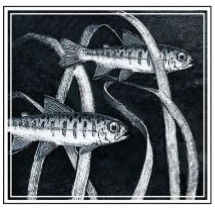

Jefferson County
Marine
Resources
Committee

Jefferson County Marine Resources Committee Remotely Operated Vehicle (ROV) Derelict Crab Pot Removal Final Report

Prepared for:
Washington Department of Fish and Wildlife

Prepared by:
Monica Montgomery, MRC Coordinator
Jefferson County Marine Resources Committee
121 Oak Bay Road
Port Hadlock, WA 98339
Email: monica.montgomery1@wsu.edu

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Introduction

Derelict crab pots pose many problems to marine life and to people. It is estimated that more than 12,000 crab pots are lost and become derelict every year in Washington's Salish Sea, killing over 180,000 harvestable crab each year. Although all crab pots in Washington State are required to have biodegradable escape mechanisms, crab and other species can still get trapped and die before the escape mechanism opens. Identification and safe removal of derelict crab pots eliminates present and future threats to marine life and habitat and improves safety on the water.

Since 2002, the Northwest Straits Foundation (NWSF), an affiliate of the Jefferson County Marine Resources Committee (MRC) through the Northwest Straits Initiative, has worked with the Washington Department of Fish and Wildlife (WDFW) to remove more than 6,000 derelict crab pots from the Salish Sea. Some of this work took place in Port Townsend Bay, with the MRC partnering on education outreach efforts targeting local recreational crabbers. In 2022, the MRC sought to expand this work, with guidance from NWSF and support from WDFW, to address other areas in East Jefferson County where concentrations of derelict crab pots continue to be reported by residents. In responding to community concerns, the MRC focused its derelict crab pot removal efforts near the Adelma Beach and Cape George areas in Discovery Bay.

The MRC partnered with the Sea Dragons, a local STEM robotics group, to pilot the use of a submersible ROV (remotely operated vehicle) as a more cost-effective and community-driven method for locating and removing derelict crab pots. The MRC followed WDFW published guidelines for derelict fishing gear removal in Washington marine waters. To optimize the utility of the ROV in locating pots for removal, the MRC contracted sidescan sonar surveys to generate a working list of coordinates for potential derelict crab pots. With a limited work window totaling 2.5 days on the water, the team successfully relocated and removed derelict crab pots near Adelma Beach using the ROV.

Funding from the State of Washington as well as the US Environmental Protection Agency through the Puget Sound Partnership was provided to the MRC through the Northwest Straits Commission (NWSC). Other support for this project came from the Northwest Straits Foundation, Willamette University, Applied Education Foundation, Coastal Sensing & Survey, and community members Ross Anderson and Erik Wennstrom.

Scope of Work

This project focused on the removal of derelict crab pots located near the Adelma Beach and Cape George areas of Discovery Bay in Jefferson County, Washington. Crab pot sidescan surveys of these areas were contracted through Coastal Sensing & Survey. A total of one day was spent doing sidescan sonar surveys and 2.5 days (one full day and three mornings) were spent on the water operating the ROV to relocate and remove derelict crab pots. Figures 1-4 show the areas covered with sidescan sonar surveys.

A Scientific Collection Permit application along with a General Study Plan was submitted to WDFW on March 7, 2022 and was approved by WDFW on April 12, 2022 (Permit number: MONTGOMERY 22-112), authorizing scientific sampling of wildlife between May 1, 2022 and April 30, 2023. A derelict fishing gear removal and disposal plan was prepared and submitted to WDFW on March 11, 2022 and was approved by WDFW on May 17, 2022. The approval letter from WDFW allowed for derelict gear removal operations to be conducted between May 1, 2022 and June 30, 2022.

Gear retrieved during the course of this project was treated in accordance with the Washington State Abandoned Property Rights Law and other salvage laws, when applicable. If identified, owners of the derelict crab pots recovered were contacted and provided an opportunity to recover their property. Derelict crab pots that could not be identified to an owner were disposed of at the local county waste disposal facility.

Methodology

Sidescan Sonar Survey

To optimize the utility of the ROV in locating pots for removal, the MRC contracted Coastal Sensing & Survey to conduct sidescan sonar surveys for obtaining GPS coordinates of likely derelict crab pots in two project areas: (1) Adelma Beach and (2) between the Cape George Marina and Beckett Point.

The EdgeTech 4125 Side Scan Sonar System operating at 400/900 kHz dual simultaneous frequency was used during the survey to locate potential derelict crab pots. A hydraulic winch and cable controlled the depth of the towfish. The survey image was projected on a monitor onboard the vessel and recorded onto a computer hard drive for later processing. Generally, the sidescan sonar survey was conducted at 4.63 km/hr (2.5 knots) with a path width of 50 meters for 900kHZ and 70 meters for 400kHZ on either side of the boat, for an approximate area swept up to 140 m. Survey depths generally ranged from about 3 m (10 ft) to 60 m (200 ft) in order to identify as many derelict crab pots as possible within the survey area.

