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FINAL REPORT

PORT GARDNER 2016 DERELICT FISHING GEAR REMOVAL PROJECT AND STUDY AREA ANALYSIS

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Introduction

Every year crab pot gear is lost in Washington waters of the Salish Sea due to entanglement with debris, vessel hits, vandalism, and other reasons. These lost crab pots cause negative economic and environmental impacts.[1] Identification, location and safe removal of derelict crab pots reduce these destructive impacts of derelict fishing gear, as has been demonstrated in previous derelict gear removal projects.

For several years, the Snohomish County Marine Resources Committee has worked to solve the problem of derelict fishing gear in Snohomish County marine waters through education programs and support for derelict fishing gear removal operations. In 2004 and 2005, the Snohomish MRC focused survey and removal efforts in the commonly fished commercial, Tribal and recreational Dungeness crab (*Cancer magister*) fishing area of Port Gardner. In 2008, the MRC supported a survey and removal project in Port Gardner just west of Jetty Island outside the Port of Everett. The 2008 operations overlapped an area where derelict crab pot surveys and removals were conducted in 2004 and 2005. This area has been identified as the Port Gardner Study Area and repeated surveys and removal in the Study Area have been completed in 2008, 2009, 2011, 2012, 2013, 2015, and now in 2016. Along with the goals of removing derelict crab pots that impact the local resource and marine ecosystem, multiple years of completed surveys and removals within the same area provide an opportunity to analyze gear loss over time. This also allows for observing changes in the rate of compliance by fishers regarding use of legally mandated escape cord in both the commercial and recreational crab fisheries. These are important factors with respect to the impacts of derelict gear on the valuable Dungeness crab resource.

The goals of the Northwest Straits Foundation (NWSF) 2016 Port Gardner derelict gear project were to locate and remove derelict crab pots (lost in the 2015 fishing seasons) from the Port Gardner Study Area in the commonly fished commercial, Tribal and recreational Dungeness crab (*Cancer magister*) fishing area of Port Gardner; to document compliance with escape cord regulations; and to assess reason for pot loss. In addition to the standard gear characteristics and impact (species entrapped) information collected and summarized; in-water and out-of-water analysis of each derelict crab pot and its components were conducted to determine the most likely cause for pot loss. Additionally, derelict crab pot removal data summarizing number of pots lost and escape cord compliance in the Port Gardner Study Area during 2015 fishing seasons was compiled with data provided in NRC reports completed in December 2012, December 2013, and June 2015, and summarized here. Combined, these report components will increase the ability to identify trends and/or anomalies in the characteristics of the lost

[1] Antonelis, K., D. Huppert, D. Velasquez and J. June. 2011. Mortality of Dungeness crabs due to lost traps and the cost benefit of removal in Washington State waters of the Salish Sea. *North American Journal of Fisheries Management*, 31:5, 880-893.

gear in the area, and the practices of the recreational and commercial fishers utilizing these fishing grounds.

The Northwest Straits Foundation secured funding from Washington State Department of Natural Resources for derelict crab pot survey and removal operations. The Foundation then contracted with Natural Resources Consultants, Inc. (NRC) to manage the project. The removal operations were coordinated with the WDFW, Snohomish County, Tribal governments, NOAA, the U.S. Fish and Wildlife Service (USFWS) and the U.S. Coast Guard (USGC).

Scope of Work

The project consisted of 1.5 days of sidescan sonar survey fieldwork in the Port Gardner Study Area, with an associated 0.25 days of post-survey processing. This was followed by five days of dive removal operations for derelict crab pot targets. Dive removal operations were conducted in the commonly fished area immediately west of Jetty Island in Port Gardner. During derelict gear removal operations, project personnel performed data collection methods to include a visual analysis of the derelict gear removed to estimate the reason for pot loss for each target. Additionally, pot loss rate and escape cord compliance was compared to summaries of data collected from previous years in the Study Area.

Methodology

Sidescan Sonar Survey

Fenn Enterprises performed the sidescan sonar surveys on January 8 and 9, 2016, in Port Gardner followed by 0.25 days of post-survey processing. A Marine Sonic sidescan sonar system operating at 600 kHz with a differential global positioning system (DGPS) was used during the survey to locate derelict fishing gear. The sonar system employed a heavy towfish, towed off the bow of an 8 m (26 ft) survey vessel. A hydraulic winch and cable controlled the depth of the towfish. The sidescan sonar image was projected on a monitor onboard the vessel and recorded onto a computer hard drive for later processing.

The sidescan sonar survey was conducted at an average speed of 4.63 km/hr (2.5 knots) with a sonar signal range of 40 m on both sides of the vessel for an approximate path width of 80 m (262 ft). Survey depths in Port Gardner generally ranged from about 3 m (10 ft) to 32 m (105 ft) in order to identify derelict fishing gear within the dive depth capabilities of the recovery team.

The intent of the sidescan sonar survey was to locate derelict crab pots lost in the 2015 fishing season to be removed from the previously cleaned Port Gardner Study Area. Counts and precise locations of derelict fishing gear were recorded during post-survey

processing of the data. The products from the sidescan sonar survey included a trackline file of the area surveyed, calculation of the area covered and the positions (latitude and longitude) of likely derelict fishing gear targets found (Figure 1).

Derelict Fishing Gear Removal

Fenn Enterprises was contracted to conduct the dive recovery operations of crab pots in the Port Gardner area. Two divers equipped with SCUBA operated off a 12 m (40 ft) dive support and gear recovery vessel, the R/V *Surveyor II*. Derelict gear target locations derived from the sidescan sonar survey were transferred into electronic navigation software (Nobeltec®) as waypoints and plotted over navigation charts of the Port Gardner area. NRC Operations Coordinator (OC) selected target locations for removal.

Using GPS and Nobeltec, the dive support vessel was directed to the exact location of the potential derelict gear targets. When the vessel arrived at the target location, a clump weight with a line and float was deployed at the target location. The dive support vessel drifted nearby as a single diver was deployed, while a safety backup diver stood by on deck. A 30 m (100 ft) length of rope was passed through a loop on the rope near the clump weight and the diver held the other end. Typically the clump weight landed within two meters of the derelict gear target and the diver visually located the derelict pot. However, in poor water visibility conditions, the diver would drag the 30 m rope around the clump weight in a circle until it tangled with the derelict fishing gear and then the diver worked back along the rope to the gear. The derelict gear was freed by hand by the diver and a recovery line from the vessel was attached and it was hauled aboard the recovery vessel with a hydraulic winch.

A variety of information about the derelict crab pot was reported by the diver to the OC or observed directly onboard the support vessel. Data recorded by the OC included whether the derelict pot was from the commercial or sport (recreational) fishery, whether it was equipped with escape cord, whether the gear was actively fishing or not and the number of live and dead Dungeness crab and other entrapped organisms. Also documented was information about the overall condition of the gear, the depth and type of seabed where the gear was located, and if there was any evidence that would elucidate the reason the pot was lost. The OC also searched for owner identification, and if present, recorded contact information that was later used to coordinate returning gear items to their owners.

During removal operations at Port Gardner, the derelict fishing gear was stored in a locked secure waste container in the parking lot of the 10th Street public boat ramp in the Port of Everett until pots were either returned to their owners, transferred to a secure location, or transferred to the Snohomish County solid waste facility.

Investigating Reasons for Pot Loss

In order to successfully address the derelict crab pot issue in the Puget Sound region, it is important to understand why pots are being lost. The reasons for pot loss are many, and may vary depending on the area. While the full story behind each lost pot cannot be found through inspecting a derelict crab pot, much information about the probable reasons for pot loss can be found by investigating the gear both underwater and out-of-water. Therefore, since the Snohomish County MRC Port Gardner 2013 derelict gear removal project, careful attention has been given to investigating the reason for pot loss. The anticipated reasons for pot loss were divided into twelve categories: (1) line length to water depth mismatch, (2) vessel strike, (3) barge strike, (4) vessel or barge strike (5) tampering / sabotage, (6) gear malfunction (7) user error, (8) entanglement with other gear, (9) entanglement with something else, (10) other, (11) unknown and (12) abandoned. Divers were instructed to report to the OC any visual evidence they witnessed underwater that would explain why the pot was lost. At the surface, the onboard OC further inspected the pot and its components (i.e., harness, clips, buoy lines, etc.), looking for signs that could determine how each pot was lost; such as broken gear components, cut or tangled buoy lines, evidence of tampering or sabotage, significant structural damage and more. Photographs of each removed crab pot were taken for future reference and further investigations, if needed.

