EVALUATION OF THE CURRENT STATE OF NAUTICAL CHARTS IN THE ARCTIC:

HYDROGRAPHIC PERSPECTIVE FROM COAST SURVEY'S PARTICIPATION ON USCGC *SPAR*'S (WBL-206)
NORTHWEST ALASKA PATROL, 2008

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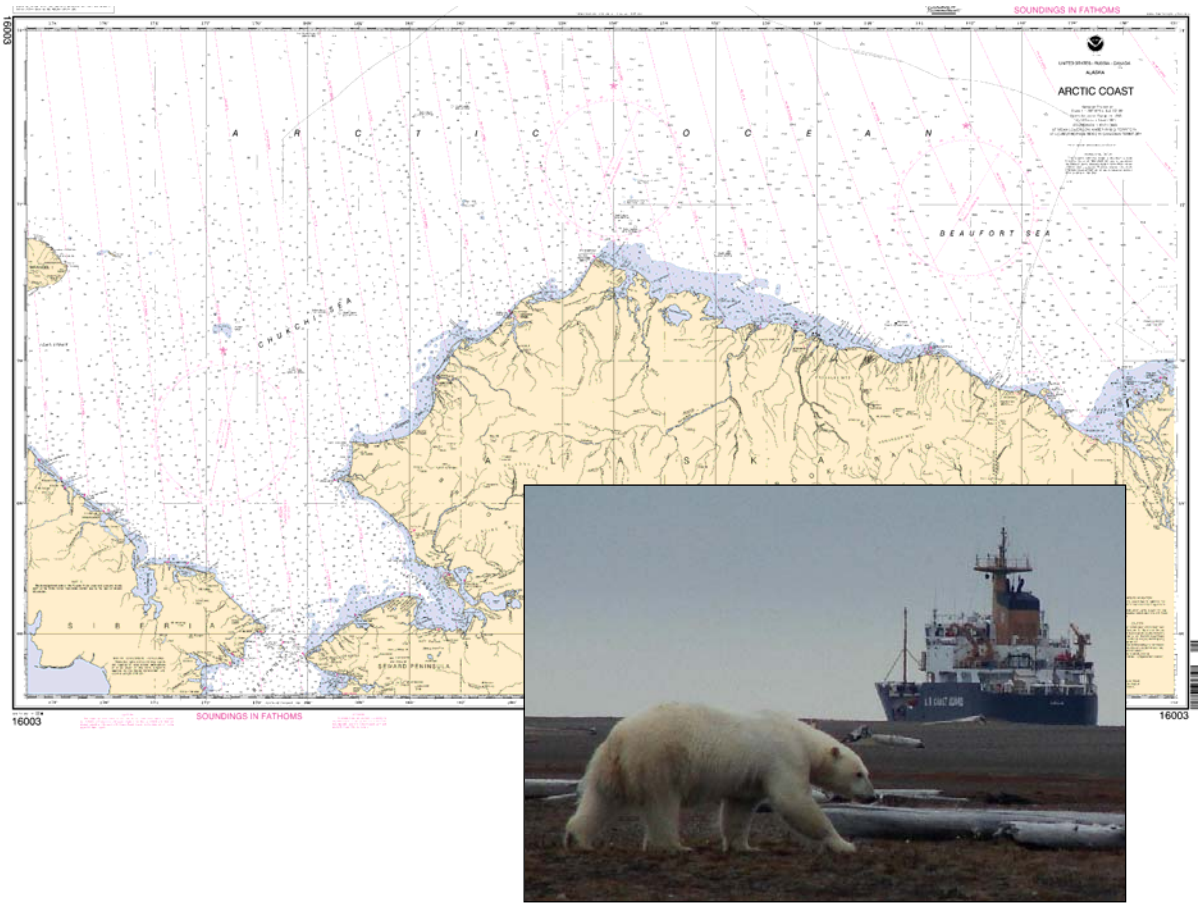

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ABSTRACT:
As the number of users in the arctic increases, the need for contemporary hydrographic data has become clear. The challenging operational environment of the Arctic will require creative solutions to address data acquisition. The existing field operation strategies will need to be re-examined, and a combination of existing operational paradigms and creative solutions will likely be needed to address hydrography in the region.

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1. PURPOSE:

The 2008 forward presence in the Arctic by the United States Coast Guard (USCG) included the USCGC *Spar*'s (WLB-206) waterways assessment survey and patrol along the western and northern coasts of Alaska, from the Bering Strait to Demarcation Point, at the US/Canadian border demarcation line. NOAA's Office of Coast Survey (OCS), Navigation Services Division arranged to have a NOAA hydrographer accompany *Spar* on its cruise. The goals for the hydrographer were:

a. Evaluate first hand nautical charts and Coast Pilot information for the region.
b. Participate in a hydrographic systems/data collection technical exchange.
c. Evaluate Coast Survey options for data collection in the Arctic.
d. Evaluate the region's ports and logistics with NOAA fleet operations in mind.

2. BACKGROUND:

The momentum of the world seems to be moving north. The Arctic, ice locked for the duration of most of human presence in the region, has not historically been an area of wide commerce. As such, the nautical charts and hydrographic surveys of the region are sparse and dated. Nearshore hydrographic survey operations on the North Slope were conducted in the late 1940's and early 1950's when an Arctic field party was established to conduct both hydrographic and geodetic surveys for the establishment of the Distant Early Warning radar line. In the interim OCS has had little presence in the region. For much of that time the users in the region were mainly subsistence whalers and tug captains running summer supply/fuel barges to coastal villages. There is now a shift away from a mainly subsistence utilization of the area toward commercial use, due in large part to the recession of the summer sea ice pack. The summer arctic sea ice coverage is roughly 50% of what it was half a century ago, and in 2007 the summer sea ice extent broke the previous record minimum (set in 2005) by 23%. The Northwest Passage and the Northern Sea Route are now open during the summer months. These trans-Arctic shipping routes are between 25-40% shorter than current routes and connote a potential 20% monetary savings per voyage. Artic tourism has also experienced a rapid increase. In 2004 there were 50 cruise vessels in the Arctic, in 2007 there were 250. In addition, the US Geological Survey estimates that approximately 15% of the world's untapped oil and 30% of the natural gas lie below the region. The economic drivers of an estimated 90 billion barrels of oil awaiting exploration, and the opening of navigable arctic sea routes have acutely focused the attention of the five Arctic nations on the region. Logically, the increase in commercial traffic means a greater number of consumers of OCS products. Likewise, the USCG, a substantial and important consumer of OCS products, has increased its presence in the Arctic. The increased use of Arctic waters will no doubt demand an increased presence in the region from each NOAA line office. In particular NOS/OCS should lead the increased NOAA presence in the region as many of our products represent baseline knowledge which other line offices and organizations will need.

3. COAST PILOT & NAUTICAL CHARTS:

3.1. Coast Pilot Updates:

Coast Pilot (CP) entries in the area are, in some cases, based on data gathered by Revenue Cutters in the 1800's. Coast Pilot entries were examined and updated at all villages visited and in areas where *Spar* was close enough to land to afford photography and data gathering. Much of the data was anecdotal and was obtained via meetings with local officials. Runway lengths were obtained from the FAA. Efforts on updating the CP were focused on CP9 26th Ed. ch9 "Arctic Ocean" as well as ch8 "Bering Sea" namely Village Cove on St Paul Island and ch6 King Cove. Photos were taken of Kivalina, Red Dog, Wainwright Inlet, Wainwright, Barrow, Kaktovik, Demarcation Point, as well as Village Cove (St Paul Island), and King Cove (Shumigans). Coast Pilot entries were updated for CP9 26th Ed. ch9 sec 6, 8, 46-Kotzebue Sound, 49-Deering, 61-Kotzebue, 82-Red Dog Mine, 83-Kivalina, 91&92-Point Hope, 101-Point Lay, 112-Wainwright Inlet, 113&114-Wainwright, 127, 128 &129-Barrow, 142, 143, 175&176-Prudhoe Bay,

201&202-Kakovik, 222, 224-Demarcation Point, and 229-Herschel Island. Two cities were listed in the CP as having a US Customs Office, currently no customs stations exist in arctic Alaska, the nearest port of entry is Nome.

