405	148° 35.1494	6-Aug
N10	Northstar	70° 29.0187	148° 41.7696	6-Aug
N11	Northstar	70° 28.4650	148° 42.0122	29-Jul; 6-Aug
N12	Northstar	70° 27.3503	148° 42.1061	29-Jul; 6-Aug
N13	Northstar	70° 26.9832	148° 43.5749	29-Jul; 9-Aug
N14	Northstar	70° 25.9829	148° 40.3584	9-Aug
N15	Northstar	70° 26.7197	148° 44.5858	9-Aug
N16	Northstar	70° 29.9089	148° 42.3907	7-Aug
N17	Northstar	70° 29.8177	148° 40.3584	6-Aug
N18	Northstar	70° 29.0908	148° 42.2610	6,7-Aug
N19	Northstar	70° 29.1251	148° 40.5610	6-Aug
N20	Northstar	70° 27.9697	148° 41.6865	6-Aug
N21	Northstar	70° 26.8124	148° 41.7302	9-Aug
N23	Northstar	70° 29.3749	148° 41.9297	6-Aug
N24a	Northstar	70° 38.6646	148° 39.1849	8-Aug
N25	Northstar	70° 29.7314	148° 43.9868	15-Aug
PB1	Other	70° 24.2655	148° 31.3879	7-Aug
PBS	Liberty	70° 17.5583	147° 48.1414	7-Aug
S2	Other	70° 24.3032	148° 14.1992	5,8-Aug
S4	Other	70° 25.7847	148° 14.1101	5-Aug
S5	Other	70° 26.5846	148° 14.0971	5-Aug
SIS	Northstar	70° 25.9079	148° 41.5673	8-Aug
SK1	Other	-	-	
SK2	Other	-	-	
SK4	Other	-	-	
SK6	Other	-	-	
SK7	Other	-	-	
SK8	Other	-	-	
TGV	Tigvariak Island	70° 12.4541	147° 14.2344	12-Aug
TOTALS				

[1] Only one coordinate provided per station, even when multiple visits or trawls were made

Table 1 (cont.). cANIMIDA Stations Sampled in the 2004 Summer Survey

Station ID	Sample Type								
	Sediment	Water	LV Water	Amphipods	Isopods	Bivalve (Clams)	Deployed Mussel_ SPMD	Fish	Field Blanks
3A	1		1			1	1		
3B	1								
4A	1			1					
4B	1								
4C	1	0							
5(0)	1			2	1				
5(1)	1	1							
5(10)	1								
5(5)	1	1							
5(5) - L1		0							
5(5a)	1								
5A	1								
5B	1			1					
5D	1								
5E	1								
5F	1					1			
5H	1		1			1	1		
E0		1							
E1		1							
E2		1							
E3		1							
K0		1							
K1		1							
K2		1							
K3		1							
K4		0							
K5		0							
L01	1	1							
L01A	1								4
L04	1	1		1					
L06	3		1				1		
L07	1								
L08	1					1			
L09	1					1			
L14								5	
L17	1	1							
L18	1			1					
MZ							3		
N01	1	1							
N02	1								
N03	1			1	1				
N04	1		1	1			1		2
N05	1		1				1		
N06	3		1				1		
N07	1								
N08	1								
N09	1								
N10	1								
N11	1			1					
N12	1			1					
N13	1			1					
N14	1								
N15	1								
N16	1								
N17	1								
N18	1			1					
N19	1								
N20	1								
N21	1								1
N23	1	1							
N24a		1							
N25								5	
PB1		1							
PBS								78	
S2		2							
S4		1							
S5		1							
SIS								83	
SK1		0							
SK2		0							
SK4		0							
SK6		0							
SK7		0							
SK8		0							
TGV								66	
TOTALS	51	21	6	12	2	5	9	237	7

KEY	
1	Indicates number of samples collected
1	Indicates samples collected at unplanned location
0	Indicates proposed sample not collected.