Comparing Results from Derelict Pot Removals in Port Gardner

In 2008, the derelict fishing gear survey and removal project in Port Gardner successfully surveyed and cleaned a specific area of heavily concentrated Dungeness crab pot fishing effort just west of Jetty Island outside the Port of Everett. The 2008 operations overlapped an area where derelict crab pot surveys were conducted in 2004 with subsequent removals in 2004 and 2005. This area has been identified as the Port Gardner Study Area and repeated surveys and removal in the Study Area have been completed in 2009, 2011, 2012, 2013, 2015, and in 2016. Along with the goals of removing derelict crab pots that impact the local resource and marine ecosystem, multiple years of completed surveys and removals within the same area provide an opportunity to analyze gear loss over time. This also allows for observing changes in the rate of compliance by fishers regarding use of legally mandated escape cord in both the commercial and recreational crab fisheries. These are important factors with respect to the impacts of derelict gear on the valuable Dungeness crab resource.

To calculate pot loss rates over time for the sport crab fishery, we identified how many fishing seasons occurred between derelict gear operations, which part of the year those seasons occurred (summer or winter) and how many days of fishing were available for sport fishers during those seasons. A standard unit of fishing effort was established based on effort in the summer fishing season. Sport fishing effort expended during winter seasons is significantly less than summer seasons and WDFW biologists estimate winter effort at 10% to 15% that of summer effort (D. Velasquez, personal communication).

Fishing effort during winter 2015 was at the higher end of normal, therefore, a correction factor of 0.15 was applied to winter season days available to account for the difference in effort, standardizing the unit of effort measurement to summer day equivalent (SDE).

Spatial analysis of the sidescan sonar survey areas and derelict gear targets investigated per project was conducted using ArcGIS®. A detailed description of the differences in pot loss and escape cord compliance in the Study Area between projects from 2004 through 2012 were provided to Snohomish County in a report from NRC dated December 31, 2012 [2], and reports of findings after the 2013 and 2014 fishing seasons were provided to Snohomish County in subsequent reports [3,4]. This document reports on how the data collected in 2016, on pots lost in 2015, compares to those from previous years. Some derelict pots exhibiting dilapidated characteristics as the result of likely being derelict for longer than the amount of time since the 2015 project were identified as such and not used in the analysis. Additionally, crab pot targets that were beyond maximum diver depth (BMDD), defined as greater than a depth of 32 meters (105 feet) were not included in the analysis.

Results

Sidescan Sonar Survey and Pot Removals

In the 1.5 days of sidescan sonar surveys conducted in Port Gardner on January 8 and 9, 2016, 2.42 km^2 were covered and 147 potential derelict crab pot targets were detected or 60.7 targets/km^2. A total of 133 of the original targets were found to be derelict crab pots, all of which were removed by divers (Table 1 and Figure 2). Of the targets investigated but identified as not derelict crab pots: one crab pot target was a tribal subsistence pot (with buoy) and was left in place, one target was a tire of similar shape and size to a crab pot and was left in place, one target was a mooring block about the size of a crab pot with mooring line still attached but with no float, two targets were round wood debris, one target was buried too deep in sediment to be removed, one target was a duplicate of another target in close proximity, one target was a coil of crab pot buoy line and removed, five targets were not found, and upon investigation one target was identified as beyond the safe maximum diver depth (BMDD) of 32 m (105 feet). Table 1 provides the characteristics of pots removed in Port Gardner.

Derelict Crab Pot Removal

Derelict fishing gear was removed from Port Gardner on January 11, 13, 14, 15 and 20, 2016. A total of 140 crab pots were removed. A total of the 133 derelict crab pots removed were identified in the sidescan sonar surveys and seven pots were found by

[2] http://www.snocomrc.org/media/1313/nrc-snocomrc2012-finalrpt-reduced.pdf
[3] http://www.snocomrc.org/media/1309/2013-port-gardner-derelict-fishing-gear-project.pdf
[4] http://www.snocomrc.org/media/1312/nrc-portgardner2015_finalrpt_6-26-2015.pdf

divers during removal operations. Derelict crab pots were removed from water depths ranging from 4.6 m (15 ft) to 30.8 m (101 ft) from mud and mixed sand/mud substrate.

Of the 140 derelict pots removed, 37 (26%) were commercial pots and 103 (74%) were sport pots (Table 1). Thirty-six (26%) pots were determined to be actively fishing and 104 (74%) were no longer fishing. Of the 140 pots removed, 17 (12%) were not equipped with legal escape cord, 109 (78%) had legal escape cord and 14 (10%) pots were too deteriorated to determine whether escape cord was used or not. Of the 109 pots equipped with legal escape cord, the escape cord had disintegrated on 75 (69%) and was still intact on 34 (31%) pots.

Of the 37 commercial pots recovered, 27 (73%) were equipped with escape cord, escape cord use could not be determined on six pots (16%), and four pots (11%) were observed to be non-compliant with escape cord regulations. Thirteen (13%) of the 103 sport pots were not equipped with legal escape cord, 82 (80%) had legal escape cord and the use of escape cord could not be determined on eight (8%) sport pots. Of the 36 crab pots found to still be fishing, 11 (31%) were not equipped with proper escape cord and 25 (69%) had legal escape cord that had either yet to deteriorate (24 pots) or were still fishing even after the escape cord had disintegrated (1 pot) due to the pot lid being inadvertently held shut by the large rubber bands that hold the door in place in conjunction with the escape cord and door hook when actively fishing.

Of the 140 derelict pots recovered, 40 (29%) pots contained a total of 398 Dungeness crab and 17 red rock crab (*Cancer productus*) (Table 1). Of the 398 Dungeness crab recovered, 308 (77%) were live and 90 (23%) were dead. Sixteen (4%) of the Dungeness crab recovered were females (10 live and 6 dead). Three hundred twenty-two (81%) were males (297 live and 25 dead) and the sex was not determined for 60 (15%) of the crab due to the extent of decomposition of the individuals. Derelict pots determined to be still actively fishing contained 353 (89%) Dungeness crab (291 live and 62 dead). Pots determined to be no longer actively fishing contained 45 (11%) Dungeness crab (17 live and 28 dead). Crab pots without legal escape cord contained 77 (19%) Dungeness crab (61 live and 16 dead). Crab pots with legal escape cord contained 321 (81%) Dungeness crab (247 live and 74 dead), 92% of which were found in pots that had escape cord still intact.

Table 1. Total number of derelict pots recovered, type of pot (commercial or sport), fishing status (fishable or not), rot cord use and numbers of live and dead Dungeness crab observed in Port Gardner during the NWSF 2016 derelict fishing gear project. Source: NRC.

Fishable/Not Fishable		Fishable			Not Fishable				All Pots			
	Rot Cord Use	Rot Cord	No Rot Cord	Total	Rot Cord	No Rot Cord	Unknown	Total	Rot Cord	No Rot Cord	Unknown	Total
Commercial	# Pots Recovered	9	4	13	18	0	6	24	27	6	4	37
	# Dungeness Crab Dead	30	11	41	5	0	0	5	35	11	0	46
	# Dungeness Crab Alive	186	43	229	4	0	0	4	190	43	0	233
	# Red Rock Crab Dead	1	0	1	0	0	0	0	1	0	0	1
	# Red Rock Crab Alive	0	0	0	3	0	0	3	3	0	0	3
Sport	# Pots Recovered	16	7	23	66	6	8	80	82	13	8	103
	# Dungeness Crab Dead	17	4	21	22	1	0	23	39	5	0	44
	# Dungeness Crab Alive	44	18	62	13	0	0	13	57	18	0	75
	# Red Rock Crab Dead	0	1	1	1	0	0	1	1	1	0	2
	# Red Rock Crab Alive	1	2	3	8	0	0	8	9	2	0	11
All Pots	# Pots Recovered	25	11	36	84	6	14	104	109	17	14	140
	# Dungeness Crab Dead	47	15	62	27	1	0	28	74	16	0	90
	# Dungeness Crab Alive	230	61	291	17	0	0	17	247	61	0	308
	# Red Rock Crab Dead	1	1	2	1	0	0	1	2	1	0	3
	# Red Rock Crab Alive	1	2	3	11	0	0	11	12	2	0	14
	# Total Crab	279	79	358	56	1	0	57	335	80	0	415

Other animals found in the crab pots removed included 55 live mottled starfish (*Evasterias troscheli*), six live sunflower starfish (*Pycnopodia helianthoides*), three live northern kelp crab (*Pugettia productus*), one live helmet crab (*Telmessus cheiragonus*), one live pygmy rock crab (*Cancer oregonensis*), one live spiny pink starfish (*Pisaster brevispinus*) and one live unidentified sculpin.