3.2. Chart Discrepancies:

Twenty-two chart discrepancy reports were submitted for charts: 16005, 16043, 16061, 16063, 16082, 16085, 16101, 16102, 16103, 16104, 16121, 16122 and 16123.

3.3. Nautical Charts Evaluation:

NOS Arctic charts can be greatly improved by addressing; chart scale, shoreline data and sounding density. The scale is not appropriate for some crucial areas, the shoreline is often incorrect and the sounding density is sparse. A combination of three factors has contributed to the inadequacy of NOS charts in the region;

a) Technological limits in hydrographic data gathering at the time of hydrography.
Source data from the 1940-50's surveys are partial bottom coverage with positioning reliant on visual triangulation. Positioning was limited to the nearshore and subject to the adverse weather conditions common in the region. Contemporary hydrography in the region will require the establishment of controlling and subordinate water level stations as well as portable differential GPS (DGPS) reference stations.

b) The highly changeable nature of the bottom/foreshore and shoreline.
Unlike much of southern Alaska, the arctic Alaska seafloor is typically sandy sediment and gravel. The foreshore and coastal land area is generally marked by barrier islands, broad shallow lagoons and shifting shoals, subject to sediment transport from erosion/deposition and ice scouring. The bathymetry of the region lends itself to the use of side scan sonar and/or phase differencing sonar. Coastal villages, typically, are built on sandy or gravelly spits of land that are subject to coastal erosion - in some cases entire villages have been moved in response to erosion and are not correctly positioned on current charts. Accurate shoreline and nearshore hydrography are crucial considering there are no pier facilities north of Nome and supply barges typically beach themselves or lighter to landing craft that are then beached.

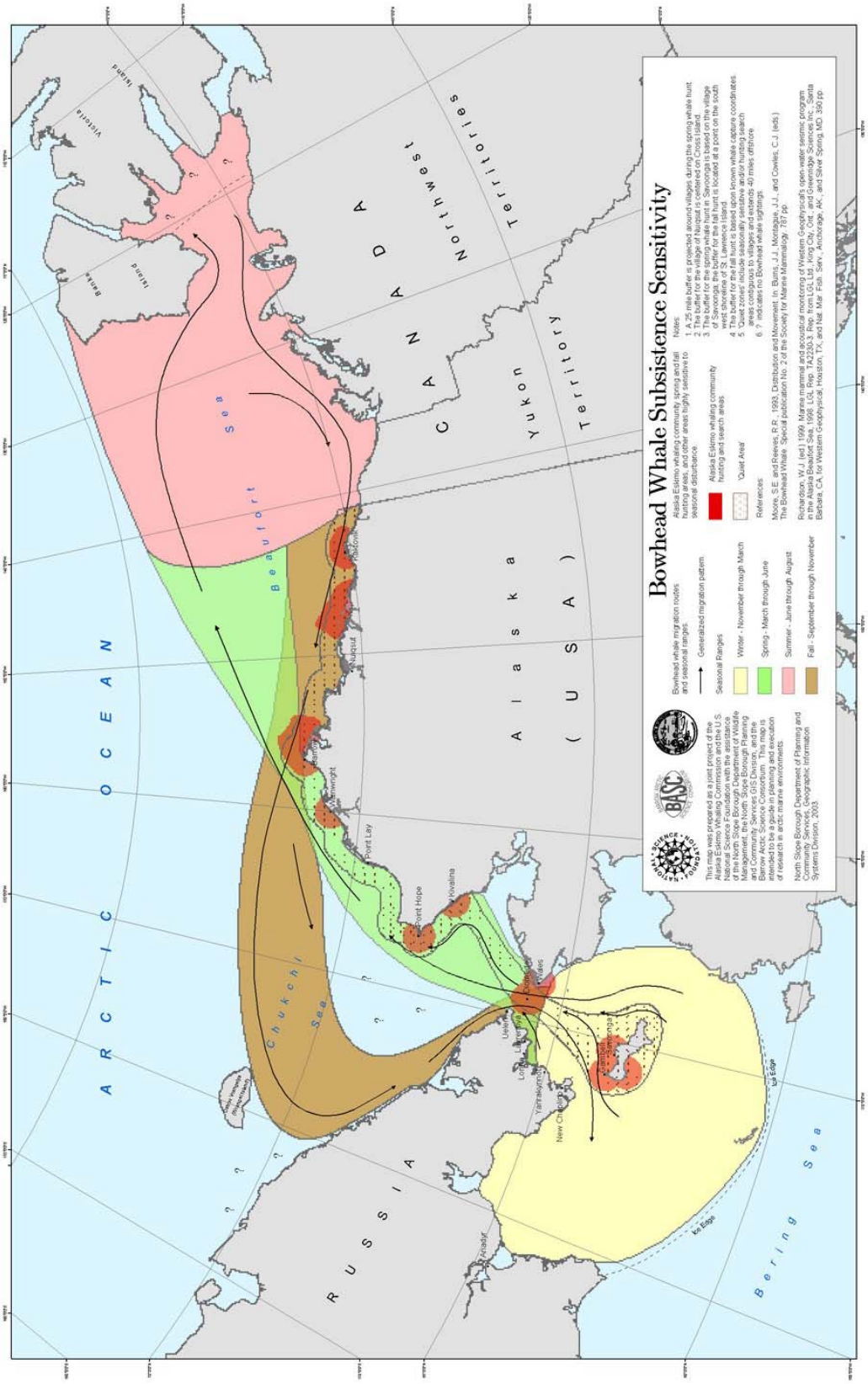
c) Decades in low priority status for re-survey.
Throughout the past 50 years vessel traffic in the region could be generalized as a small group of users who rely more heavily on local knowledge than on accurate charts, making the area generally a lower priority for updated hydrography. While the bulk of users in the area still rely mainly on local knowledge, there is a trend toward an increase in new users with limited local knowledge and having, presumably, a greater reliance on OCS products.

Based on interactions with local mariners and the USCG it is clear that the users are not satisfied with current state of our Arctic chart catalogue. Ledyard Bay, Lisburne Peninsula, Gambell and Kotzebue Sound are the most poorly charted areas. The region north of Omalik Lagoon (approximately 30nmi south of Point Lay), along the North Slope east to Demarcation Point are appropriately scaled and have a relatively dense concentration of soundings to about 3-4nmi offshore. While these charts undoubtedly are in need of updated bathymetry, they would also greatly benefit from updated shoreline data and positioning of navigational landmarks.

The highest priority for OCS in the region should be to issue a chart of more appropriate scale for the approaches to Kotzebue, preferably 1:50000 or larger. Similarly, a larger scale (1:300000 or larger) chart for Kotzebue Sound is needed. A larger scale chart for Kotzebue Sound is a daunting task, and data acquisition will be a multi-year project as Kotzebue Sound is roughly twice the size of Cape Cod Bay and generally shallower than 14 fathoms. The USCG has also expressed a need for a larger scale (1:50000) chart for Gambell/Western St Lawrence Island. All of the arctic charts would be substantially improved by gathering contemporary orthoimagery, and correctly positioning navigational landmarks. The most prominent and consistently accurately charted landmarks are the DEW line antennae, several of which are in the process of being demolished. The USCG is investigating establishing year round short range shore-based AToN at Kotzebue, Point Barrow, Wainwright, and Point Hope.

Inupiat subsistence whalers have requested 25nmi radius precautionary zones be charted around the villages of Gambell, Savoonga, Wales, Little Diomede, Kivalina, Point Hope, Wainwright, Barrow, Nuiqsut, and Kaktovik. Whaling captains have also asked that the voluntary "quiet zones" be added to the chart (figure 1).

Figure 1: Proposed quiet areas and precautionary areas for subsistence whaling activities.



4. SPECIFIC AREA DESCRIPTION & RECOMMENDATIONS:

Outlined below are several areas visited by USCGC *Spar* on its 2008 Arctic cruise and constitute the bulk of the inhabited areas in coastal mainland arctic Alaska. The areas are listed in order of their highest priority for chart updating.