The intent of the sidescan sonar survey was to cover as much of the crabbing grounds in the survey areas as possible within the survey time budgeted and to provide locations of derelict crab pots for recovery operations and education outreach purposes. Derelict crab pots were readily identified on the sidescan sonar images. Counts and precise locations were recorded during post-survey processing of the data that allowed greater time to examine the images. The products from the sidescan sonar survey included a trackline file of the area surveyed, calculation of the amount of the areas covered and the positions (latitude and longitude) of likely derelict crab pot targets.

Remotely Operated Vehicle (ROV) Design

The Sea Dragons Robotics Team's customized ROV incorporates two low light cameras, a Deepsea 1500 lumen LED light for optical assistance in low light environments, six thrusters, a hydraulic powered manipulator, and a custom onboard battery built to maximize dive time. The vehicle's frame is constructed from recycled aerospace grade carbon fiber to optimize size and weight while maintaining a durable structure. Two polycarbonate canisters on the ROV house the batteries, electronics, internal cameras, and internal sensors. The canisters are each rated to depths of 100 meters (328 ft) while being designed to have a compact and lightweight configuration. Each canister is fitted with specific airtight end caps and penetrators for waterproof cable pass through. The ROV's topside water-resistant control system is equipped with a laptop and dual gamepad controllers that two pilots use to manipulate the ROV. A custom GUI (Graphical User Interface) has been designed to maximize pilot efficiency during dives. The ROV is also outfitted with navigational equipment to enable geographic orientation and directional control for surveying transects. All ROV dives are recorded via the two high quality low light cameras onboard the ROV and saved directly to the control station laptop. The ROV is tethered to the control station using a two-hundred-foot Ethernet cable that sends signals to the onboard Arduino controlled system. Six Blue Robotics T-100 thrusters power the ROV, optimized in a lifting configuration ideal for maneuvering in the strong tides of the Salish Sea. A custom lithium-ion battery system utilizing LGMH1 18650 recycled cells produces 26.8 amp hours and provides a nominal voltage of 14.4 volts, enabling the ROV to operate for 2 hours.

Derelict Crab Pot Recovery

A list of the precise locations of potential derelict crab pots detected during the sidescan sonar surveys was used by the team to locate derelict crab pots with the ROV. These target locations derived from the sidescan sonar surveys were transferred to a GPS unit as waypoints. Using the GPS unit, a Sea Dragon member navigated the team, operating from two 14-foot boats, to the exact location of the derelict crab pot target. The boat with the ROV pilots dropped anchor near the target location, and with the ROV, ran alternating circular transects outwards around the anchor line, using the ROV to visually locate the target derelict crab pot. The second boat floated nearby as a support vessel. Once a crab pot was detected, the ROV pilots shared observations about the condition of the crab pot and the team assessed the need and potential for removal. Information collected included whether the crab pot was from the commercial or recreational fishery, whether it was equipped with escape cord, whether the gear was actively fishing or not, the number of marine life entrapped, the depth and type of seabed where the pot was located, and if there was any evidence that would elucidate the reason the pot was lost. Once it was determined that the pot was not fishing lawfully and could be removed, the ROV surfaced to attach a tethered grappling hook. The team then relocated the pot, attached the grappling hook, and manually pulled the pot to the surface for removal. MRC team members on the support vessel counted, recorded, and released any entrapped marine life and searched for owner identification – and if present, recorded contact information that was later used to coordinate returning the lost crab pot to the owners.

Results

Sidescan Sonar Survey

One day of sidescan sonar survey work targeting derelict crab pot targets was conducted in Discovery Bay, near Adelma Beach and between the Cape George Marina and Beckett Point, on May 17, 2022. The MRC had intended on additionally surveying north of Cape George; however, a small craft advisory limited time on the water in Discovery Bay. Approximately 419,411 m^2 of area was covered near Adelma Beach and 1,730,955 m^2 near Cape George (Figures 1 - 4). Survey results detected 31 potential derelict crab pots near Adelma Beach and 126 pots near Cape George – the majority (76 pots) of which were deeper than 105ft, the maximum depth that divers are allowed for removal efforts (Tables 1-3).

Derelict Crab Pot Removal

Dedicated derelict crab pot removal operations were conducted for a total of 2.5 days in Discovery Bay (June 14, 19, 20, and 21). As a pilot project working with students to explore a new method of derelict crab pot removal using an ROV, the first full day of operations (June 14) was dedicated to trial and error, adapting to a number of environmental and equipment challenges. Though the team was unable to relocate derelict crab pot targets using the ROV this first day, one derelict crab pot hooked by the vessel's anchor was incidentally recovered from Adelma Beach when pulling up the anchor at the end of the day. The crab pot was half covered in marine growth, including seven mottled sea stars (*Evasterias troschelii*). With an aged and frayed rope attached to it, it was determined that the pot may have been lost due to a boat propeller cutting its line.