Two commercial pots with owner identification were returned to their owners. Tulalip Tribal marine enforcement personnel retrieved 11 Tulalip Tribal pots to be returned to owners. Twenty five usable sport pots were given out to the public during offloading activities at the marina. A total of seven sport pots in good condition and not exhibiting owner identification were transported and stored in a secure location to be used as give-away or auction material at derelict fishing gear outreach/education events sponsored by the Northwest Straits Foundation, Snohomish County MRC, and/or NRC. Pots removed from Port Gardner that were not returned to owners or saved for later use were transported and disposed of at the Snohomish County Southwest Recycling and Transfer Station facility where the total weight of gear disposed was approximately 2,860 lbs.

Investigating Reasons for Pot Loss

Based on the information provided by removal divers and inspection of recovered gear on the removal vessel deck, the estimated reason for gear loss was determined for 104 (74%) of the 140 pots removed. In cases where the evidence suggested multiple reasons for pot loss, the OC decided upon the one most likely reason given the evidence, while also providing a potential alternate reason for the pot becoming derelict. Of the 140 derelict pots removed, 47 (34%) were determined to have been lost due to gear malfunction and/or user error (Table 2). This was often identified by broken gear components (i.e. clips, bridals, buoy sticks, etc.) or insufficient line capacity (too thin). Other evidence suggested that some buoys were not correctly attached to the pot, causing the line to release from the pot, and more evidence showed that buoys were released from buoy

lines due to knots coming undone or knots being small enough to pass through the center hole of the buoy.

A distinction was made between vessel strikes and barge strikes based on the often mangled condition of relatively new pots, suggesting that their buoys had been snagged by a slow moving vessel (barge) and the pot was dragged across the seafloor until the line severed. Vessel strikes often exhibit a clean cut of the buoy line from a fast moving propeller, or they leave an extremely wound-up buoy line with a much less clean cut after being wrapped multiple times in a slower-moving propeller and shaft. Vessel strikes were determined to be the cause of pot loss for 32 (23%) of the pots recovered and were evident by buoy lines being severed and sometimes would up near the terminal end of the line. Vessel/Barge strikes were found to be the cause for seven (5%) of the recovered pots to have been lost. Barge strikes were found to be the cause for one (1%) of the recovered pots to have been lost (Table 2).

Evidence of tampering and/or sabotage of gear was evident in 16 (11%) of the removed pots. The term "suitcased" is used to describe a pot that has been retrieved (probably emptied) and then returned to the water after the buoy line with buoy has been coiled and secured inside the pot. This was evident in two of the pots found, while one pot was found to have the door zip-tied open and the remaining 13 pots were found to have a cleanly severed buoy line near its connection to the pot (Table 2).

Finally, 36 (26%) of the 140 pots removed did not exhibit enough evidence to determine a reason for pot loss, and were therefore categorized as 'unknown' (Table 2). Of those 36 pots, 22 were thought to potentially be lost by gear malfunction or user error.

Table 2. Total number of derelict pots recovered by suspected reason for pot loss observed in Port Gardner during the NWSF 2016 derelict fishing gear project. Source: NRC.

Reason for Pot Loss	Number of Pots	% of Total
Gear Malfunction or User Error	47	34%
Vessel Strike	32	23%
Tampering / Sabotage	16	11%
Vessel/Barge Strike	7	5%
Barge Strike	1	1%
Abandoned	1	1%
Unkown	36	26%
Total Pots Removed	140	100%

Comparing Results from Derelict Pot Removals in Port Gardner

Derelict pot density (pots/km^2) and analysis of escape cord compliance within the Study Area were calculated for 2015 fishing seasons based on data collected during this project in January 2016. Pot loss rates were calculated within the Study Area for 2015 fishing based on survey area covered, number of available fishing day opportunities and number of confirmed derelict crab pots. They are summarized in Tables 3 and 4 along with the corresponding data from removal operations conducted in 2004/2005, 2008, 2009, 2011, 2012, 2013 and 2015.

For the 2016 derelict pot removal project, 1.98 km^2 of the entire 2.42 km^2 survey area was within the bounds of the Study Area and 1.91 km^2 overlapped the 2015 survey area inside the Study Area. A total of 137 confirmed derelict crab pots (36 commercial and 101 sport) or 69.19 pots/ km^2 (18.18 pots/ km^2 commercial and 51.01 pots/ km^2 sport) were removed from the Study Area. Seventeen (17) of these were considered not to be newly lost based on their age and condition, leaving 120 removed derelict crab pots (27 commercial and 93 sport) within the Study Area determined to be newly lost (Table 3 and Figure 3), yielding a newly lost pot density of 60.61 pots/ km^2 (13.64 pots/ km^2 commercial and 46.97 pots/ km^2 sport) lost during 2015 fishing seasons. Recreational crab fishing opportunities in the Port Gardner area between removal operations in early 2015 and removal operations in early 2016 included the entire summer 2015 and the entire winter 2015 seasons. Combined, these seasons totaled 142 available fishing days (50 days in summer and 92 days in winter). To account for the significant difference in effort between summer and winter seasons we standardized the amount of available days to summer day equivalents (SDE) by applying a correction factor of 0.15 to the amount of winter days available resulting in a total of 64 SDE available for recreational crab fishing during the period. This provides a sport pot loss rate of 1.46 pots lost/SDE (0.74 pots/km^2/SDE) between 2015 and 2016 derelict gear operations (Table 4). The use of escape cord could be discerned on 26 of the 27 newly lost commercial pots; of those, 22 (85%) were properly equipped with legal escape cord, and four (15%) were not equipped with legal escape cord. Escape cord use could be determined on 91 of the 93 newly lost sport pots removed; of those, 78 (86%) were equipped with legal escape cord, and 13 (14%) were not (Table 5).

Table 3. Area surveyed, number of derelict pots recovered and average derelict pot density documented during removal operations conducted 2009, 2011, 2012,

2013, 2015 and 2016 within the Port Gardner "Study Area". Source: NRC.

Month/Year of Removal Operations	Crab Fishing Seasons since Prior Removal	Survey Area within 'Study Area' (square km)	Total # Pots Removed/Disabled			Pot Density (per square km)			Area w/in 'Study Area' used for New Pot Loss Analysis (square km)	# Newly Lost Pots			Pot Density (per square km)		
			Comm	Sport	Total	Comm	Sport	Total		Comm	Sport	Total	Comm	Sport	Total
August 2004 & October 2005	NA	1.59	68	98	166	42.77	61.64	104.40	NA	NA	NA	NA	NA	NA	NA
May 2008	NA	1.87	69	70	139	36.90	37.43	74.33	NA	NA	NA	NA	NA	NA	NA
May 2009	S'08	1.72	48	106	154	27.91	61.63	89.53	1.62	39	91	130	24.07	56.17	80.25
April 2011	S'09, S'10	1.81	40	71	111	22.10	39.23	61.33	1.81	33	57	90	18.23	31.49	49.72
December 2012	S'11, W'11, S'12, W'12	1.92	33	88	121	17.19	45.83	63.02	1.92	22	74	96	11.46	38.54	50.00
December 2013	S'13, W'13	1.94	14	74	88	7.22	38.14	45.36	1.92	11	73	84	5.73	38.02	43.75
January 2015	S'14, W'14	1.93	18	23	41	9.33	11.92	21.24	1.93	16	23	39	8.29	11.92	20.21
January 2016	S'15, W'15	1.98	36	101	137	18.18	51.01	69.19	1.98	27	93	120	13.64	46.97	60.61

The overall number and density (pots per area) of crab pots lost within the Study Area continues to show a downward trend over time since derelict gear survey and removals began in 2004, even with the spike in total pots seen in the 2016 data (Table 3, Figure 4 and 6). The sport pot loss rate (pots lost per day) decreased in 2011 and 2012, then increased from 0.64 pots/day (0.33 pots/km^2/day) in 2012 to 1.31 pots/day (0.68 pots/km^2/day) in 2013; reflecting an increase of 104% from the previous period. That increase was followed by a 70% decrease from 1.31 pots/day to 0.39 pots/day (0.20 pots/km^2/day) within the recreational fishery inside the Port Gardner Study Area from during the 2014 fishing seasons. However, the pot loss rate substantially increased to 1.46 pots/day (0.74 pots/km^2/day) during 2015 fishing seasons; representing a 270% increase from the 2014 to 2015 fishing seasons (Tables 3 and 4, Figures 9 and 10).

Table 4. Area surveyed, number of derelict pots recovered and average derelict pot density between operational periods 2009, 2011, 2012, 2013, 2015 and 2016 within the Port Gardner "Study Area". Source: NRC.