Table 1 (cont.). cANIMIDA Stations Sampled in the 2004 Summer Survey

Station ID	Comments
3A	Two SPMDs samples and one container of mussels.
3B	
4A	
4B	
4C	Water samples not collected, site beyond influence of suspended solids from rivers.
5(0)	Extra amphipod sample collected. Oportunistic isopod sample collected.
5(1)	Water station added within area containing suspended solids from rivers.
5(10)	
5(5)	
5(5) - L1	Water samples not collected, site beyond influence of suspended solids from rivers.
5(5a)	Error in coordinates for 5(5). 5(5a) added at correct location.
5A	
5B	
5D	
5E	
5F	
5H	Two SPMDs samples and one container of mussels.
E0	
E1	
E2	
E3	
K0	Water station added within area containing suspended solids from rivers.
K1	
K2	
K3	
K4	Water samples not collected, site beyond influence of suspended solids from rivers.
K5	Water samples not collected, site beyond influence of suspended solids from rivers.
L01	
L01A	Error in coordinates for L01. L01A added at correct intended location for L01.
L04	
L06	Two SPMDs samples and one container of mussels.
L07	
L08	
L09	
L14	5 total samples (from 10 fish) (2 PHC/MET, 3 CYP1A) Multiple fish/jar.
L17	New station added in Liberty area.
L18	New station added in Liberty area.
MZ	Zero time Mussels
N01	Water station added within area containing suspended solids from rivers.
N02	
N03	Oportunistic isopod sample collected.
N04	
N05	
N06	
N07	
N08	
N09	
N10	
N11	
N12	
N13	
N14	
N15	
N16	
N17	
N18	
N19	
N20	
N21	
N23	Water station added within area containing suspended solids from rivers.
N24a	Water station added within area containing suspended solids from rivers.
N25	5 total samples (from 19 fish) (3 PHC/MET, 2 CYP1A) Multiple fish/jar.
PB1	
PBS	78 total samples (25 PHC/MET, 32 CYP1A, and 21 bile)
S2	Two samples collected, one Aug 5 and one on Aug 8 to assess temporal changes.
S4	
S5	
SIS	83 total samples (28 PHC?MET, 31 CYP1A, 24 bile)
SK1	Water samples not collected, site beyond influence of suspended solids from rivers.
SK2	Water samples not collected, site beyond influence of suspended solids from rivers.
SK4	Water samples not collected, site beyond influence of suspended solids from rivers.
SK6	Water samples not collected, site beyond influence of suspended solids from rivers.
SK7	Water samples not collected, site beyond influence of suspended solids from rivers.
SK8	Water samples not collected, site beyond influence of suspended solids from rivers.
TGV	66 total samples (20 PHC/MET, 30 CYP1A, 16 Bile)
TOTALS	

Additional Blanks/Source material samples
SPMD Trip Blanks
Absorbent pad wipe of hydraulic fluid
Absorbent pad wipe of diesel fuel
Northstar composite crude oil