Due to the strong currents and difficulty operating the ROV near Cape George, the team focused removal efforts entirely at Adelma Beach, which is much more protected, calm, and shallow. On the morning of June 19, the team located 3 crab pots using coordinates from the sidescan sonar survey; however, opted to leave them in place as they appeared to no longer be fishing and were covered in plumose anemones (*Metridium spp.),* seemingly creating habitat and functioning as artificial reef (see Figure 7). On the morning of June 20, the team located and recovered two derelict crab pot targets at a depth of 67-69 feet. The first pot appeared to be in good condition and had a perfectly intact rope, indicating it may have been lost due to a poorly tied knot. Trapped inside were two live and two dead Dungeness crabs (*Cancer magister*) and one lyre crab (*Hyas lyratus*). See Figure 8. The second pot had its rope cut short, indicating it may have been lost due to a boat propeller. This pot contained one live red rock crab (*Cancer productus*), two lyre crab, and four mottled sea stars. On the morning of June 21, the team located one derelict crab pot but opted not to recover it due to changing weather conditions and prioritizing safety on the water. This was the last opportunity for the team to conduct removal efforts before the Tribal crabbing season opened.

A total of 6 derelict crab pot targets were located using the ROV and 3 pots were recovered (2 with the ROV, 1 incidentally while pulling the anchor) from Adelma Beach during just 2.5 days of pot removal operations. From the 3 recovered pots, a total of 2 live Dungeness

crabs (*Cancer magister*), 1 live red rock crab (*Cancer productus*), 3 live lyre crab (*Hyas lyratus*), and 11 live mottled sea stars (*Evasterias troschelii*) were encountered (Table 4). Additionally, 2 dead Dungeness crab were encountered in 1 of the ROV recovered pots. Sidescan sonar surveys for derelict crab pots identified a total of 157 pot targets. After ROV investigation and removals, 154 crab pot targets remain in the survey areas and 3 were recovered. One pot was returned to its owner and two pots were disposed of at Jefferson County Transfer Station, the county's solid waste disposal facility. There were no commercial crab pots encountered.

Conclusion

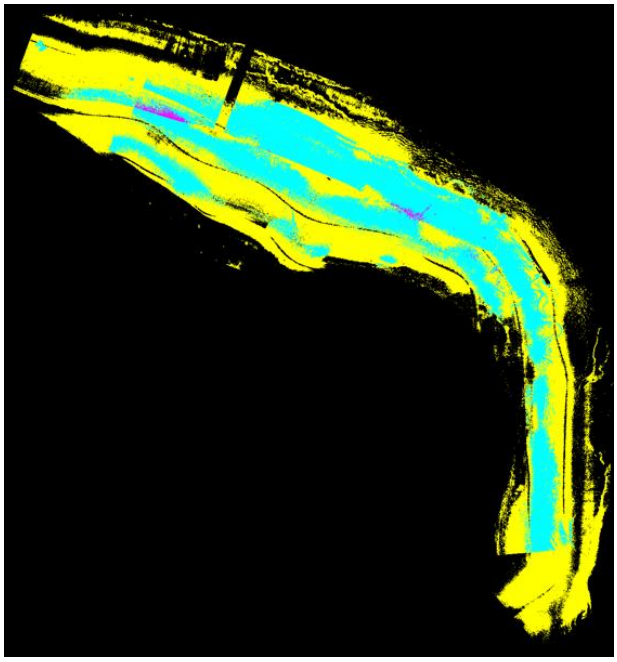
The derelict crab pots recovered were generally still capable of entrapment and causing mortality of marine organisms. The data collection effort only recorded what was actually removed from the pots onboard the vessel. This methodology likely underestimated the overall entrapment and mortality rate associated with derelict crab pots.

By listening to community concerns and utilizing the unique skillsets of local youth, the MRC acted as an incubator for testing a new and innovative approach to addressing the issue of derelict crab pots in the Salish Sea. With a short on-the-water window to test and refine methods, the Sea Dragons successfully demonstrated the ability of a submersible ROV to locate and recover derelict crab pots. The MRC plans to continue growing its partnership with the Sea Dragons to enhance the ROV's capabilities to operate at even greater depths (to recover pots deeper than 105 ft, the maximum depth allowed for diver removal), refine ROV survey methods for pots with unknown locations (when contracting sidescan sonar surveys is not feasible), and remove derelict crab pots in other areas across East Jefferson County.