4.1 KOTZEBUE – 16005

4.1.1 Deficiency Investigations:
Kotzebue (figure 2) should be the highest priority area for updated hydrography. With a population of approximately 3,000 Kotzebue is the second largest city in arctic Alaska, and is the seat of the Northwest Arctic Borough. Currently the largest scale chart available for the area is 16005 at 1:700000. Kotzebue Sound at approximately 30nmi across at the entrance and approximately 67nmi long should have a new chart at a scale of 1:300000 or larger. Similarly, a new chart at the scale of 1:50000 is needed for the approaches to Kotzebue. There is a commercial salmon fishery in the Chukchi Sea and Kotzebue Sound during the summer and fall. Kotzebue Sound also has a small fishery for red king crab. A limited amount of sport fishing also occurs in the sound.

4.1.2 Reconnaissance Hydrography:
Contemporary hydrography and shoreline data are gravely needed. Hydrographic data gathered by USCGC *Spar* showed data of approximately 2-5 fathoms over areas that are currently charted as exposed at low tide. Data also showed depths of approximately 4-5 fathoms approximately 9nmi west of Kotzebue inside the charted 6 fathom curve.

4.1.3 Waterfront Planimetry Verification:
There is an uncharted lagoon east of Kotzebue. Current chart scale does not allow for accurate depiction of the shoreline.

4.1.4 Harbor Reconnaissance:
The sound is ice-free from early July to early October. Kotzebue has no deep draft pier facilities but has a heavily trafficked small boat harbor located in the uncharted lagoon east of town. There is a buoyed natural channel (approximately 14 ft.) leading into the town. Ocean going tugs currently anchor approximately 10-15nmi offshore and lighter cargo to shallow draft barges. Kotzebue serves as the transfer point for nearshore to inland shipping. Crowley Northland maintains a fuel farm at Kotzebue from which its tugs and barges conduct re-supply runs to other arctic villages; the USCG estimates that 7million gallons of fuel move through Kotzebue *per annum*. There is a pier in good condition and the city of Kotzebue is currently planning to investigate the possibilities of developing a new pier facility with deep draft capabilities.

4.1.5 Landmark Verification:
Not observed

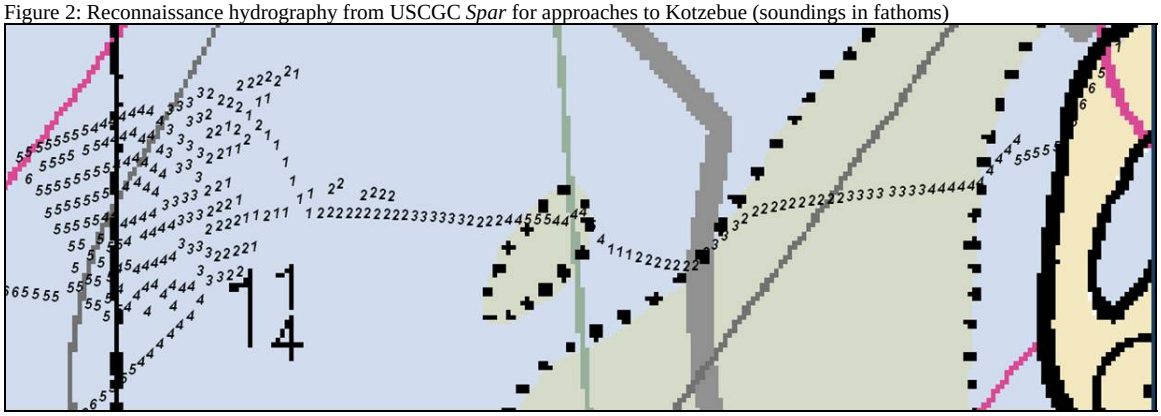
4.1.6 AToN Verification:
Seasonal floating AToN are maintained by contract and mark a natural channel leading into Kotzebue. Currently no floating AToN are charted.

4.1.7 Coast Pilot Inspection:
Updates were made for CP9 26th Ed. ch9 sections 46, 49 and 61 regarding the entries for Kotzebue Sound and Kotzebue.

4.1.8 Tide/Water level Observations:
Not observed

4.1.9 User Evaluation Public Relations Effort:
Through interviews the users made it abundantly clear that they are not satisfied with the current scale and accuracy of 16005 in the area of Kotzebue Sound, and have requested larger scale charts for Kotzebue Sound and the approaches to Kotzebue.

Figure 2: Reconnaissance hydrography from USCGC *Spar* for approaches to Kotzebue (soundings in fathoms)



4.2 KIVALINA & RED DOG MINE – 16005

4.2.1 Deficiency Investigations
The foreshore is charted as an "unsurveyed area" as most supply barges beach themselves to offload, the foreshore area should be updated with contemporary hydrographic data. Currently the largest scale chart available in the area is 1:700000 (16005), a 1:50000 scale chart encompassing the town of Kivalina and the Red Dog Mine/Delong terminal facility is needed.

4.2.2 Reconnaissance Hydrography:
Hydrographic data gathered by USCGC *Spar* showed depths of approximately 3-7 fathoms in the unsurveyed area in the vicinity of Kivalina. *Spar* hydrography showed depths at the Red Dog pier of approximately 18 ft.

4.2.3 Waterfront Planimetry Verification:
The shoreline area in the vicinity of Kivalina has shown marked erosion the shoreline is not accurately depicted at current chart scale.

4.2.4 Harbor Reconnaissance
Kivalina has no deep draft or small boat facilities, a shallow lagoon is accessible only by small boat. A large amount of commercial traffic in the Arctic is focused around Cominco-Red Dog Mine/Delong Terminal facility (figure 3). The mine is the largest producer of zinc in the world and in 2006 moved approximately $1billion worth of ore. Large bulk carriers are brought in by a harbor pilot and anchored approximately 4nmi south of the pier facility. Product is then barged out to the carriers. Red Dog has a public pier facility approximately 350 ft. in length, and of depth suitable for tugs drawing 15-16 ft. and barges drawing 20 ft. Space at the pier is extremely limited due to the mine operations, and Cominco, understandably, is not very open to giving up pier space for any amount of time. Pilotage is recommended when approaching the pier.

4.2.5 Landmark Verification
The town of Kivalina appears to be charted in the water (figure 3). Due to coastal erosion in the area around Kivalina, there are preliminary plans to move the entire town to a new location.

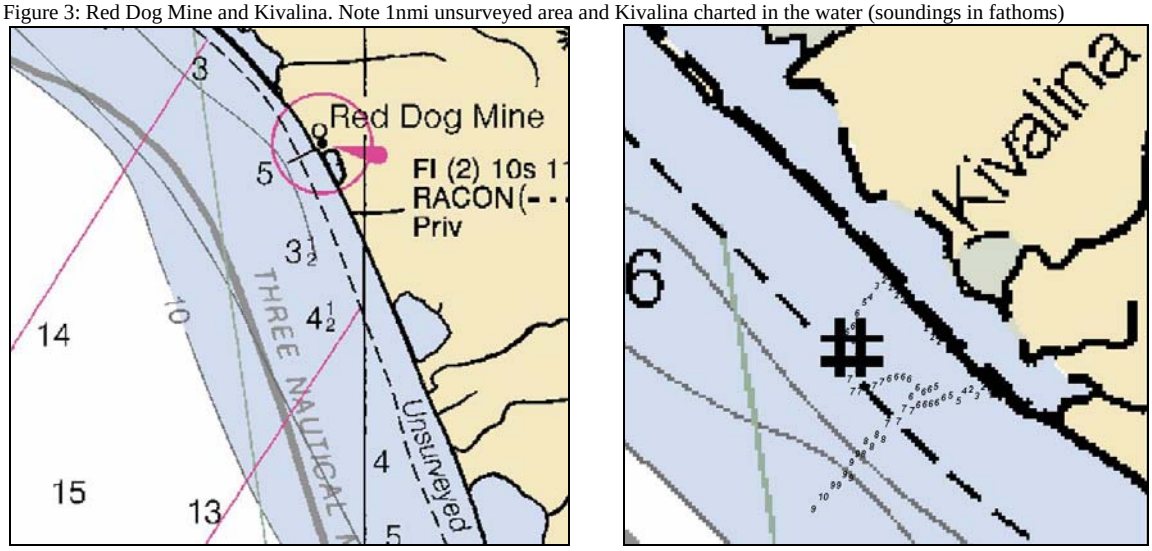
4.2.6 AToN Verification
A private Racon at Red Dog was observed to be not functioning.