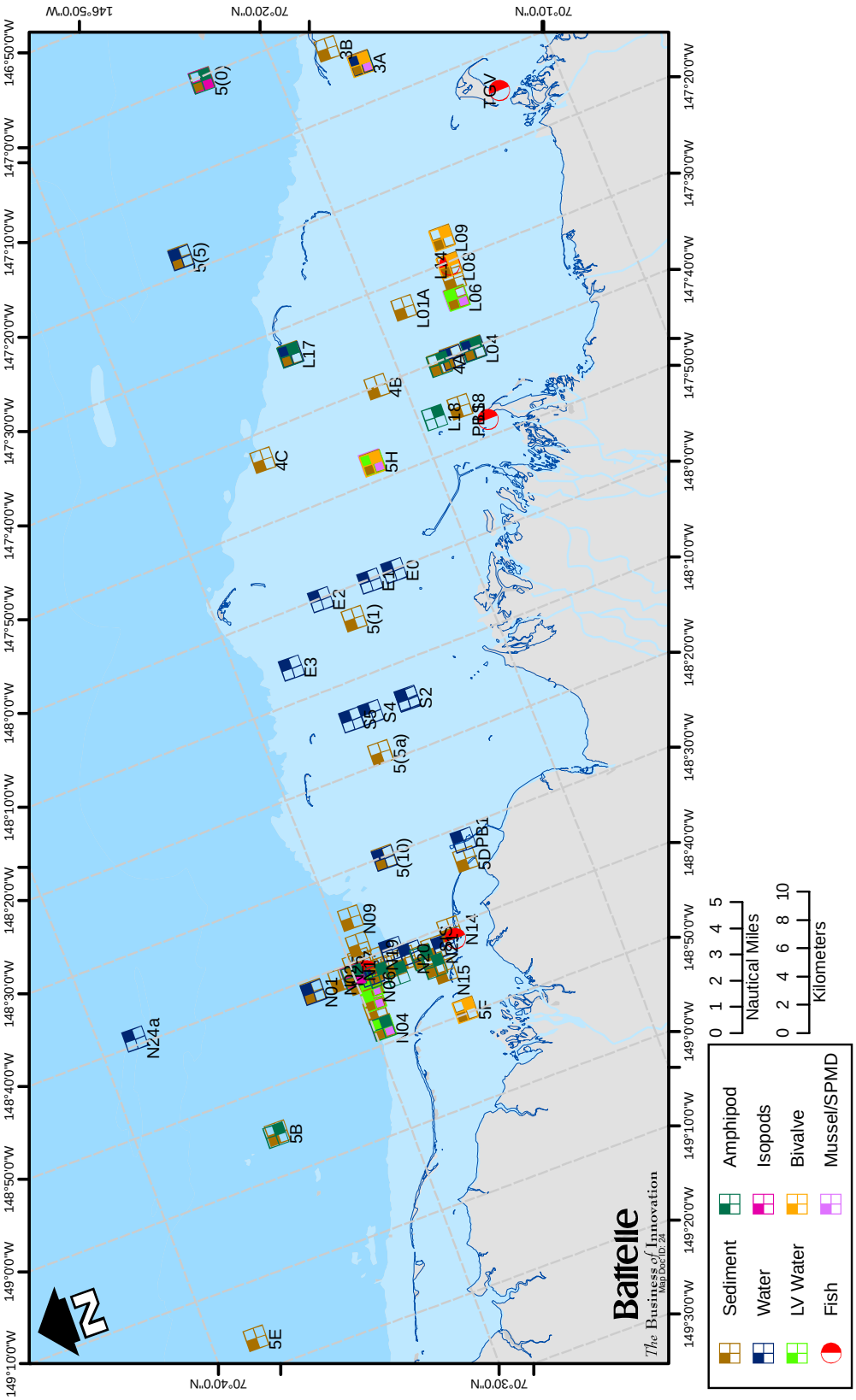


Figure 1. cANIMIDA Summer 2004 Sampling Stations
All Stations

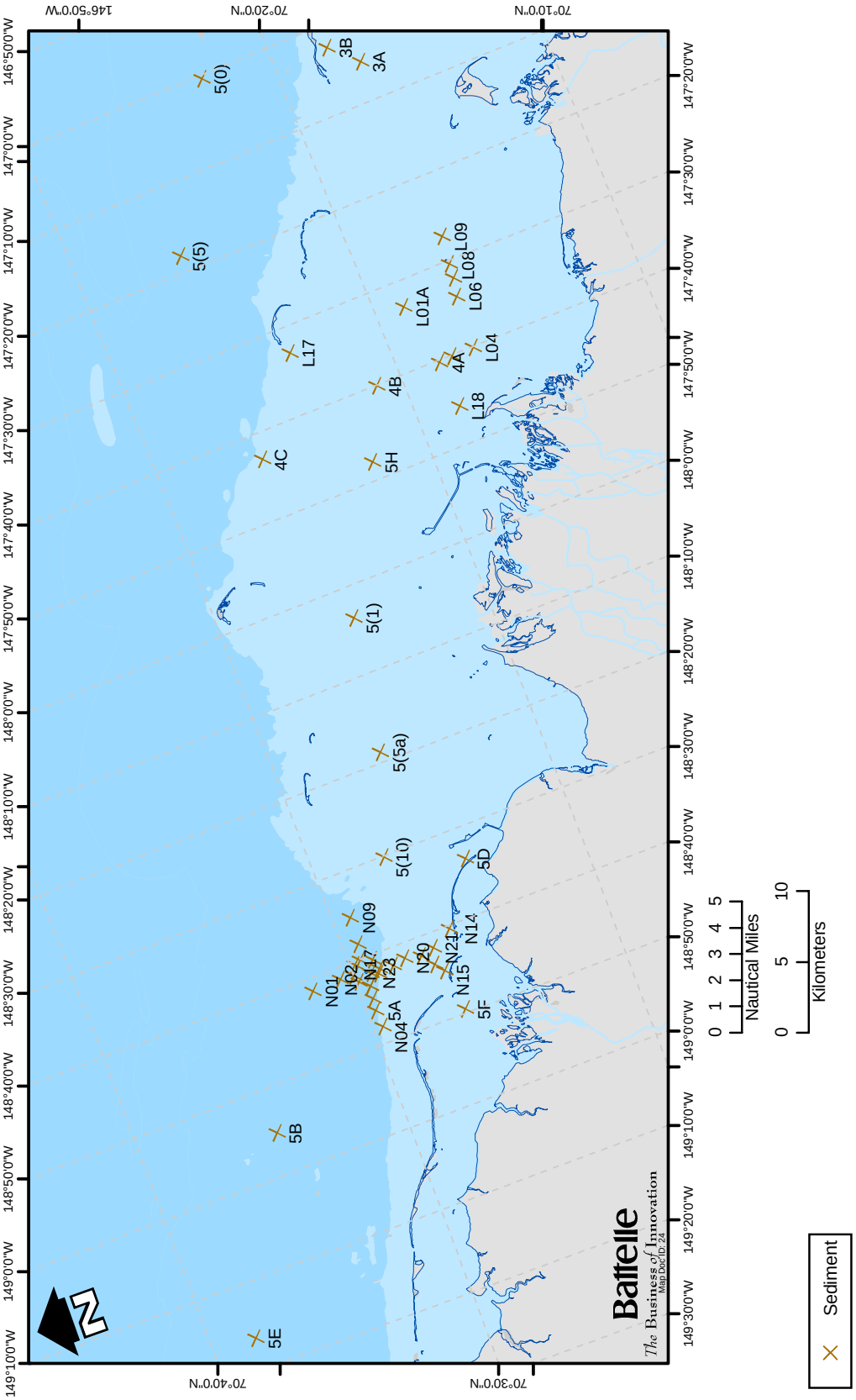


Figure 1 (cont.). cANIMIDA Summer 2004 