Appendix

Figure 1: Area surveyed near Adelma Beach, Discovery Bay

Area Mapped at 100 Pct - Meters Square	419,411.8
Area Mapped at 200 Pct - Meters Square	153,333.8
Area Mapped >= 300 Pct - Meters Square	1,956.8



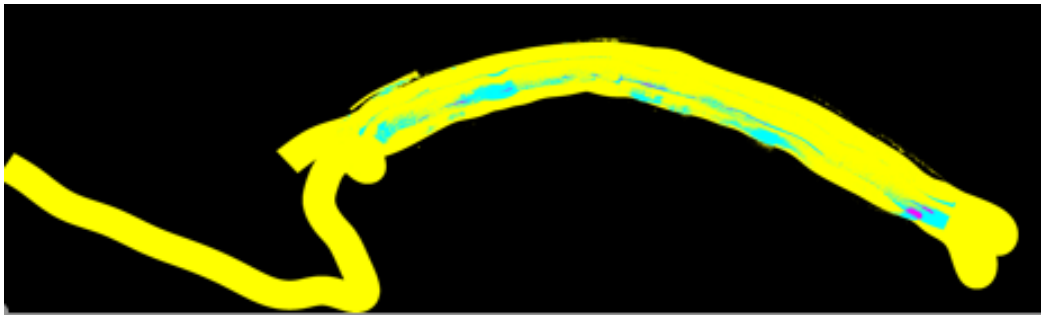
Map created by Coastal Sensing and Survey

Figure 2: Area surveyed with pots pinned near Adelma Beach, Discovery Bay

Map created by Coastal Sensing and Survey

Figure 3: Area surveyed between Cape George Marina and Beckett Point, Discovery Bay

Area Mapped at 100 Pct - Meters Square	1,730,954.9
Area Mapped at 200 Pct - Meters Square	122,316.0
Area Mapped >= 300 Pct - Meters Square	3,565.2



Map created by Coastal Sensing and Survey

Figure 4: Area surveyed with pots pinned between Cape George Marina and Beckett Point, Discovery Bay

Map created by Coastal Sensing and Survey

Table 1: Coordinates and estimated depths for derelict crab pots detected near Adelma Beach, Discovery Bay. Three pots were removed from this site and four were left in place.

Pot #	Latitude	Longitude	Pot Depth (ft)	Pot Recovery Notes
1	48.04850911	-122.8409526	67.1	
2	48.04773816	-122.838184	49.2	
3	48.04676244	-122.8336949	44.5	
4	48.04600747	-122.8336182	59.3	
5	48.04592812	-122.8324405	56.6	Recovered upon pulling boat anchor (incidental)
6	48.04542459	-122.8324735	69	Located and recovered
7	48.04547737	-122.8323454	66.9	Located and recovered
8	48.04560459	-122.8313072	54.9	
9	48.04491971	-122.8314367	64.7	Located and left in place; Appeared to no longer be fishing and instead functioning as artificial reef
10	48.04475567	-122.8312763	64.3	Located and left in place; Appeared to no longer be fishing, functioning as artificial reef
11	48.04459124	-122.8318154	71.4	
12	48.04445578	-122.8318576	72.8	Located and left in place due to on-the-water safety concerns
13	48.0440951	-122.8305232	62.1	Located and left in place; Appeared to no longer be fishing and instead functioning as artificial reef
14	48.04973658	-122.8447292	59.5	
15	48.04886372	-122.8432218	77.5	
16	48.04934429	-122.8419723	48.3	
17	48.04798906	-122.8381356	44.7	
18	48.04618738	-122.8331572	51.9	
19	48.04251756	-122.8302516	60.9	
20	48.03855928	-122.8308265	61	
21	48.04766212	-122.8415041	95.6	
22	48.04637722	-122.8376855	77.9	
23	48.04612737	-122.8378807	84.9	
24	48.0459728	-122.8374772	84.5	
25	48.0455491	-122.8336771	71.5	
26	48.04769824	-122.8451232	125.7	
27	48.04693469	-122.8462644	127.2	
28	48.04499315	-122.8341791	87.3	
29	48.04497087	-122.8340099	87.1	
30	48.04477229	-122.8338712	88.8	
31	48.04538198	-122.83733	98.7	

Table 2: Coordinates and estimated depths for derelict crab pots detected between Cape George Marina and Beckett Point, Discovery Bay. Of the 126 potential derelict crab pots detected, the majority (76) are located deeper than 105ft, the maximum depth allowed for diver removal. No pots were removed from this site.

Pot #	Latitude	Longitude	Pot Depth (ft)
1	48.0934531	-122.88331	174.5
2	48.0934344	-122.88358	186.7
3	48.0934518	-122.88361	187.6
4	48.0935103	-122.88366	189.2
5	48.0938078	-122.88376	190
6	48.0938419	-122.88176	63.1
7	48.0945261	-122.88349	158.7
8	48.0944296	-122.88393	184.8
9	48.095581	-122.88391	167
10	48.095782	-122.88264	93
11	48.0959122	-122.88221	67.8
12	48.0963956	-122.88473	177.9
13	48.0964117	-122.88463	173.9
14	48.0970792	-122.88359	104
15	48.0966746	-122.88482	168.5
16	48.0969787	-122.88421	134.1
17	48.0966402	-122.88329	106.3
18	48.0966849	-122.8832	101.3
19	48.0962597	-122.883	102.4
20	48.096107	-122.88233	72.6
21	48.0985968	-122.8857	138.4
22	48.0985463	-122.88547	130.4
23	48.0989185	-122.88478	96.3
24	48.099911	-122.88567	103.9
25	48.0825299	-122.89083	171.7
26	48.0817965	-122.88915	61.6
27	48.081781	-122.88947	74.6
28	48.0827167	-122.89059	169.4
29	48.0830225	-122.89073	177.2
30	48.0831121	-122.89071	177.3
31	48.0827572	-122.88865	76.9
32	48.0831799	-122.88968	132.4
33	48.0835967	-122.88934	132.4
34	48.0838578	-122.88976	158.9
35	48.0836898	-122.8897	151.2
36	48.0841494	-122.88963	160.9
37	48.0841583	-122.88975	165.7
38	48.0847023	-122.8891	163.3
39	48.0848095	-122.88862	148.4