Month/Year of Removal Operations	Crab Fishing Seasons since Prior Removal	Summer Season Days since Prior Removal	Winter Season Days since Prior Removal	Total Summer Day Equivalent (SDE)	# Newly Lost Sport Pots	Sport Pots Lost per km^2	Sport Pots Lost per SDE	Sport Pots Lost per km^2 per SDE
May 2009	S'08	37	0	37	91	56.17	2.46	1.52
April 2011	S'09, S'10	83	0	83	57	31.49	0.69	0.38
December 2012	S'11, W'11, S'12, W'12	96	155	115	74	38.54	0.64	0.33
December 2013	S'13, W'13	45	87	56	73	38.02	1.31	0.68
January 2015	S'14, W'14	45	107	58	23	11.92	0.39	0.20
January 2016	S'15, W'15	50	92	64	93	46.97	1.46	0.74

Escape cord compliance observed in derelict commercial pots within the Study Area has shown an increase over time, from 68% pot compliance (excluding "Unknown") in 2004/2005 observations to 85% pot compliance in 2016; peaking in 2013 with 100% compliance (Table 5, Figures 7 and 8). The average observed escape cord compliance within recovered commercial pots in the Port Gardner Study Area from 2004/2005 to present is 81.1% (99% CI = 72.8% - 89.5%). Within the sport fishery, the observed escape cord compliance went from 79% pot compliance in 2004/2005 to 100% pot compliance in pots removed in 2008. Escape cord compliance reached a low of 77% in pots removed in 2009 followed by an increase to 95% pot compliance observed in 2011 operations. Escape cord compliance then dropped to 79% in the pots removed in 2012, increased to 95% and 96% in 2013 and 2015, then decreased to 86% in 2016 (Table 5, Figures 9 and 10). The average observed escape cord compliance within recovered sport pots in the Port Gardner Study Area from 2004/2005 to present is 88.2% (99% CI = 80.5% - 95.9%).

Dungeness crab catch and mortality in derelict crab pots removed from the Port Gardner "Study Area" and nearby have been thoroughly reported in the previous section of this document, as well as in the yearly reports from the previous removal projects. Therefore, the findings of Dungeness crab catch and mortality are not included in this analysis of newly-lost pots within the "Study Area".

Table 5. Escape cord compliance observed in derelict pots recovered between operational periods 2009, 2011, 2012, 2013, 2015 and 2016 within the Port Gardner "Study Area". Source: NRC.

Month/Year of Removal Operations	Crab Fishing Seasons since Prior Removal	Newly Lost Pots Inside "Study Area"		Escape Cord: Used		Escape Cord: Not Used		Escape Cord: Unknown		% of Total Pots Equipped with Legal Escape Cord		% of Pots Equipped with Legal Escape Cord: Excluding Unknown	
		Comm	Sport	Comm	Sport	Comm	Sport	Comm	Sport	Comm	Sport	Comm	Sport
August 2004 & October 2005	NA	68	98	28	56	13	15	27	27	41%	57%	68%	79%
May 2008	NA	69	70	52	70	16	0	1	0	75%	100%	76%	100%
May 2009	S'08	39	91	27	68	9	20	3	3	69%	75%	75%	77%
April 2011	S'09, S'10	33	57	29	54	4	3	0	0	88%	95%	88%	95%
December 2012	S'11, W'11, S'12, W'12	22	74	18	57	4	15	0	2	82%	77%	82%	79%
December 2013	S'13, W'13	11	73	11	69	0	4	0	0	100%	95%	100%	95%
January 2015	S'14, W'14	16	23	12	22	4	1	0	0	75%	96%	75%	96%
January 2016	S'15, W'15	27	93	22	78	4	13	1	2	81%	84%	85%	86%

*Pots removed were not determined to be newly lost or old
Only data within 'Study Area' used in this analysis

Conclusions

This project successfully investigated 100% of the original 147 sidescan sonar survey targets. Divers removed 133 (90%) of the 147 derelict fishing gear targets found during the sidescan sonar surveys along with seven others that were not identified in the surveys. For the third time in derelict crab pot removal operations in the Port Gardner Study Area, the removal team made efforts to identify the reason for pot loss on each of the derelict pots removed. Results from this analysis showed that in the 2015 fishing seasons, the two most common reasons for pot loss in the area are either gear malfunction and user error or vessel strikes. Other reasons for pot loss that were identified were tampering/sabotage, barge strikes and abandonment. Because sidescan sonar surveys during these projects focus on water depths that are within the maximum allowable diver safety depths of 32 m (105 feet), they do not cover the steep slope just west of the Study Area where the water depth quickly increases from ≤ 27 m (90 feet) to over 32 m. In surveys conducted in previous years, several derelict crab pot targets were identified along this slope in water depths beyond 32 m. We assume that a common reason for those crab pots becoming derelict can be attributed to the line length and water depth mismatch, as fishers presume they are deploying their gear on the shallow side of the slope, when actually their pot lands on the deeper side of the slope to the west. Alternatively, pots deployed along the shelf may slide down the hill into deeper waters, submerging the buoy. Targeted sidescan sonar surveys and pot removals utilizing remotely operated vehicles (ROV) can be performed in this and other areas to identify and remove gear, while also gathering information on the reason for pot loss.

Results show that the number of pots lost per fishing day opportunity within the recreational crab fishery in the Port Gardner Study Area in 2015 fishing seasons was over 3.5 times of the observed loss rate of 2014 fishing seasons, just over what it was in 2013 fishing seasons, and 2.3 times what it was in 2011 and 2012 fishing seasons. The spike in pot loss rates in the 2013 fishing seasons was concerning, as results from the 2012 report concluded that the pot loss rates were continuing downward from year to year. While the data collected in 2015 initially suggested the 2013 season increase in pot loss rates was an anomaly, the results from 2016 operations (2015 fishing seasons) indicate that these fluctuations from year to year may reflect the reality of sport pot loss in the Port Gardner Study Area. The long-term trend in sport pot loss in the Study Area continues to have decreased since 2008, as the pots lost per fishing day opportunity in the 2015 fishing season was 60% of what it was in 2008 fishing season (data collected in 2009 removals). Multiple factors could contribute to the year to year variation in pot loss in the Study Area, such as:

- Amount of fishing effort
- Recreational fleet's experience and knowledge of best fishing practices
- Amount of commercial and recreational vessel traffic

- Variations in weather
- Variation in WDFW and/or Snohomish County Sherriff pot sweep efforts

Results from removal of derelict pots from the 2015 season show a 10% decrease in escape cord compliance in recreational crab pots in the Port Gardner Study Area from 96% in 2014 to 86% in 2015. The 86% compliance was the lowest observed in the area since the 2012 season.

Without full investigation of commercial fishing effort between derelict gear projects in the Port Gardner Study Area, a pot loss by effort rate is not available. While the total number of derelict commercial pots in the Study Area decreased from 2008 to 2013 fishing seasons, there has been a slight increase in the most recent two years (2014 and 2015 fishing seasons). The general decreasing trend in pot loss between 2009 and 2013 may be attributed to both a change in fisher behavior as well as a decrease in available or appropriated fishing opportunities. While there was a slight increase in number of commercial pots found within the Study Area from 11 in 2013 to 16 in 2015 to 27 in 2016, overall the commercial pot density remains much lower than was observed in 2011 and prior.

When evaluating pot loss over time, there are two key considerations that made the 2015 (Summer and Winter) Dungeness crab seasons in Port Gardner unique. One is that the 2015 season was the most productive in terms of available harvestable crab in recent history, therefore providing both commercial and recreational crabbers greater opportunity and incentive to increase effort and harvest. Second, due to court ruling one Puget Sound Treaty Tribe was granted access to harvest Dungeness crab in the Port Gardner region where they had not in recent history. Therefore, the size of the commercial (tribal) fishing fleet, and associated effort in Port Gardner most likely increased. Having new participants in a specific area such as Port Gardner may increase the likelihood of crab pot loss due to site-specific inexperience, as well as the potential for increased conflicts between user groups. One additional complication to pot loss analysis by sector is that there seems to be an increasing number of commercial (tribal and non-tribal) fishers using modified recreational style pots, therefore adding a challenge to discerning which fishery (commercial or sport) a derelict pot came from.

Recommendations

Based on the observations and results of the derelict gear removal project and analysis of data from previous years, the following are recommendations to further reduce the impacts of derelict fishing gear in the Port Gardner area.