4.2.7 Coast Pilot Inspection
Updates were made for CP9 26th Ed. ch9 sections 82 and 83 regarding the entries for Kivalina and Red Dog. Photos were submitted for both Kivalina and Red Dog.

4.2.8 Tide/water level Observations
Not observed.

4.2.9 User Evaluation Public Relations Effort
Users expressed concern over the scale of the chart and the unsurveyed foreshore.

Figure 3: Red Dog Mine and Kivalina. Note 1nmi unsurveyed area and Kivalina charted in the water (soundings in fathoms)



4.3 POINT HOPE – 16123

4.3.1 Deficiency Investigations
Chart 16123, the largest scale chart for Point Hope (figure 4) at 1:50000, is largely based on foreign surveys conducted between the years of 1884-1949. Sounding density is extremely sparse with as much as 5-6nmi between soundings. There is no Loran-C overprint for charts 16103, 16104, 16121, 16122, 16123, and 16124. All of these charts, which constitute the largest scale (1:50000) available for Lisburne Peninsula and Ledyard Bay, are very sparsely populated with soundings. Point Hope is a significant historic and archeological site and could potentially become a popular destination for cruise ships.

4.3.2 Reconnaissance Hydrography
Hydrographic data from the USCGC *Spar* 2008 Arctic cruise showed deep water to within 50 yards of the beach in the area south of Point Hope. Data showed soundings of between 30 to 90 ft. up to approximately 1.5nmi offshore. A strong current is likely responsible for deep water south of the point, this current turns sharply north at the point. Sounding data north of Point Hope were slightly shallower than those to the south.

4.3.3 Waterfront Planimetry Verification
The land area around Point Hope has eroded substantially and is incorrectly represented on the chart.

4.3.4 Harbor Reconnaissance
There are no deep draft or small boat facilities at Point Hope.

4.3.5 Landmark Verification
A small lagoon north of Point Hope is not named on the chart the name of this lagoon is “Ipiutak Lagoon.” The airstrip, a conspicuous landmark is also not charted. A charted landmark church no longer exists. The village of Point Hope moved east in the late 1970’s and is not represented on the chart.

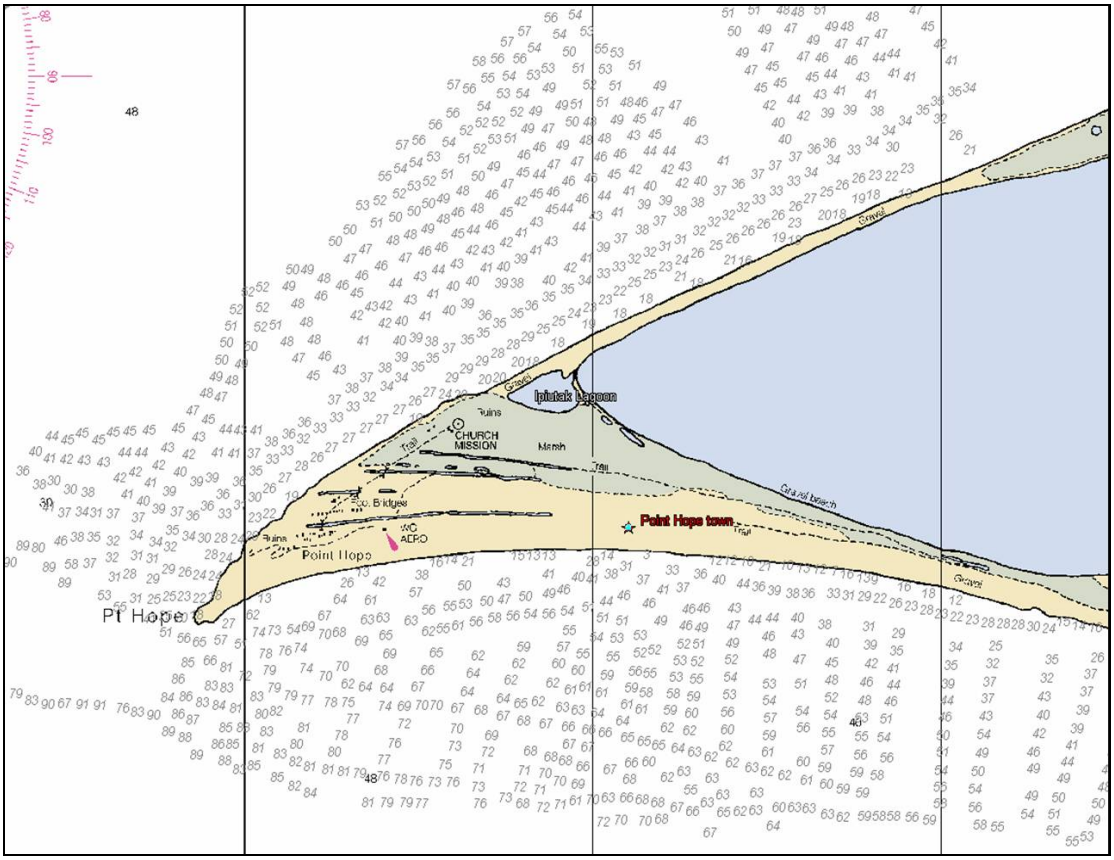
4.3.6 AToN Verification
A flashing white and green aerobeacon appeared to be correctly charted.

4.3.7 Coast Pilot Inspection
Updates were made for CP926th Ed. ch9 sections 91 and 92 regarding the entry for Point Hope

4.3.8 Tide/Water level Observations
Not Observed

4.3.9 User Evaluation Public Relations Effort
Users expressed concern over the dearth of soundings on the chart

Figure 4: Point Hope reconnaissance Hydrography from USCGC *Spar*, note sparse charted sounding density (soundings in ft.)



4.4 BARROW & POINT BARROW – 16082, 16083

4.4.1 Deficiency Investigations

Barrow (figure 5), the most populous city in arctic Alaska, is the seat of government for the North Slope Borough, as well as an economic and transportation hub. Recently a German cruise ship anchored unannounced off Barrow and unloaded some 400 passengers (approximately 10% of Barrow's poulation) ashore causing serious concerns about the depleation of vital supplies from local stores. The local government has requested anchorage areas be added to the chart in the vicinity of Browerville, north of Barrow. Barrow is planning to develop a small boat harbor near Elson Lagoon, north of town – much of Elson Lagoon (figure 6) is inshore of the Navigable Area Limit Line and single beam "quick hit surveys" may be the best way to address the area. The anchorage area, Elson Lagoon, and the beach approaches should be updated with contemporary hydrographic data. Contemporary shoreline imagery data should be gathered in the vicinity of Barrow, Point Barrow and Elson Lagoon/Plover Islands.

4.4.2 Reconnaissance Hydrography

Charted soundings stop at approximately 4nmi offshore. Depths from USCGC *Spar* hydrography seemed to agree with the charted soundings for the most part, suggesting perhaps a relatively stable bottom.

4.4.3 Waterfront Planimetry Verification

The land area around Point Barrow and the Plover Islands showed marked changes from charted land area, contemporary imagery and shoreline data are needed in the area.

4.4.4 Harbor Reconnaissance

Barrow currently has no deep draft of small boat pier facilities.

4.4.5 Landmark Verification

The USCG positioned four landmarks in the vicinity of Barrow and Point Barrow. Among the landmarks positioned were the conspicuous Barrow Arctic Science Consortium (BASC) tower located near its facilities at the former Naval Arctic Research Laboratory, and a conspicuous smokestack north of town. Both of these landmarks are visible from the proposed anchorage area.

4.4.6 AToN Verification

Not Observed.

4.4.7 Coast Pilot Inspection

Updates were made for CP9 26th Ed. ch9 sections 127 128, 142 and 143 regarding the entries for Barrow and Point Barrow. A photo was submitted for Barrow as viewed from the Browerville anchorage.

4.4.8 Tide/Water level Observations

Not observed.

4.4.9 User Evaluation Public Relations Effort

Users expressed a need for updated hydrography and greater sounding density in the area further than 4nmi offshore.

Figure 5: Proposed Barrow anchorage area (sounding in ft.)