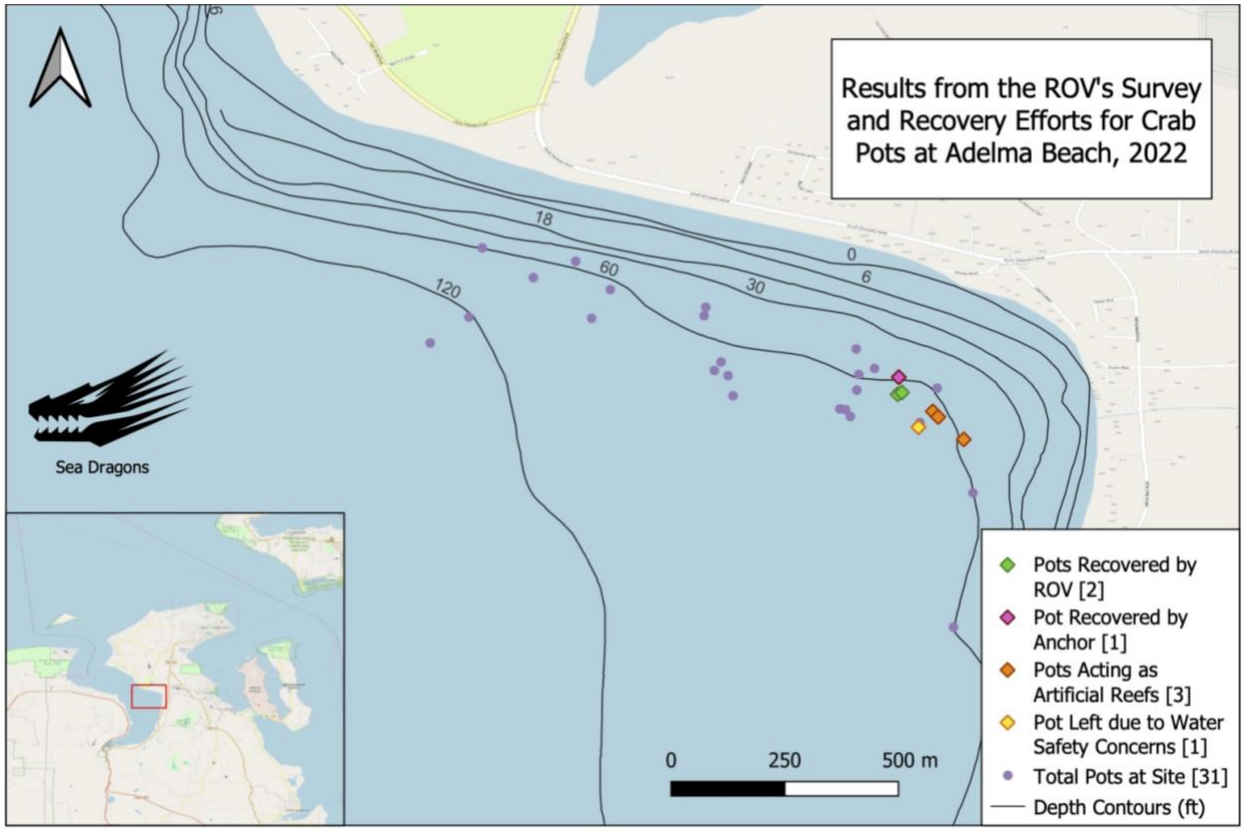
40	48.0848775	-122.88864	151.7
41	48.0850792	-122.88876	163.5
42	48.0847119	-122.88724	94.5
43	48.0851556	-122.88701	100.6
44	48.0859098	-122.88744	143
45	48.0855449	-122.88847	167.8
46	48.086177	-122.88691	130.7
47	48.086367	-122.88709	143.9
48	48.0864284	-122.88725	153.1
49	48.086496	-122.8873	157.6
50	48.085474	-122.88528	56.8
51	48.0865223	-122.88696	143.7
52	48.0866779	-122.88679	140.5
53	48.0859228	-122.88539	71.7
54	48.0868444	-122.88638	130.1
55	48.0864402	-122.88467	64.3
56	48.0871916	-122.88649	147.4
57	48.0874332	-122.88644	153.5
58	48.0874625	-122.88661	161.2
59	48.0875676	-122.88551	125.1
60	48.0879917	-122.88535	133
61	48.0881854	-122.88528	135.9
62	48.0880694	-122.88515	128.9
63	48.0878735	-122.88379	70.5
64	48.0887254	-122.88533	154.7
65	48.0901182	-122.88505	183.7
66	48.0902002	-122.88502	182.8
67	48.0901558	-122.88455	165.7
68	48.0901281	-122.88336	107.9
69	48.0911772	-122.88456	189.1
70	48.0910139	-122.88467	186.5
71	48.0910104	-122.88396	173.4
72	48.09093	-122.8837	154.1
73	48.0918173	-122.88385	181.8
74	48.0919194	-122.88183	66.5
75	48.0812698	-122.8906	137
76	48.0815497	-122.88997	96.3
77	48.0816391	-122.88923	56.9
78	48.0815358	-122.88911	47.4
79	48.0814828	-122.88903	43.1
80	48.0814859	-122.88907	43.9
81	48.0814178	-122.88919	44.8
82	48.0815583	-122.88888	41.5
83	48.0819185	-122.89041	134.2
84	48.0819004	-122.89035	130.5