Sampling Stations Sediment Stations

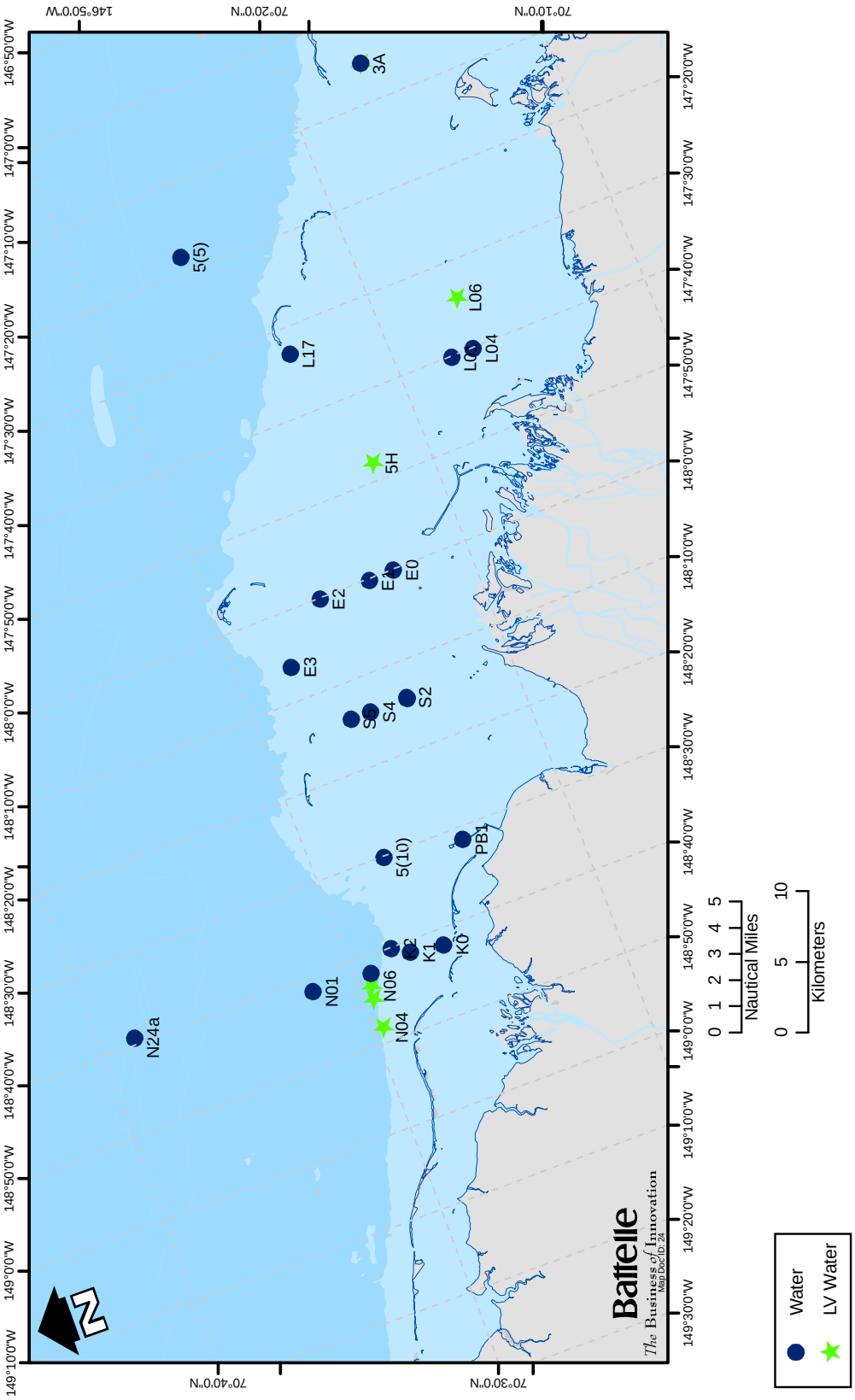


Figure 1 (cont.). cANIMIDA Summer 2004 Sampling Stations Standard Water and Large Volume Water Stations