- **Recreational crabbers should be educated on the best fishing practices that prevent crab pot loss. The following is a list of practices that can reduce pot loss:**

    - Avoid high vessel traffic areas, ferry, barge and log tow routes
    - Remain near pots during soak time
    - Use weighted buoy lines to reduce potential vessel strikes
    - Use buoy lines of proper length (i.e., 1/3 longer than water depth)
    - Know the depth of water where pots are set
    - Use multiple buoys in high current areas to avoid buoy submersion
    - Augment pot weight to avoid pot migration in high currents
    - Leave ample spacing between pot drops to avoid buoy entanglement
    - Augment marker buoys with additional floats and/or poles with flags to make them more visible to vessel operators

- **Education programs should include suggestions to recreational fishers to test the durability and functionality of all gear components and knots prior to deploying crab pots, and replace items or re-tie knots if they seem to be compromised or faulty. This could reduce gear loss through gear malfunction and/or user error.**

- **Education programs should include information regarding proper installation of escape cord, the use of thin vs. thick strands of escape cord and that in order to comply with regulations, escape cord must be made of biodegradable material rather than synthetics such as nylon. In addition, special attention should be placed on the placement of bait clips, bait jars, bridles, etc., that can prevent the opening of a crab pot door despite the deterioration of escape cord.**

- **The use of legal escape cord on crab pots should continue to be enforced.**

- **Enforcement sweeps of pots left out during non-crabbing days during the recreational crabbing seasons should be increased, and information from those sweeps should be incorporated into annual loss rate estimates.**

- **The Study Area should be surveyed and gear removed annually to eliminate the lost harvest due to derelict crab pots in such a popular crabbing location, and to further determine crab pot loss rates and gain greater information about the commercial and recreational fishing behaviors.**

- **Targeted sidescan sonar surveys and pot removals utilizing remotely operated vehicles (ROV) should be performed in areas deeper than 105 feet to identify and remove gear, while also gathering information on the reasons for pot loss.**

Acknowledgements

The Port of Everett kindly provided free moorage for the dive support vessel during the project, their assistance is greatly appreciated. We also wish to thank the Snohomish County MRC for their continued support and cooperation during the project, and their dedication to eliminating the harmful effects of derelict crab pots in Puget Sound marine waters. Don Velasquez and Don Rothaus of WDFW, Cathy Stanley and Mike McHugh of Tulalip Fisheries assisted in planning by providing valuable fisheries updates and information prior to derelict gear operations.

Figure 1. Sidescan sonar survey effort and derelict crab pot targets found at Port Gardner during the Northwest Straits Foundation 2016 derelict fishing gear project. Source: NRC, Inc. and Fenn Enterprises.

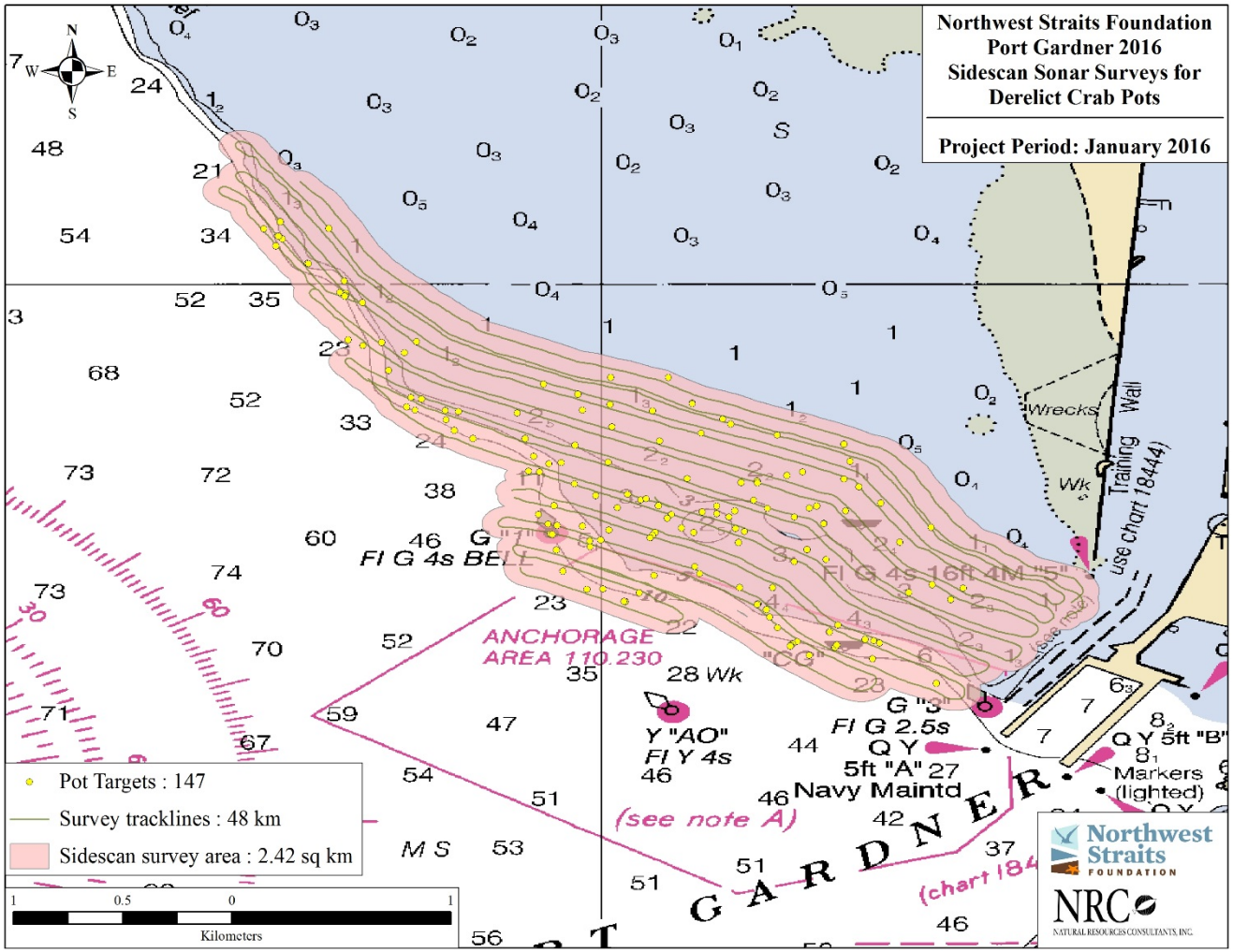

Figure 2. Sidescan sonar survey effort and disposition of derelict crab pot targets found in Port Gardner during the Northwest Straits Foundation 2016 derelict fishing gear project. Source: NRC, Inc. and Fenn Enterprises.