85	48.0825815	-122.88905	86.2
86	48.0826521	-122.88937	102.9
87	48.0826181	-122.88881	78.1
88	48.0842589	-122.88667	61.2
89	48.0847018	-122.88757	105
90	48.0848161	-122.88552	42
91	48.0857628	-122.8859	82.9
92	48.086203	-122.88514	72.1
93	48.087056	-122.88379	45.2
94	48.0872996	-122.88509	102.3
95	48.0885557	-122.88426	105.5
96	48.0899562	-122.88365	115.9
97	48.0912058	-122.88288	103
98	48.0917307	-122.88263	103.9
99	48.0915718	-122.88293	111.8
100	48.0909508	-122.88175	51.4
101	48.0921315	-122.88222	92.6
102	48.0928813	-122.88209	90.5
103	48.0946388	-122.88144	30.2
104	48.0941767	-122.88237	96.2
105	48.0961564	-122.8834	121.2
106	48.0962062	-122.88338	122.3
107	48.0974697	-122.88543	167.2
108	48.0985033	-122.88473	103.2
109	48.0995689	-122.88317	20.4
110	48.0942552	-122.88342	162.7
111	48.0936637	-122.8833	172
112	48.0940206	-122.8837	183
113	48.094015	-122.88299	147.5
114	48.0931574	-122.88254	119.3
115	48.0916732	-122.88214	79.3
116	48.0916254	-122.88165	53.7
117	48.091975	-122.88404	191.1
118	48.0918395	-122.88393	185.8
119	48.09148	-122.88257	94.3
120	48.0902184	-122.8835	116.6
121	48.090264	-122.88387	133.3
122	48.0903938	-122.88415	153.2
123	48.0906411	-122.88431	168.5
124	48.0896733	-122.88489	173.7
125	48.0845435	-122.88599	48.3
126	48.0818857	-122.88872	48.3

Table 3: Number of pots at various depth ranges near Adelma Beach and Cape George, Discovery Bay