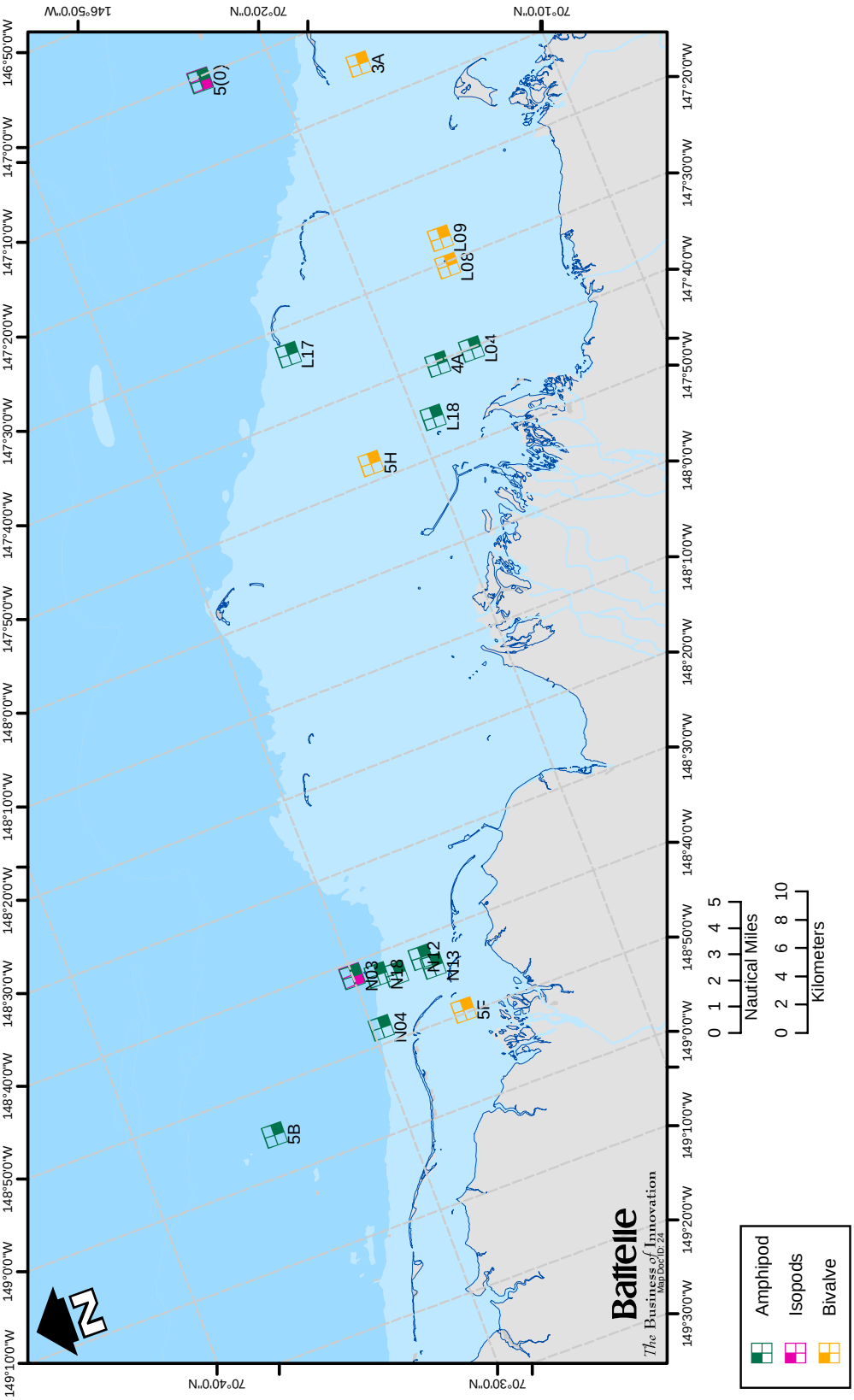


Figure 1 (cont.). cANIMIDA Summer 2004 Sampling Stations Amphipod and Bivalve (clam) Stations