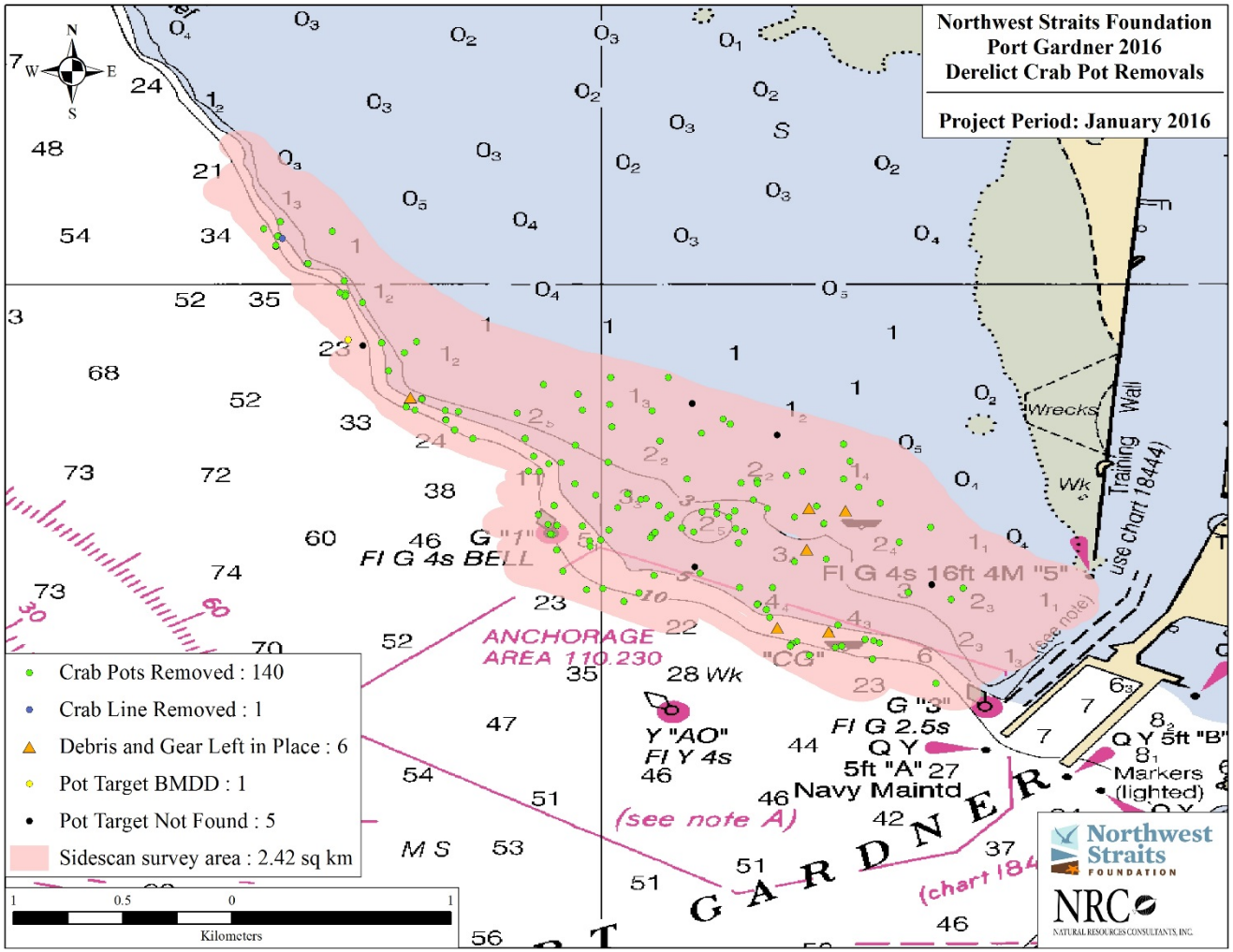

Figure 3. Derelict crab pot targets removed or disabled during the 2016 operations within the Port Gardner "Study Area". Source: NRC, Inc. and Fenn Enterprises.

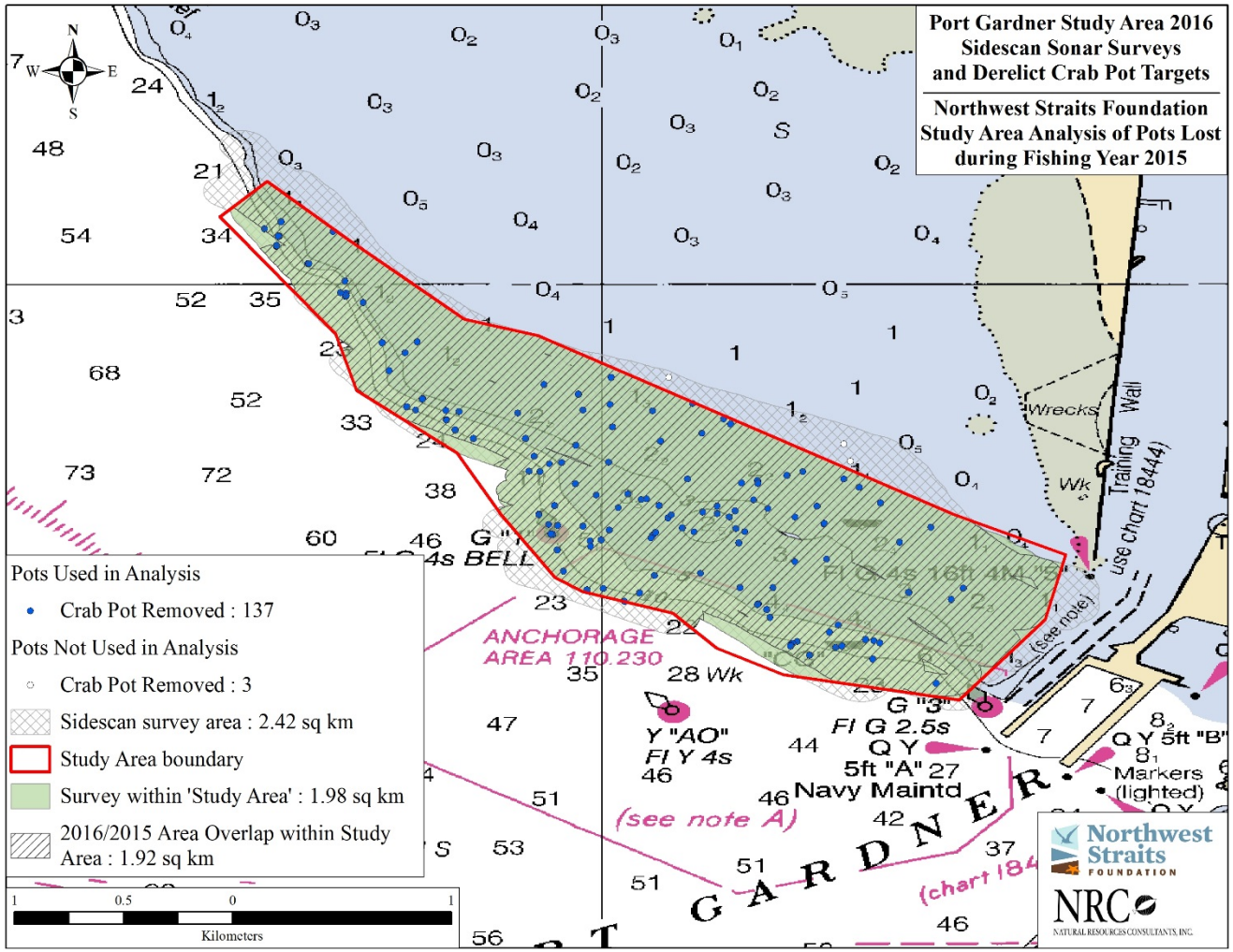

Figure 4. Number of derelict crab pots removed/disabled within the Port Gardner "Study Area" by project from 2004/2005 through 2016. Source: NRC, Inc.

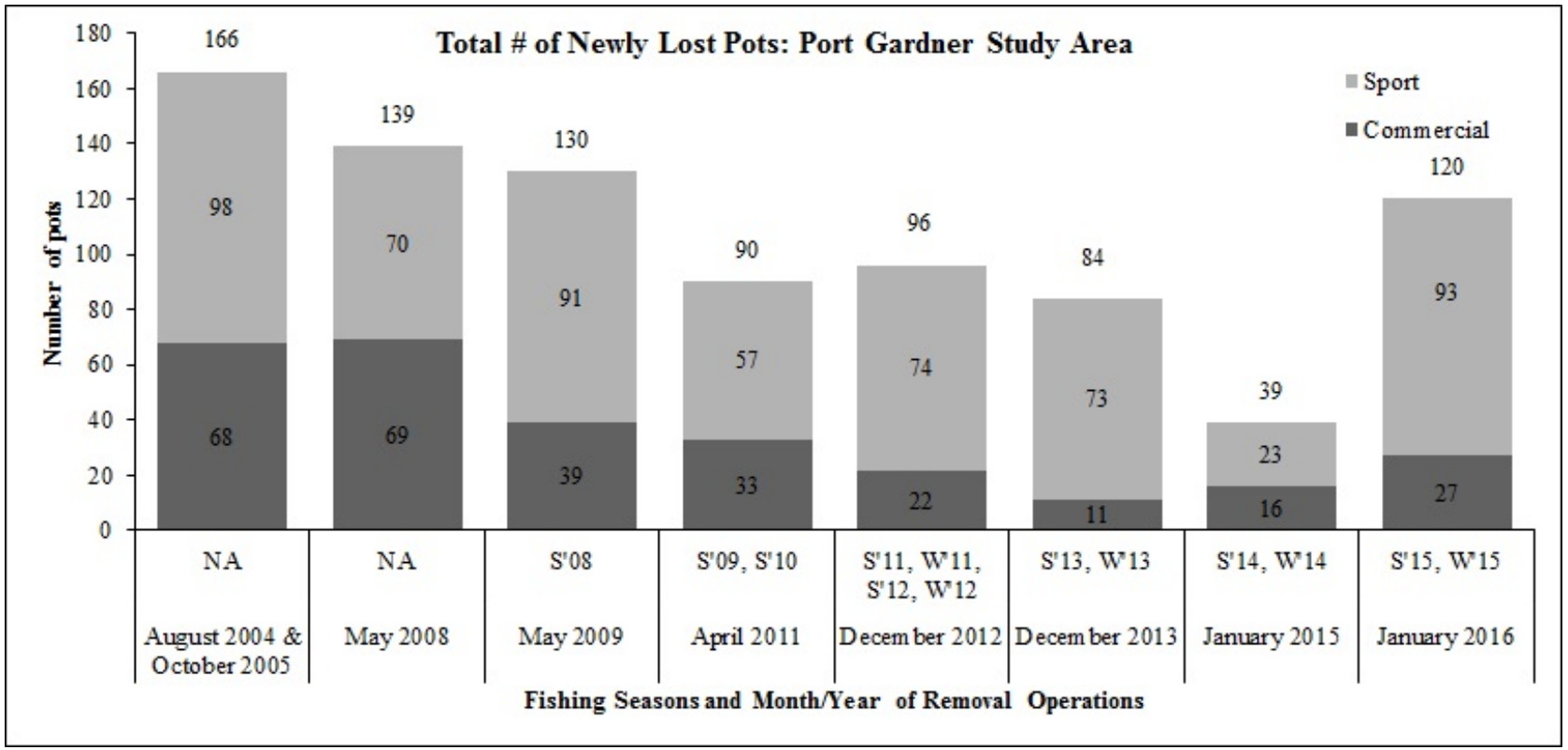

Figure 5. Number of derelict sport pots removed/disabled within the Port Gardner "Study Area" by project and number of recreational crab fishing days available between projects Source: NRC, Inc. and WDFW.