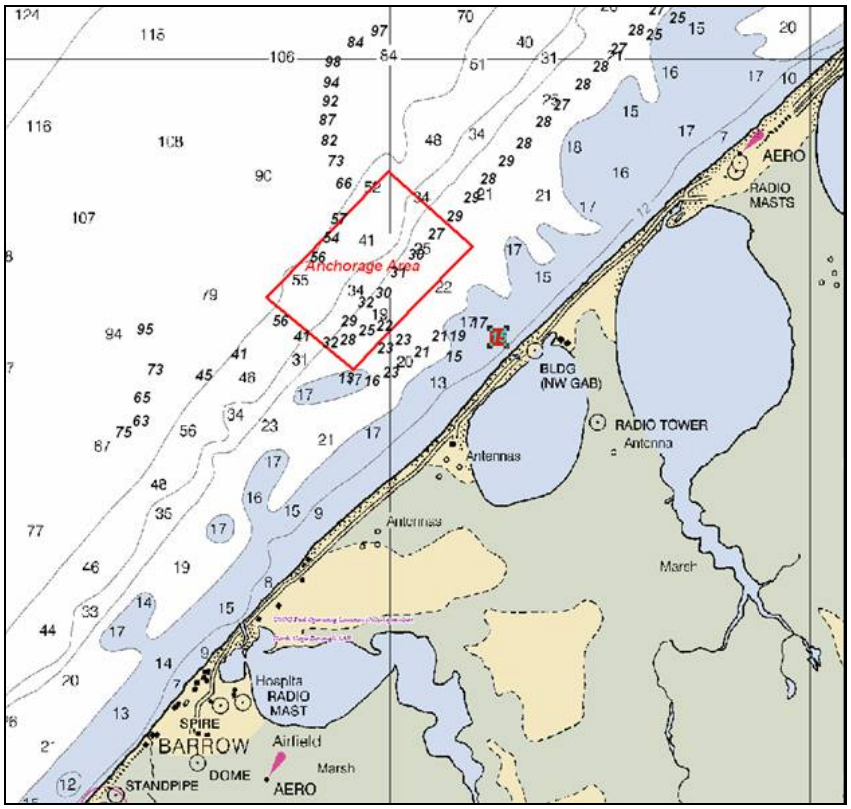
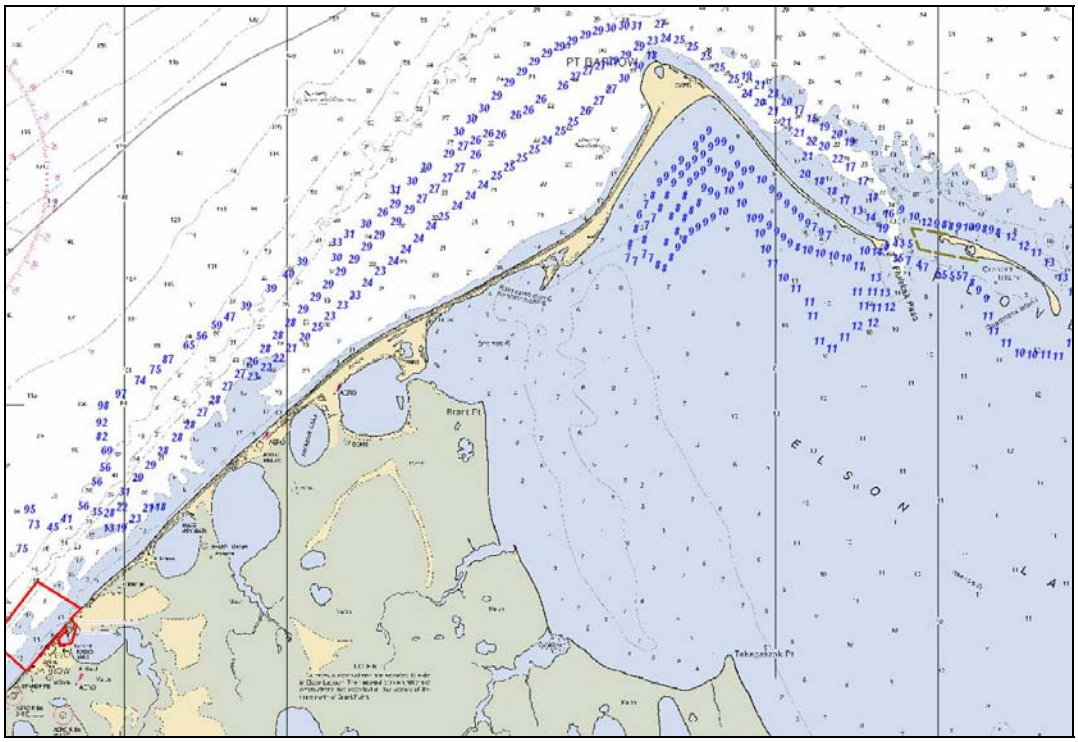


Figure 6: USCGC *Spar* reconnaissance hydrography for Point Barrow and Elson Lagoon (soundings in ft.)



4.5 PRUDHOE BAY – 16061

4.5.1 Deficiency Investigations
Prudhoe Bay was last surveyed 1950, 18 years prior to oil and gas development. There are several manmade islands in the bay. The chart would undoubtedly benefit from updated shoreline data as there were noted changes to charted islands, and possibly several manmade changes to the bay. Unfortunately, thick fog and a limited amount of time spent in the Prudhoe Bay area hindered reconnaissance.

4.5.2 Reconnaissance Hydrography
Limited hydrographic data gathered by *Spar* showed data generally deeper than charted soundings.

4.5.3 Waterfront Planimetry Verification
Land area changes at Cross Island and Thetis Island were noted.

4.5.4 Harbor Reconnaissance
Not observed.

4.5.5 Landmark Verification
Charted stacks at the main production island are believed to be correctly charted.

4.5.6 AToN Verification
Private aids located at the artificial island of Oooguruk were found to be correctly charted.

4.5.7 Coast Pilot Inspection
Updates were made for CP9 26th Ed. ch9 sections 175 and 176 regarding the entries for Prudhoe Bay and Deadhorse.

4.5.8 Tide/Water level Observations
Not observed.

4.5.9 User Evaluation Public Relations Effort
Users articulated a need for contemporary hydrographic data and for a higher sounding density for the area further than 4nmi offshore.

4.6 WAINWRIGHT – 16085

4.6.1 Deficiency Investigations
Several offshore oil and gas development leases are relatively near to Wainwright (50-140nmi). Due to this proximity to the Chukchi Sea lease development area, the Olgoonik native corporation has shown interest in developing a deep draft pier facility at Wainwright. Whether or not this development will come to fruition is dubious, and will depend on substantial financial input from the oil and gas industry and/or public funds. Regardless of facilities development, Wainwright stands to see an increase in vessel traffic with offshore oil and gas production.

4.6.2 Reconnaissance Hydrography
Not observed.

4.6.3 Waterfront Planimetry Verification
Not observed

4.6.4 Harbor Reconnaissance
Wainwright has a small boat ramp in usable condition located on Wainwright Inlet. The inlet is deep enough for small boat traffic and is relatively well protected. The entrance to the inlet has a shallow bar approximately 7 ft. in depth.

4.6.5 Landmark Verification
A green and white aerobeacon was observed to be incorrectly charted. Personnel from USCGC *Spar* gathered contemporary positioning data at the tower.

4.6.6 AToN Verification
Not observed

4.6.7 Coast Pilot Inspection
Updates were made for CP9 26th Ed. ch9 sections 112, 113 and 114 regarding the entries for Wainwright and Wainwright Inlet. Photos were submitted for both Wainwright and the entrance to Wainwright Inlet.

4.6.8 Tide/Water level Observations
Not observed.

4.6.9 User Evaluation Public Relations Effort
Users expressed a need contemporary hydrographic data and for a higher sounding density for the area further than 4nmi offshore.