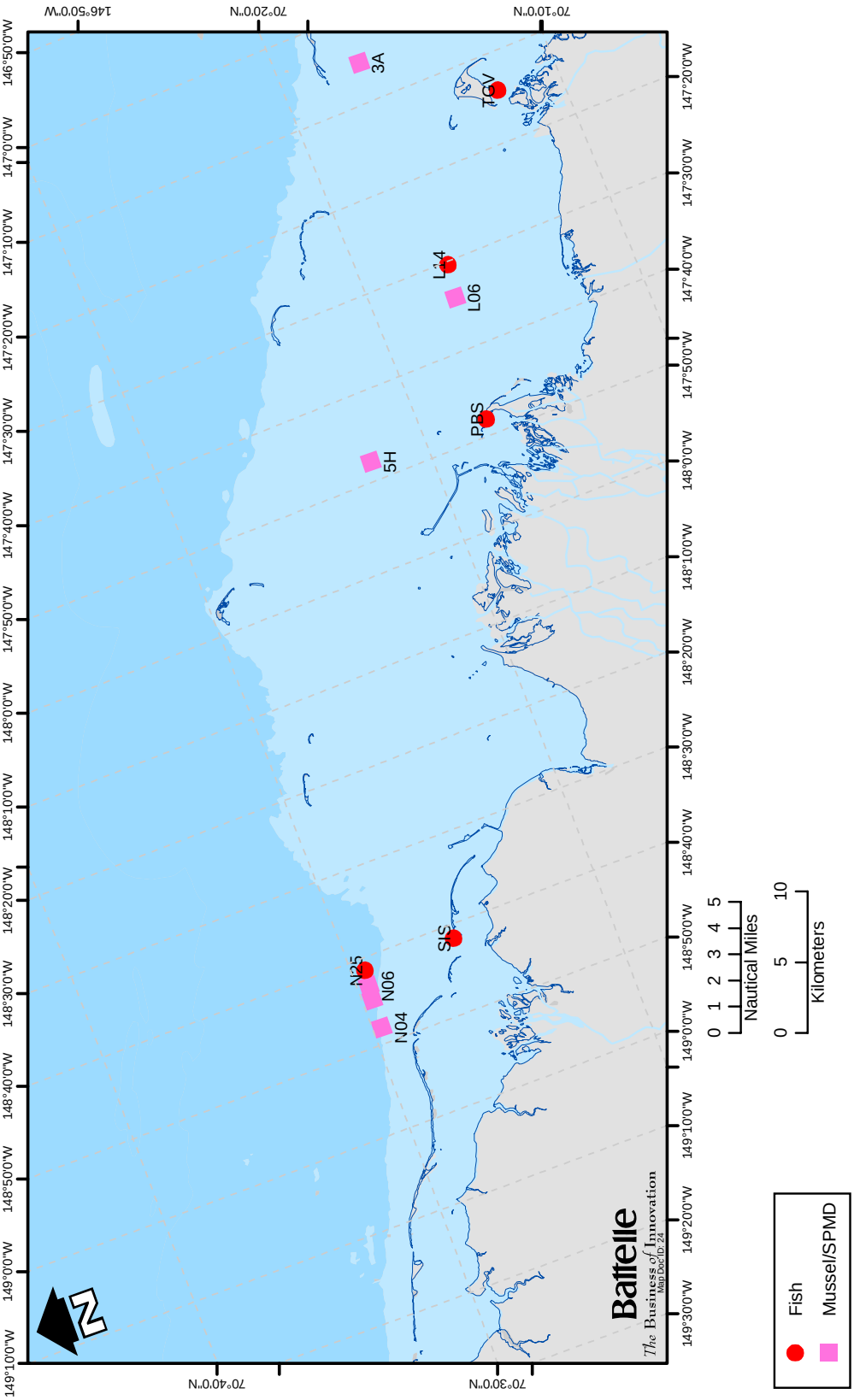


Figure 1 (cont.). cANIMIDA Summer 2004 Sampling Stations Fish Collection and Mussel/SPMD Deployment Stations