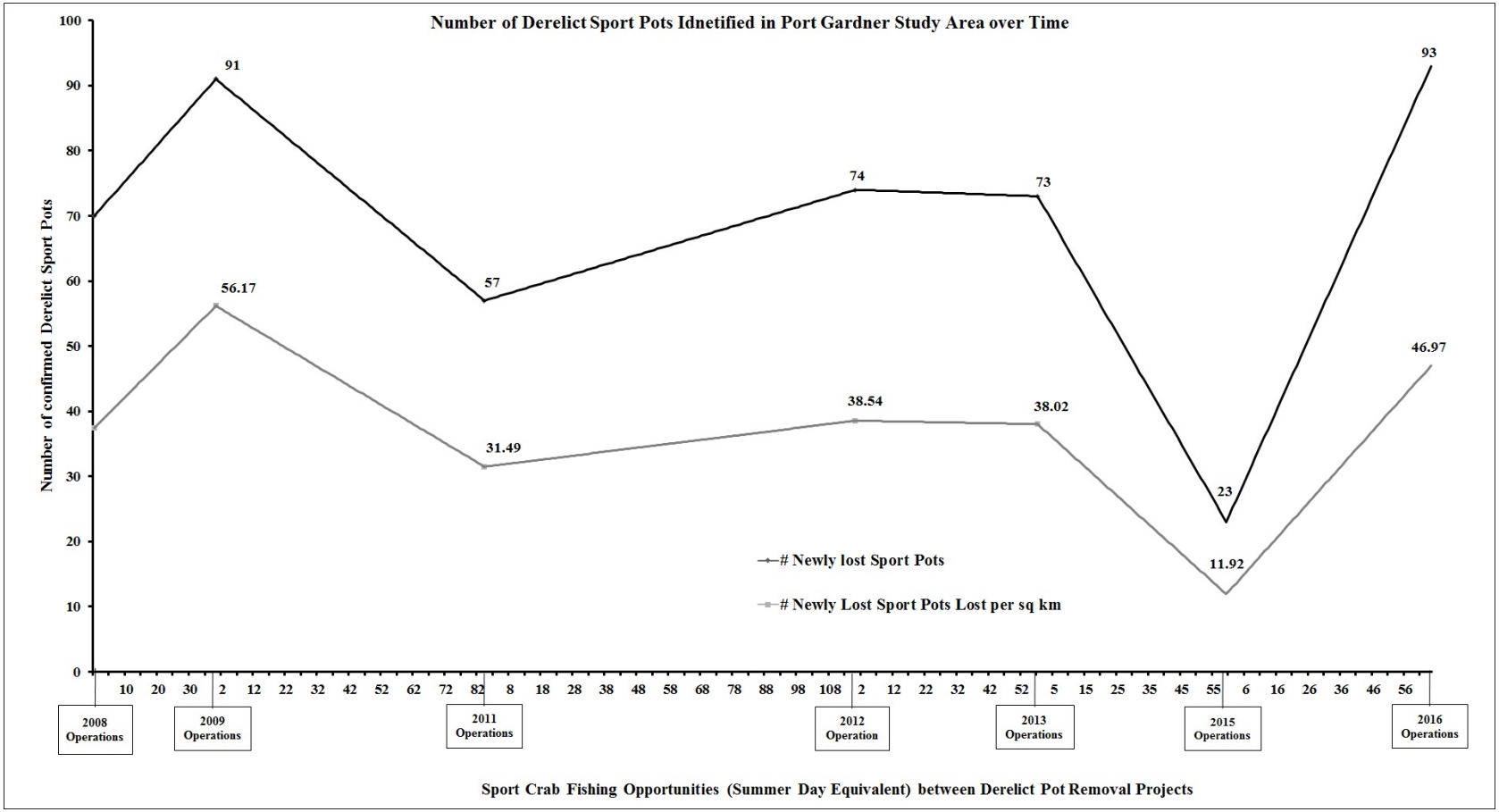

Figure 6. Observed sport pot loss per available fishing day within the Port Gardner "Study Area" by year. Source: NRC, Inc. and WDFW.

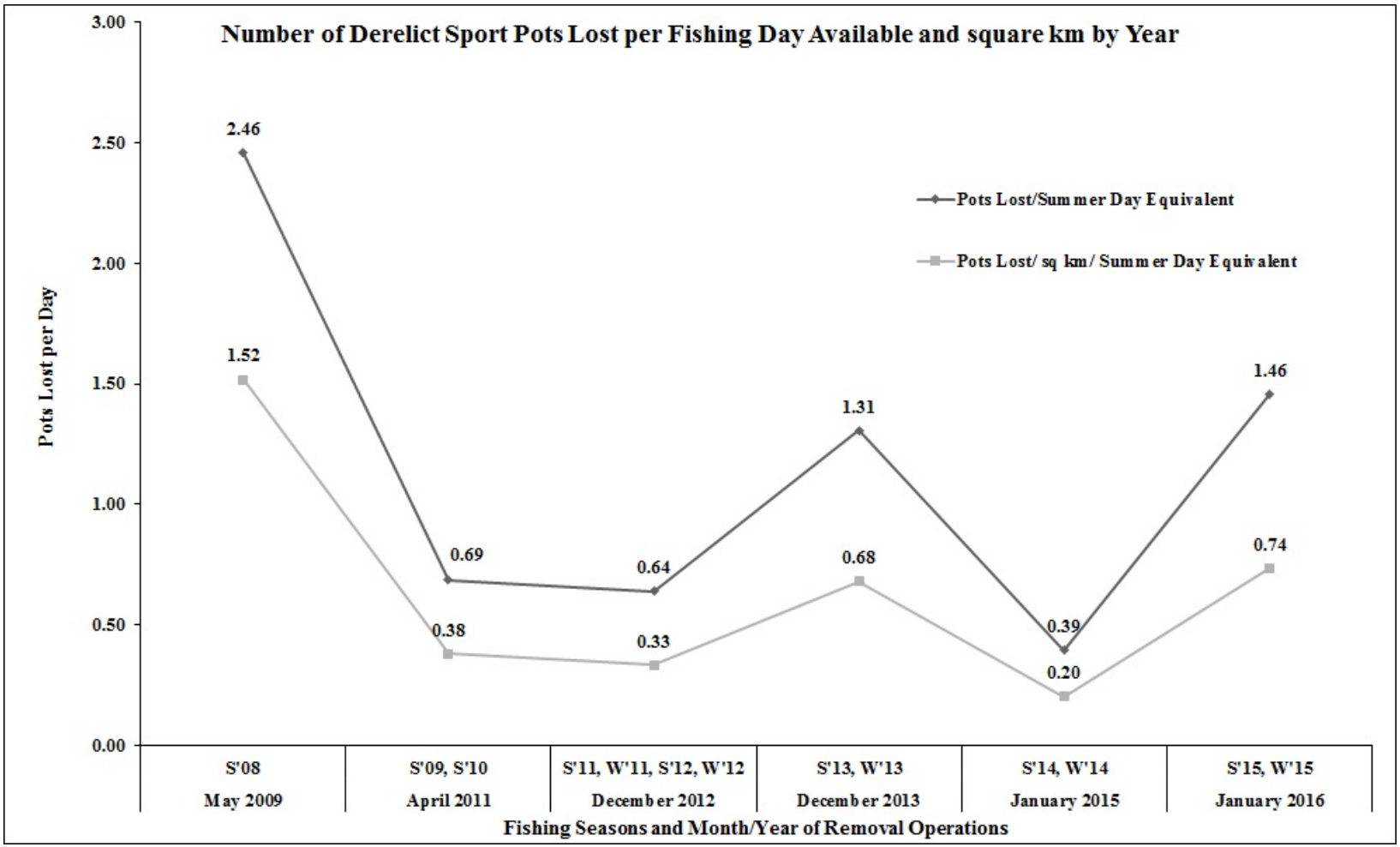

Figure 7. Summary of escape cord compliance observed on commercial derelict crab pots removed in the Port Gardner "Study Area" from 2004/2005 to 2016. Source: NRC, Inc.