4.7 KAKTOVIK/BARTER ISLAND – 16043

4.7.1 Deficiency Investigations
Oddly, Barter Island and Approaches is likely the best chart in the North Slope with a scale of 1:50819 and a 1:20000 inset. That being said sounding data essentially ends at approximately 3nmi offshore and, owing to the changeable nature of the area, sounding data is almost certainly in need up updating. Contemporary hydrographic, and shoreline data are needed. Supplies and fuel are shipped to Kaktovik during the summer months on barges that are beached at an area due north of Pipsuk Bight. There are no small boat facilities, and limited options for visitors to purchase supplies or meals. Local leaders expressed a desire to construct small boat facilities however this development is in the preplanning stages. Kaktovik lies within the controversial Arctic National Wildlife Refuge 1002 area.

4.7.2 Reconnaissance Hydrography
An uncharted shoal was noted approximately 400yds north of the beach running from east to west for approximately 0.5nmi and with depths of approximately 3-4 ft.

4.7.3 Waterfront Planimetry Verification
Not Observed

4.7.4 Harbor Reconnaissance
The village is in the early pre-planning stages of constructing a small boat dock and boat ramp. Currently there are no deep draft of small boat facilities at Kaktovik. The area approaching Bernard Harbor is marked by shifting shoals and local knowledge is required for safe transit.

4.7.5 Landmark Verification
Several uncharted landmarks (water and fuel tanks) were noted. No landmarks were positioned while in Kaktovik.

4.7.6 AToN Verification
Not observed.

4.7.7 Coast Pilot Inspection
Updates were made for CP9 26th Ed. ch9 sections 201 and 202 regarding the entry for Kaktovik. A photo was submitted for Kaktovik.

4.7.8 Tide/wter level Observations
Not observed.

4.7.9 User Evaluation Public Relations Effort
Users expressed need contemporary hydrographic data and for a higher sounding density for the area further than 4nmi offshore.

4.8 POINT LAY – 16101

4.8.1 Deficiency Investigations
The town of Point Lay (figure 8) is incorrectly charted on the barrier island, the current town is located approximately 1nmi east across Kasegaluk Lagoon on the mainland. The town was moved after a fire destroyed much of the original town. There are essentially no charted soundings beyond 4nmi offshore. Kasegaluk Lagoon is also sparsely populated with soundings and is generally beyond the Navigable Area Limit Line with depths around 2-3 ft. Echosounder data will likely not be able to be gathered in the lagoon.

4.8.2 Reconnaissance Hydrography
Hydrography from *Spar* showed relatively good agreement with charted soundings 0.7nmi off the barrier islands. However, data showed marked changes from charted soundings at Kukpowruk Pass.

4.8.3 Waterfront Planimetry Verification
The barrier islands showed marked changes from charted land area in the vicinity of Kukpowruk Pass. There is a pass through the barrier island west of Point Lay that is not charted (figure 7). This pass was created accidentally by the USAF while removing gravel from the area for the construction of the airstrip. There is currently no name in use by local mariners for this pass and it was described as being occasionally closed due to a shifting shallow bar at its entrance. A light barge powered by a jet drive outboard was noted on the eastern bank of the barrier island and was brought through the pass.

4.8.4 Harbor Reconnaissance
There are no deep draft or small boat facilities at Point Lay. There are coal deposits and exploratory mining operations approximately 20-30 miles south of Point Lay near the Kuchiak River, however there is substantial opposition from locals to shipping product from the village. Locals also expressed concern that any development in the lagoon would adversely affect the Beluga whale harvest. There are currently no plans for pier of small boat facilities near Point Lay, as a result the coal may be shipped overland to Red Dog/Delong Terminal.

4.8.5 Landmark Verification
The charted tanks, belfry and town would most accurately be charted as ruins as they are no longer effective landmarks. An uncharted cemetery was noted, as well as a prominent mound north of the cemetery which was generally referred to by locals as “Kali” although this name was generally used to describe the mound, the barrier island, and the former town site.

4.8.6 AToN Verification
Not observed.

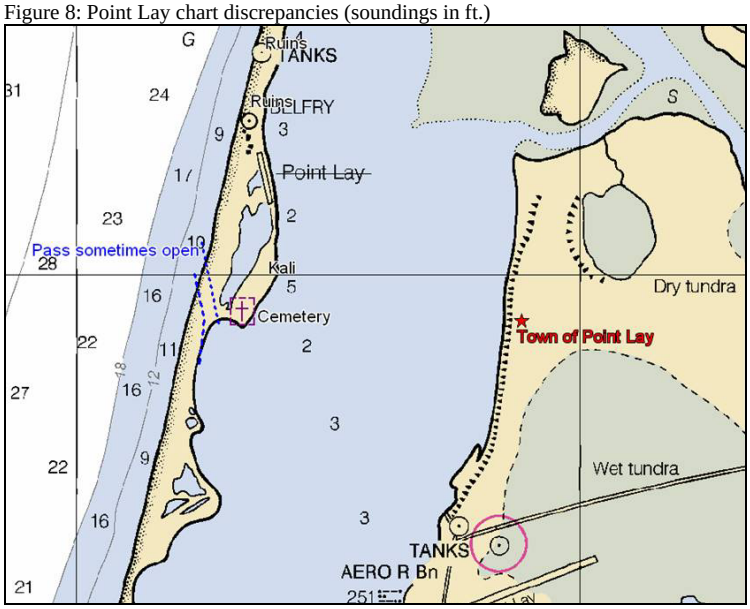
4.8.7 Coast Pilot Inspection
Updates were made for CP9 26th Ed. ch9 sections 101 regarding the entry for Point Lay

4.8.8 Tide/water level Observations
Not observed

4.8.9 User Evaluation Public Relations Effort
Users articulated a need for contemporary hydrographic data and for a higher sounding density for the area further than 4nmi offshore.

Figure 7: Uncharted pass near Point Lay (photo from Google Maps)

Figure 8: Point Lay chart discrepancies (soundings in ft.)



Future visits by OCS personnel to Wales, Tin City, Little Diomede, and Shishmaref are recommended. Areas not visited on the 2008 Arctic run but that the USCG expressed interest in updated hydrographic data are:

Gambell 16006 the USCG has requested a larger scale (1:50000 or larger) for the area around Western St. Lawrence Island and the village of Gambell.

Kuskokwim River 16300, 16304 to Bethel. The USCG reported a relatively stable bottom, the chart shows no soundings in the river all the way to Bethel.

Bechevin Bay 16535 the USCG estimated $500 million commerce passes through False Pass consisting of relatively shallow draft (15 ft.) vessels such as commercial fishing vessels and Tugs.

5. TECHNICAL EXCHANGE:

There was a general interest in hydrography among personnel onboard *Spar*. Training was conducted on; Hypack "knobology," common troubleshooting tactics and problems, data management, chart discrepancy reporting, and Coast Pilot update submission. There was a good working relationship developed with *Spar*'s operations officer, LTjg Tim Brown, which focused on NOAA survey deliverables and field procedures, as well as tactics for further USCG/NOAA partnership. Also discussed was a recommended increased utilization of Hypack as a navigational tool for small boats and options for mounting an all weather monitor for a coxswain display. Currently Hypack is not used for navigation on small boats, it is generally secured within a watertight hatch after data logging is begun. Coxswains rely heavily on a small GPS chart plotter. Techniques for visual identification of shoals (turbidity and water coloration) and shoreline indicators of deep/shoal water were discussed with coxswains and small boat personnel. In future work with *Spar* it is recommended NOAA personnel take a GPS backpack for positioning navigational landmarks and shoreline items, as well as a laptop with CARIS and a CARIS key for data processing.

6. RECOMMENDATIONS FOR OCS ARCTIC OPERATIONS

Six options exist for field operations in the Arctic with varying degrees of presence by NOAA personnel. 1) Contract Hydrography, 2) Ingesting USCG data 3) NOAA equipment and personnel operating on shore-based USCG small boats or USCG small boats deployed from a USCG vessel, 3) NOAA equipment and personnel operating on NOAA a small boat deployed from a USCG vessel, 4) a shore-based Arctic hydrographic field party and 5) NOAA Ship based Hydrography.

USCG D17 Waterways has stated that hydrography is not a mandated mission for buoy tenders and extra resources will not be provided by the USCG, similarly any partnership with a USCG cutter is not to interfere with USCG operations. At the unit level the *Spar* has expressed an understanding of the obstacles involved with arctic hydrography and has expressed a willingness to work with NOAA in addressing chart deficiencies. Any OCS operations in the region will require shore side operations in the form of tide gauge installations and establishment of DGPS beacons.