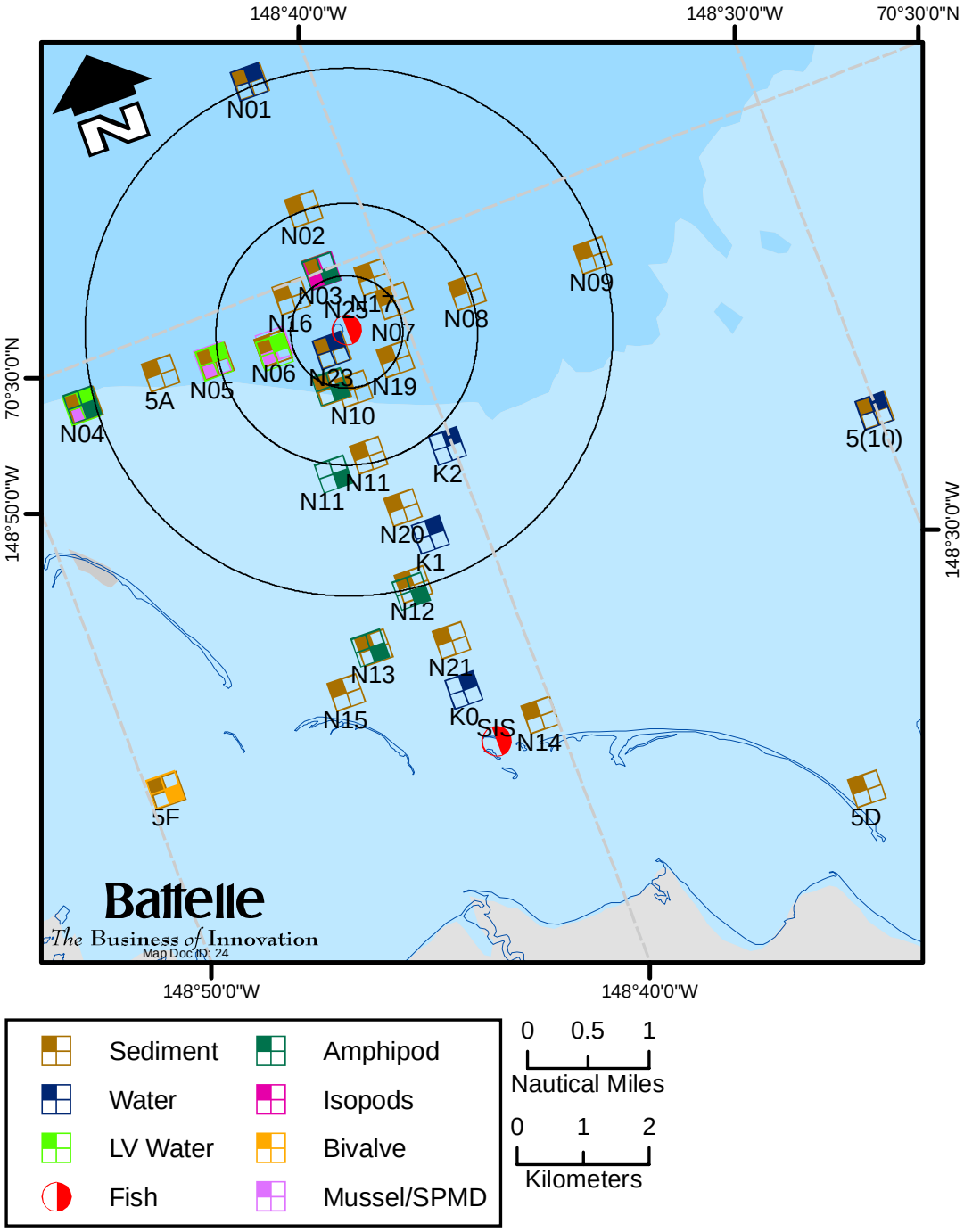


Figure 1 (cont.). cANIMIDA Summer 2004 Sampling Stations
Stations in the Northstar Area

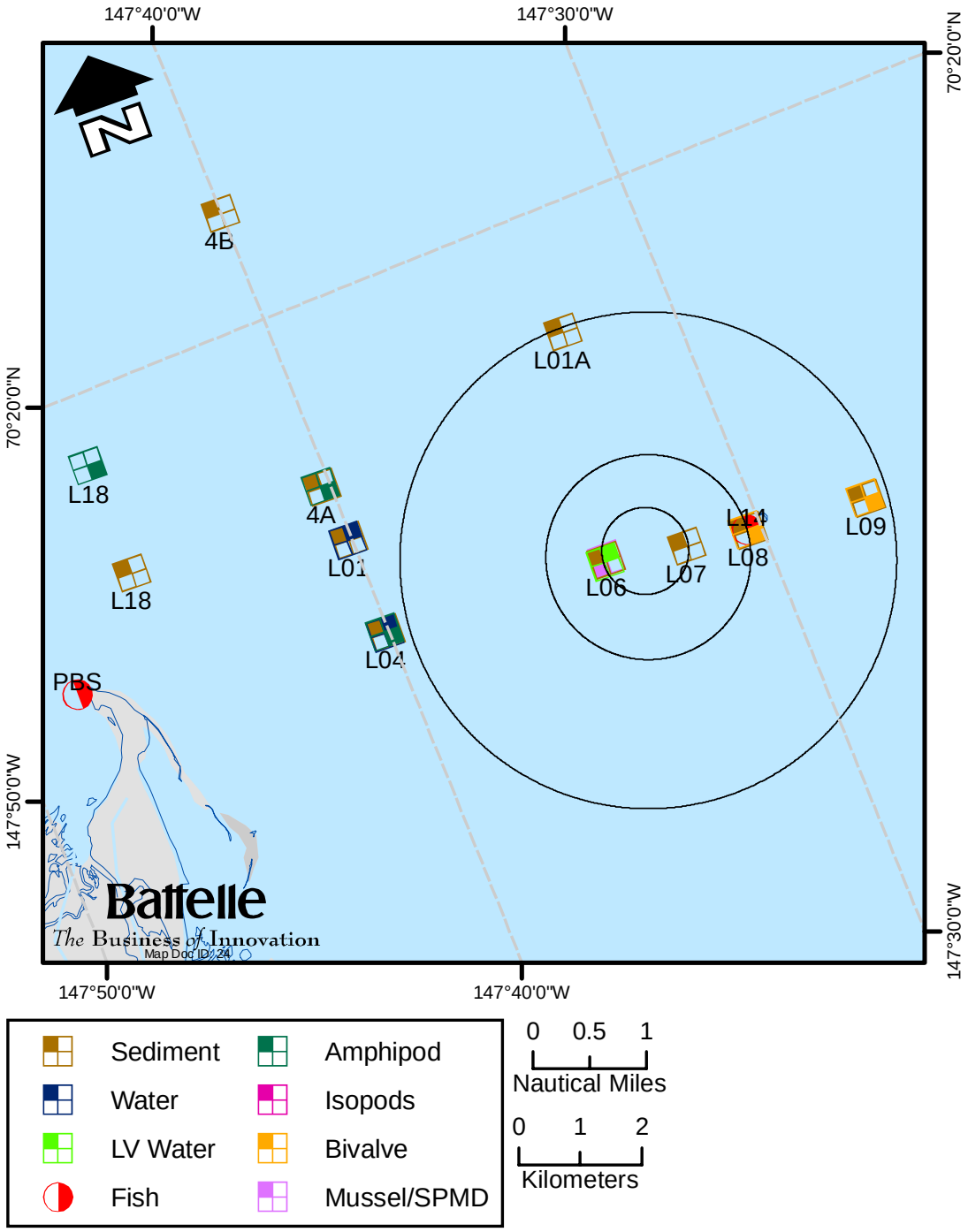


Figure 1 (cont.). cANIMIDA Summer 2004 Sampling Stations Stations in the Liberty Area