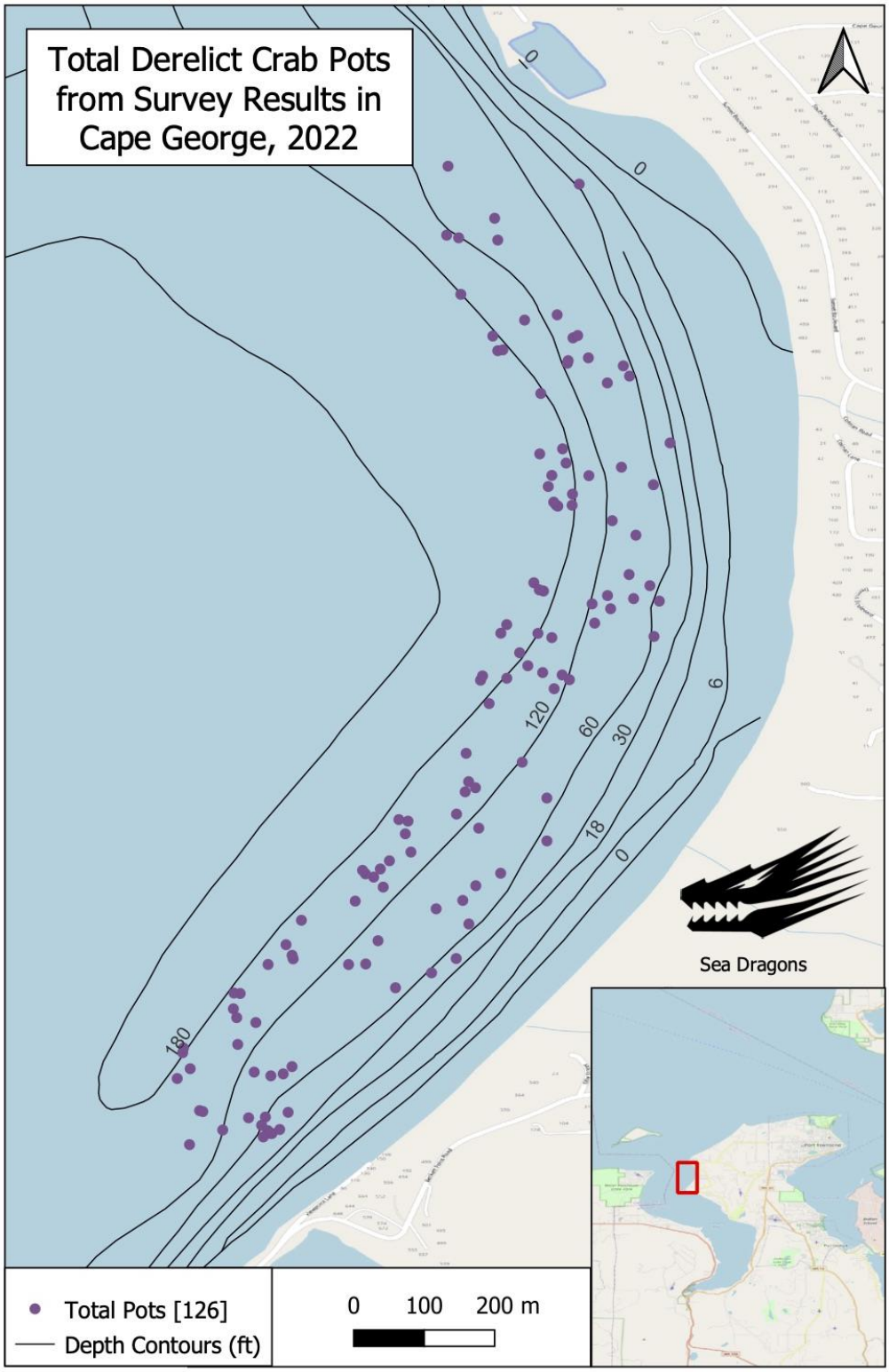
Depth Range (ft)	Pots Near Adelma Beach	Pots Near Cape George
0 – 50	4	11
50.1 – 105	25	39
105.1 – 150	2	31
150.1 – 200	0	45
Total	**31**	**126**
		Grand Total: 157

Figure 5: Map of recovered and remaining derelict crab pots located near Adelma Beach. Of the 31 pots detected, a total of 3 pots were recovered (2-green, 1-pink) and 28 pots remain (3-orange, 1-yellow, 24-purple).



Map created by the Sea Dragons

Figure 6: Map of derelict crab pots located between Cape George Marina and Beckett Point, Discovery Bay. A total of 126 potential derelict crab pots were detected. No pots were recovered from this site.



Map created by the Sea Dragons

Figure 7: Image from the ROV of a derelict crab pot left in place as it appeared to no longer be fishing and instead functioning as artificial reef, near Adelma Beach