The six options are amplified below in order of increasing degree of NOAA personnel presence.

6.1 CONTRACT HYDROGRAPHY

One option for addressing data acquisition will be to contract the work. The relatively shallow bathymetry may lend itself to LIDAR data acquisition. However, the high sediment load in the water may hinder airborne hydrography.

6.2 INGEST USCG DATA

Currently data from USCGC *Spar* hydrographic surveys do not meet NOAA/NOS data requirements outlined in the Hydrographic Surveys Specifications and Deliverable (HSSD). To accept hydrographic data from *Spar* will require at a minimum: the installation of water level stations, a CTD to obtain water column sound speed values, a method of recording heave data, a DGPS receiver, and a survey grade echosounder. Currently *Spar* small boats are using *Airmar*™ transducers operating at approximately 200kHz with an approximate beamwidth of between 11°-14° at 3dB. Horizontal accuracy total sounding error at 95% confidence level can not exceed 5m + 5% of water depth. Generally DGPS correctors are used to obtain such accuracy, a portable DGPS reference station will need to be established for hydrography. RTK and PPK may be used for positioning provided all positions meet accuracy requirements. *Spar*'s operations officer has investigated acquiring survey grade transducers and positioning equipment and has estimated the cost at approximately $70,000.

6.3 OCS Personnel and Equipment on USCG Small Boats

OCS could supply equipment in the form of a hydrographic vertical beam echosounder (VBES), DGPS receiver, Side Scan Sonar (SSS), a survey acquisition computer (Toughbook™ laptop) and possibly an all-weather monitor (coxswain display) to be used on the USCG small boats operating in the region. If a SSS is not used the projects could be considered field examinations (FE), and VBES data could treated in a similar fashion to those of "quick hit surveys" conducted by Navigation Response Team 5 (NRT5) on the east coast. The reference point to VBES offsets would need to be surveyed for the purposes of establishing a Caris HIPS vessel file (HVF) and CO-OPS tide gauge installation parties would need to be coordinated with USCG operations in the region and flown in prior to commencement of hydrographic survey operations in the region. *Spar* carries a portable DGPS beacon, but has expressed concern over its reliability; a NOAA owned portable DGPS reference station may need to be established.

A team consisting of 1-2 hydrographers could ride along on the USCG asset with a data processing computer/laptop. The hydrographer(s) would perform data processing and field data acquisition assistance. Hydrographer(s) could operate from *Spar*'s small boats or possibly from the shore-based USCG assets.

While this plan would require an initial investment of time and equipment there would be relatively little overhead for moving equipment and personnel, and after initial setup of survey equipment would require relatively limited further input. In most respects this setup would function like the "fly-away" setup used by NRB for hurricane response. Operating from USCG assets would have the added benefits associated with USCG experience in operating in the region as well as the opportunity for cross-training with USCG personnel. Similarly, both agencies would benefit from the data. However, the data acquisition period would be subject USCG operational schedule and operational needs/requirements.

6.4 Hydrographic field party operating in partnership with USCG assets

The *Spar* has expressed a willingness to carry a hydrographic filed party aboard. *Spar* can carry an NRT sized small boat on its buoy deck, as well as a sufficient quantity of gasoline. A team of 2-3 hydrographers could ride aboard *Spar* with a survey processing computer. *Spar* has offered office space for survey processing and bunk space for personnel. Again water level stations and portable DGPS reference stations would need to be established prior to commencement of hydrographic survey operations in the region. This plan would require no new acquisition of survey hardware/software, and could utilize personnel from an existing NRT. However, the team and equipment would need to be flown or shipped to Kodiak to embark on *Spar*. Again, if a SSS is not used the projects could be considered FEs, and VBES data could treated as "quick hit surveys." In essence this plan could be summed up as NRT-*Spar*, an NRT based from a USCG vessel as apposed to at a geographic location. Operating from a USCG asset would have the above stated benefits as well as added benefits of USCG shipboard support for mechanical and hardware troubleshooting. Again, both agencies would benefit from the data, but the data acquisition period, again, would be subject USCG operational schedule and operational needs/requirements.

6.5 Shore based Arctic Field Party

There is precedence for a shore-based Arctic hydrographic field party, indeed the bulk of hydrographic data in the region was gathered by such field parties. Shore based field parties can concentrate data acquisition on a single area for an extended amount of time, i.e. the ice free season. Personnel and equipment could be flown in on a C-130 or equipment could be barged to an area. The field party will need a survey vessel with four wheel drive vehicle, boat trailer and maintenance material, data processing equipment (possibly an office trailer and second vehicle), tide gauge installation and leveling equipment/material, material to establish bench marks, as well as a portable DGPS reference station (possibly a storage trailer and third vehicle). While there are gas stations, hotels and well stocked grocery stores in Kotzebue and Barrow, smaller coastal villages have limited fuel and housing options available. Operations at remote locations may require housing, sewage facilities, water, stores, fuel and electrical generator(s) to be brought in with the field party.

The field team should consist of, at a minimum, 3 Hydrographers. One of which, preferably, should be experienced officer of rank O2-3 familiar with establishing a portable DGPS reference station, tide gauge installation, and who is well suited and trained for working in the Arctic environment. All personnel would

need to have at a minimum; dive training for tide gauge install, wildlife interaction/weapons training and qualification, Arctic survival training, and extended experience in hydrographic field operations and working with limited support. In addition to the hydrographers, additional personnel may be needed for a limited duration at the onset of survey operations such as; a CO-OPS representative to aid hydrographers in establishing tide gauges and a NGS representative to help set bench marks and survey in tides stations. Currently there is no established Arctic/Alaska field party, and operations would require deploying an existing team from another region, or establishing a new team.

There is also no operational model for shore-based hydrography in the Arctic. The lack of small boat facilities would require boats to be launched from a trailer on the beach and either re-trailered or beached at the end of the day. The remoteness of the survey area will severely limit operational support for the team; and the region's weather conditions make it a potentially dangerous area for small boat operations. That being said it still may be more cost effective to establish a field party than conduct ship operations.

6.6 NOAA SHIP-BASED HYDROGRAPHY

Obviously the most productive option for survey operations will be ship-based data acquisition. The *Rainier* and *Fairweather* have in place established ship operations routines and SOPs for operations in remote regions of Alaska. Another benefit would be the gathering of contemporary current data via ADCP. The best available offshore current data from the Bering Straight to Point Barrow is based on six days of observations conducted in 1950. The limited pier facilities, and fueling opportunities north of Nome as well as the frequent foul weather and the limited number of protected anchorages will make ship operations logistically challenging. The distance from the ship's anchorage position to the working grounds would increase launch dead head time, particularly in Kotzebue.

In addressing the areas outlined in this report as highest priority, that being Kotzebue, and Point Hope, it may be appropriate to establish a filed party at Kotzebue and conduct ship operations at Point Hope. Ship operations would also be most appropriate for Gambell/Western St. Lawrence Island.

7. OPERATING ENVIRONMENT & LOGISTICS:

7.1 WEATHER:

The Navy Meteorological Forecast Center Pearl Harbor and the Kodiak NWS office can provide forecast information for the Arctic, however, the USCGC *Spar* stated that "Most NWS products did not adequately cover the Beaufort Sea, so their tailored support was crucial" NOAA ships operating in the region will undoubtedly need to take advantage of this tailored support provided by NWS HPC and local Alaska NWS Forecast Office. Adequate ice forecast and analysis information can be obtained from the National Ice Center's web postings as well as NWS Alaska Region Ice Forecaster.

7.2 PERSONAL PROTECTION

The survival time for someone exposed to Arctic Ocean waters is at maximum 90min. Full Mustang anti-exposure worksuits will be a requirement for all personnel operating on small boats. The USCG requires any of their personnel operating in the Arctic attend Arctic Survival training, NOAA personnel would without doubt benefit from receiving this or similar training prior to operating in the region. The USCG has a limited presence in the region in the form of a seasonal small boat station at Barrow and USCGCs *Spar* and *Hamilton*'s summer cruises. There are volunteer SAR organizations in most North Slope villages. These volunteer organizations conduct marine operations only during whaling season. Polar bears are common in the region, and personnel operating ashore should be weapons trained and qualified. Shore parties will need to be required to take a high caliber rifle (.30-06 or .308), and/or high caliber sidearms such as a M1911 .45 for personal protection.