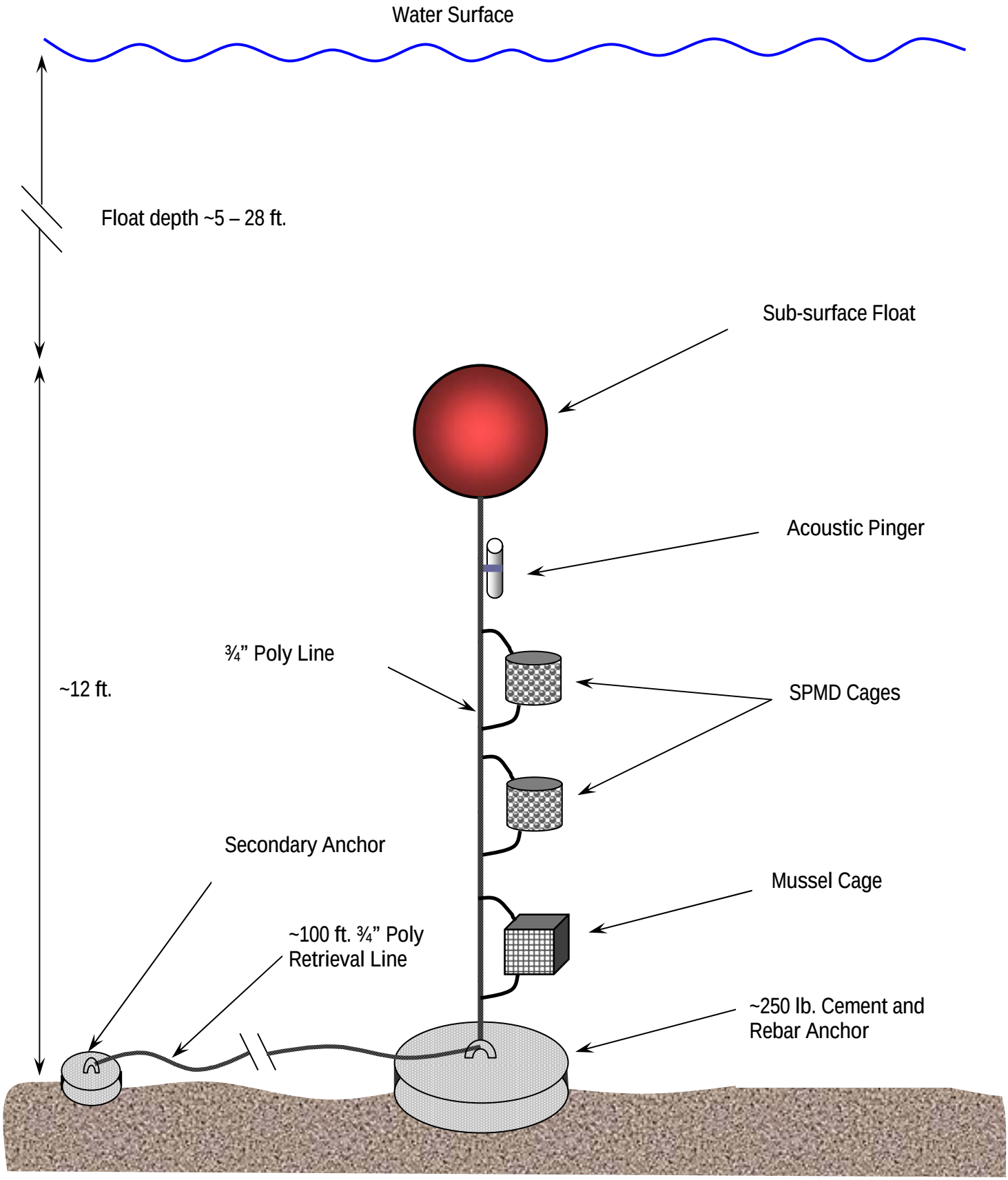


Figure 2. Schematic of the Mussel Cage and SPMD Mooring

Attachment 1: 2002 Daily Operations Logs

Attachment 2: 2002 Station Logs

Attachment 3: 2002 Fish Sampling Logs

Attachment 4: 2002 Collection Permit and Fish Transfer Permit