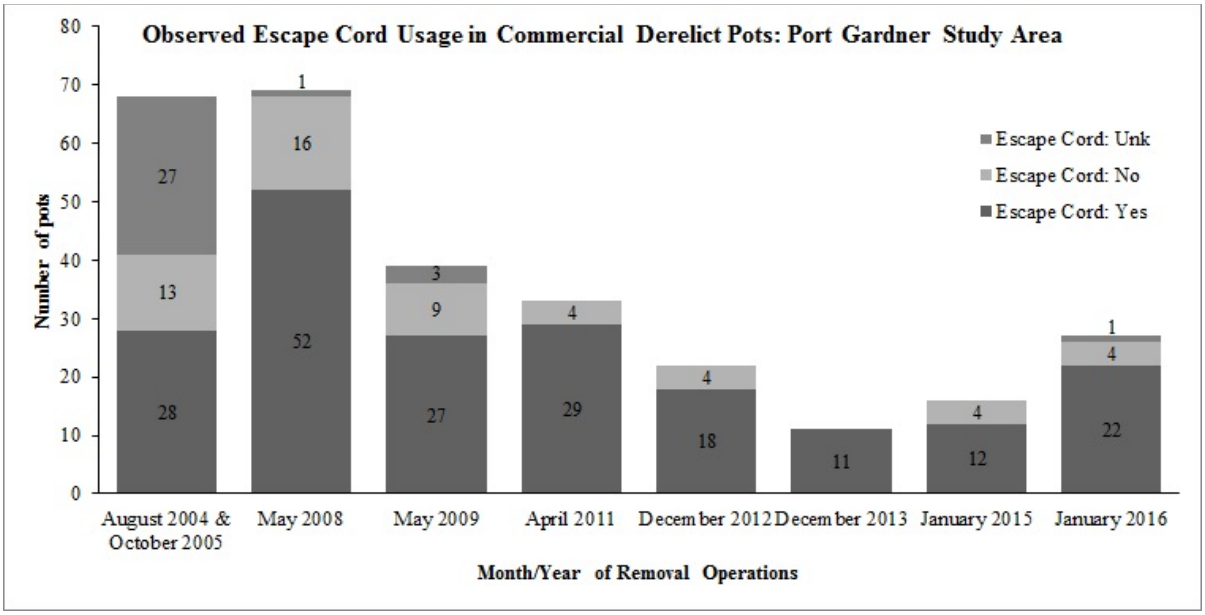

Figure 8. Percentage of legal escape cord compliance exhibited in derelict commercial pots removed exhibiting legal escape cord in the Port Gardner "Study Area" from 2004/2005 to 2016. Source: NRC, Inc.

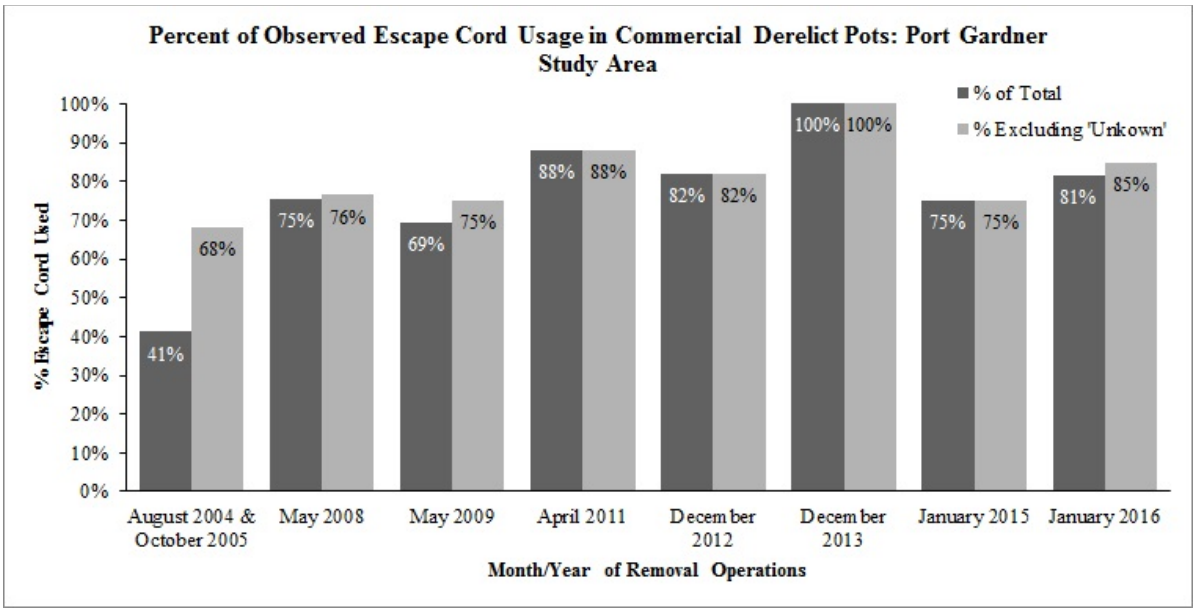

Figure 9. Summary of escape cord compliance observed on sport derelict crab pots removed in the Port Gardner "Study Area" from 2004/2005 to 2016. Source: NRC, Inc.

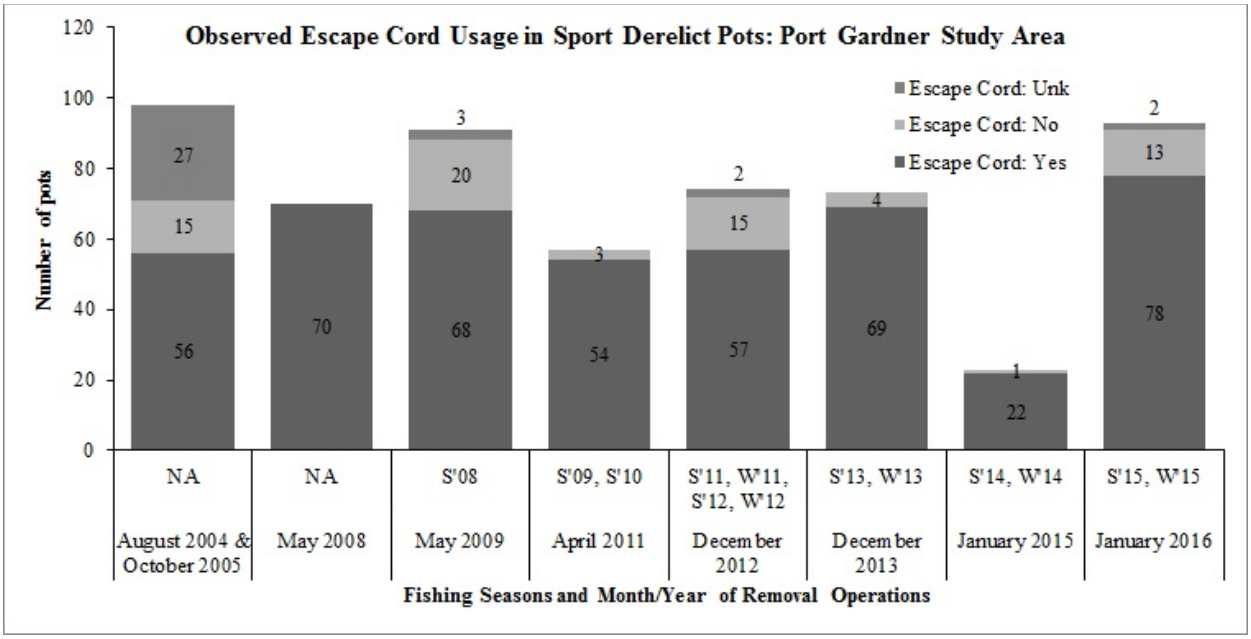

Figure 10. Percentage of legal escape cord compliance exhibited in derelict sport pots removed exhibiting legal escape cord in the Port Gardner "Study Area" from 2004/2005 to 2016. Source: NRC, Inc.