7.3 COMMUNICATIONS:

In both 2007 and 2008 the USCGC *Spar* reported adequate communications connectivity using INMARSAT-C and Iridium Satellite telephone. An adequate GPS satellite constellation was maintained to obtain reliable GPS fixes.

7.4 FUEL & CREW LOGISTICS:

Ship based hydrography in the region will be difficult due to the lack of pier facilities, the presence of ice and the foul weather common in the region. Any ship operations in the region should also be coordinated with the Alaska Eskimo Whaling Commission (AEWC) so as not to interfere with subsistence whaling activities. Food stores can be purchased from the Alaska Commercial Company Store at Nome, Barrow and Kotzebue. In 2008 the USCGC *Spar* fueled via barge transfer using Crowley Northland at a cost of $5.30/gallon. Crowley barges can transfer up to 25,000 gallons of fuel at Barrow or Kotzebue in fair weather. Barrow, Wainwright and Kotzebue are in the early planning/pre-planning stages of developing deep draft facilities.

7.4.1 Nome is the regions closest port with pier facilities. Controlling depth at Nome's breakwater pier is 21 feet. NOAA Ship's *Rainier* and *Fairweather*, drawing 16 feet can tie up to the breakwall pier but only in good weather. NOAA Ship's *Miller Freeman* and *Oscar Dyson*, drawing 20 feet would not have this option. Fuel is available at Nome but is generally very expensive – in 2008 fuel was $7.50/gallon. For crew transfer, there is an airport with commercial service to Anchorage, Barrow, Kotzebue and other regional airstrips, there are also roads from Nome to Deering (located on Kotzebue Sound) and Teller (located Port Clarence). Nome also has a hospital.

7.4.2 Port Clarence offers the closest foul weather anchorage to the arctic. The area is relatively well charted and appropriately scaled and offers essentially the only protected anchorage in the region. As stated above there is a summer passage road from Teller to Nome for crew transfer. Both Teller and Brevig Mission have small airstrips. Port Clarence offers no pier facilities or fuel. Teller Mission is potentially good staging area for crew transfer with relatively deep water up to the beach.

7.4.3 Red Dog/Delong Terminal has fuel but restricts its use to mine operations and does not typically stock extra. The facility has expressed a willingness to serve as a fuel transfer point for USCG cutters, and may be willing to serve as a fuel transfer point for NOAA ships if given adequate advance notice and a commitment to purchase fuel. There is a public pier facility approximately 350 feet in length, and with depths suitable for tugs drawing 15-16 feet and barges drawing 20 feet. USCGC *Spar* hydrography showed controlling depth at the pier of approximately 18 feet. Space at the pier is extremely limited due to terminal operations, and Cominco, understandably, is not very open to giving up pier space for any amount of time. Pilotage is recommended when approaching the pier. Red Dog has a small airstrip which services other regional airfields such as Kotzebue. The air strip is generally only used to move mine personnel and is contracted out to Alaska Airlines. The airstrip does not operate during the shipping season.

7.4.4 Kotzebue has no deep draft pier facilities but has a heavily trafficked small boat harbor. There is a buoyed natural channel (approximately 14') leading into the town. Kotzebue has an airport with a 5900 ft paved main runway and a 3800 ft gravel crosswind runway and commercial service to Nome, Anchorage and other regional airports. Kotzebue also has a hospital, hotels, stores, and a gas station.

7.4.5 Deering located on Kotzebue Sound has a summer road to Nome as well as a 2600 ft gravel runway and 2080 ft gravel crosswind runway.

7.4.6 Kivalina is marked by shifting shoals and a shallow lagoon accessible by small boat only as well as several locations suitable for small boat beach landings. There is a 3000 ft gravel airstrip NW of the village and anchorage can be had up to 1.5 to 2nmi off the town site.

7.4.7 Point Hope offers good anchorage and has a small health clinic, the nearest hospital is in Kotzebue. Point Hope also has a store with limited supplies, and a 4400 ft paved runway airstrip.

7.4.8 Point Lay lies east of the barrier islands and the extremely shallow Kasegaluk Lagoon which is rendered un-navigable during periods of sustained easterlies. Point Lay has a 3519 ft gravel airstrip with regional flights.

7.4.9 Wainwright Inlet has a small boat ramp. The inlet is deep enough for small boat traffic and is relatively well protected. The entrance to the inlet has a shallow bar approximately 7 feet in depth. Wainwright has a clinic, hotel, stores with limited supplies and a gas station. Wainwright has a 4494 ft gravel airstrip with regional flights.

7.4.10 Barrow has no pier facilities and is currently accessible only by small boat beach landings. Local officials are currently working with the State Government and the Army Corps of Engineers to develop a small boat facility at Elson Lagoon. Barrow has a hospital, several stores, hotels, gas stations, and an airport with a 6500 ft paved runway and commercial service to Nome, Anchorage and other regional airports. There is also a crosswind 5000 ft gravel airstrip located at Point Barrow.

7.4.11 Kaktovik is in the early preplanning stages of constructing a small boat dock and boat ramp. Currently Kaktovik has no pier or small boat facilities, but does have a hotel, a store with limited supplies, and a 4820 ft gravel airstrip with flights to Barrow and other regional villages.

The North Slope Borough provides all utilities in almost all North Slope villages. Water is generally treated and stored in a water tanks. Some villages have underground water lines or water is delivered by truck to home holding tanks. Flush toilets are generally available throughout the Borough, however, honeybuckets are used for sewage disposal by a limited number of residents in some villages, the Borough provides hauling services.

8. OTHER NOAA CONSIDERATIONS:

Discussions of hydrographic requirements in this report were limited to locations visited by USCGC *Spar*. The Bering Strait, while not mentioned in this report is an obvious priority as all increased traffic through the Arctic will transit this 40nmi wide region. Detailed and accurate nautical charts of this region will be a high priority for both safe navigation and incident response activities. Other items of interest to NOAA/NOS that were noticed during this Arctic cruise but that are not appropriate to be addressed in this report are as follows:

8.1 MARINE MAMMALS

Approximately 10,000 bowhead and 30,000 beluga migrate through the region. Local whaling captains have expressed interest in teaming with NOAA in gathering whale migration data. This could be accomplished through the use of fleet Ancillary Instructions. Also, recently a whale unfamiliar to and unidentifiable by the local the whaling community washed up at Point Hope.

8.2 OFFICE OF RESPONSE & RESTORATION

There is currently no known way to clean up a spill in the spring and fall ice fields. Spring and fall are also the whale migration seasons. OR&R will need an increased profile in the region if/when large scale offshore oil drilling commences in earnest.

8.3 FISHERIES

As water temperature increase in the North Bering and Chukchi Sea commercial species not common to the region will begin moving north. This combined with the decreased amount of summer sea ice will likely lead to increased commercial fishing in the region. Currently there is little if any data available for fisheries management in the Arctic region.

8.4 COASTAL ECOSYSTEMS

More than 125 species of bird summer on the North Slope; wetlands and lagoons are a vital habitat for many of these species.

8.5 NATIONAL WEATHER SERVICE

The USCGC *Spar* reported in 2008 that standard NWS products did not adequately cover the Beaufort Sea. The port supervisor at Red Dog have requested a weather buoy be placed 12-14nmi offshore from the Red Dog/Delong Terminal.

8.6 NATIONAL ICE CENTER

The local Inupiat expressed wide use of NOAA/NASA sea ice imagery and maps and requested a more user friendly webpage interface.

8.7 CO-OPS

There is virtually no data in the region regarding tides and currents. A concerted effort from CO-OPS to install tide stations along the northwest coast of Alaska would greatly aid OCS hydrographic survey activities. Any ship operating in the region should be equipped to log ADCP data.

8.8 NATIONAL GEODETIC SURVEY

There is sparse geodetic control in the region. A concerted effort from NGS to increase the density of CORS stations along the northwest coast of Alaska would greatly aid OCS hydrographic survey activities.

9. REGIONAL CONTACTS:

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