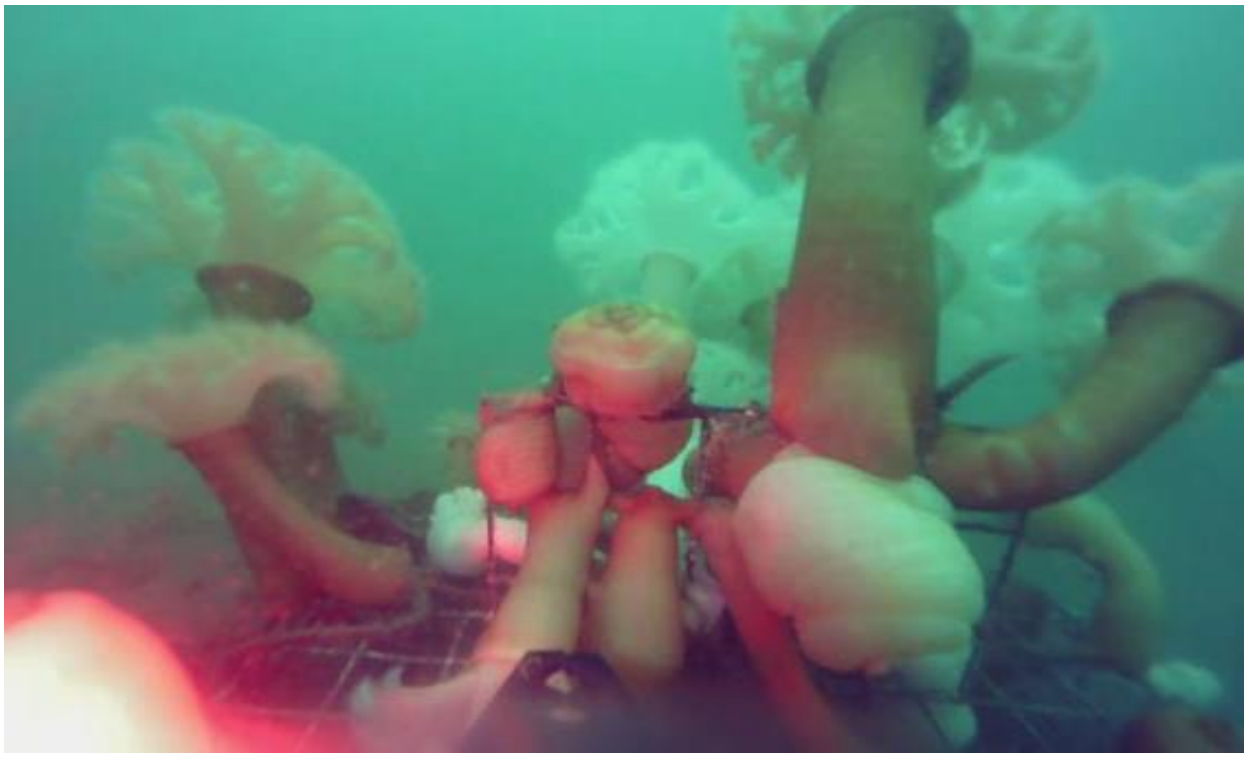


Figure 8: Image from the ROV of the first derelict crab pot recovered, with live and dead Dungeness crab entrapped, near Adelma Beach

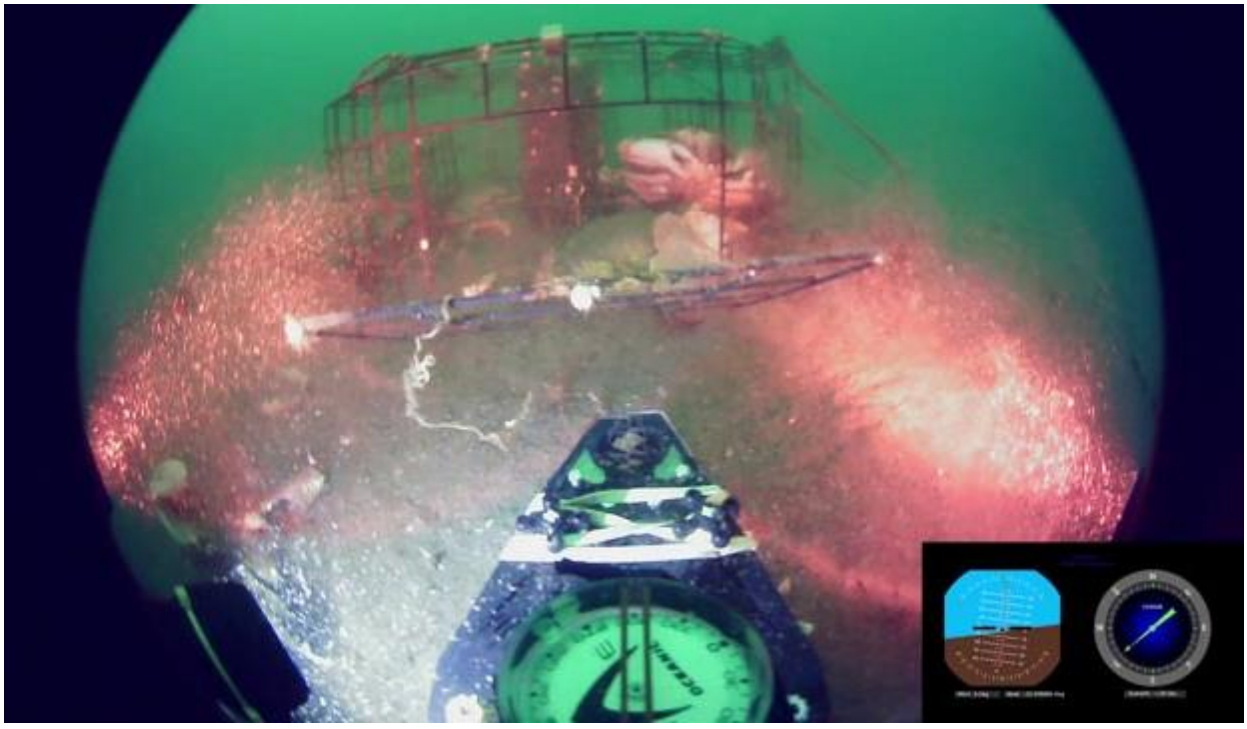


Table 4: Number of live and dead organisms encountered in 3 derelict crab pots recovered near Adelma Beach, Discovery Bay between May 1, 2022 and June 30, 2022

Species Common	Species Scientific	Alive	Dead	Total
mottled sea star	*Evasterias troschelii*	11	-	11
Dungeness crab	*Cancer magister*	2	2	4
lyre crab	*Hyas lyratus*	3	-	3
red rock crab	*Cancer productus*	1	-	1
	Total	**17**	**2**	**19**