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FINAL REPORT

LONG-TERM HABITAT MONITORING

PREPARED FOR:

NORTHWEST STRAITS INITIATIVE

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Introduction

Abandoned, lost and discarded fishing gear can present safety, liability, nuisance and environmental impact issues in marine waters. Identification, location and safe removal of derelict fishing gear (DG) can reduce these impacts. The Northwest Straits Initiative (NWSI) teamed with the National Oceanic and Atmospheric Administration (NOAA) and the Washington Department of Fish and Wildlife (WDFW) to address the issue of DG in Puget Sound and the Strait of Juan de Fuca. The result of this project is a comprehensive program to safely remove DG from the marine environment in an environmentally acceptable manner. WDFW composed guidelines for DG removal in Washington marine waters based on the NOAA/NWSC project.

These guidelines have been used in DG removal on Puget Sound waters since 2002. During this time over 1,000 derelict nets and 1,707 crab pots have been removed covering approximately 240 acres of seabed thereby preventing further entanglement and mortality of marine mammals, seabirds, fish and invertebrates. However, the overall impact of DG goes beyond impacts to animal life. Evidence shows that DG also negatively impacts marine habitat service functions such as denial of access to habitats, sediment accumulation, scouring, blocking of eelgrass growth, etc.

Studies to quantify the long-term impact of DG on marine habitats in the Puget Sound have not been conducted. The study had three objectives. First was to observe and document the impacts of derelict nets and crab pots on different marine habitats. The second was to monitor the recovery of these marine habitats immediately after DG removal, at six months and after one year. The third objective was to monitor the long-term monitoring sites for any newly deposited DG to estimate deposition rates. Gaining this knowledge significantly increases our understanding of the immediate and long-term positive results of habitat restoration from DG removal.

Methods

Using the DG master database provided by the Washington Department of Fish and Wildlife (WDFW), four derelict gillnets and one derelict crab pot were chosen for the project (Figure1). The selection of derelict gillnets was based on habitat type, net size, location and water depth (Table 1). Each net chosen differed in at least two of these categories, allowing the examination of impacts from DG on a variety of Puget Sound and San Juan Island representative habitats. One representative habitat was selected for a derelict crab pot portion of this study at Gedney Island in shallow water (23 ft deep) on sand/mud substrate with eelgrass (*Zostera* sp.) present (Table 1).

For each of the chosen DG, the initial dive consisted of an overall survey of the fishing gear including measurement of the size of impacted habitat area and determination of the nature of the impact. The DG was documented through diver reports for each dive via two-way radio communications, post-dive descriptions and analysis of underwater video footage.

Once the affected area was identified, the divers delineated the area with weighted yellow poly rope. Divers and recovery vessel then proceeded to remove the DG from the seafloor using WDFW approved standard procedures including documenting the size of the gear, age, lethality characteristics and identifying entangled marine life. Immediately after DG removal the impacts of DG and removal process on the habitat was documented by diver descriptions and underwater video, including a thorough assessment of the adjacent, unaffected habitat for baseline (control) comparison. Subsequent surveys took place at each net location approximately six months and one year after DG removal to monitor using the same techniques to document habitat recovery. Figures 2 through 6 provide examples of underwater video frames from a typical net location (LTM#3) showing the net on the seabed (Figure 2), the unaffected control area (Figure 3), the net affected area immediately after net removal (Figure 4), approximately six months after net removal (Figure 5) and approximately one year post-net removal (Figure 6). The derelict crab pot location was monitored once, approximately four months after removal (Table 2).

Diver Reports

During the post-removal monitoring dives, an onboard biologist documented all diver observations. Divers indicated whether or not the DG affected area could be readily distinguished visually from the surrounding unaffected control habitat. Divers reported the relative size, abundance and species diversity of marine plants, sessile invertebrates, mobile invertebrates and fish and took underwater video within the DG affected area and in adjacent unaffected habitat at each long-term monitoring location. Divers attempted to cover as much of the DG affected area as possible and obtain a representative sample of the unaffected area during each sampling period. Divers inspected the overall removal area for any newly deposited DG on each monitoring dive.

Video Tape Review

Videotapes were reviewed by a biologist to gather qualitative information on each of the chosen long-term monitoring sites. Three to seven video segments, each 20 to 90 seconds long were randomly selected from video footage taken during each of the three time periods (immediate post-net removal, six months and one year) for each of the net affected and unaffected habitats. The biologist attempted to assess relative abundance of plants and animals (in general species groups) within the affected and unaffected habitats. Relative abundance indices (1=absent or rare, 2=moderately abundant and 3=abundant) were assigned to each of four general species groups; (1) kelp/seaweed/hydroids, (2) sessile invertebrates, (3) mobile invertebrates and (4) fish. Abundance scores were averaged over all samples reviewed for each species group and across species groups for a total average plant and animal index value by affected and unaffected area and sampling time period. Average abundance index scores were compared between affected and unaffected areas and over sampling periods for each of the four long-term habitat monitoring areas and across all habitat areas. Changes in the difference between affected and unaffected habitat area scores over time provided a qualitative measure of habitat recovery or lack of recovery after net removal.

A second qualitative assessment of habitat recovery was conducted by a biologist reviewing random video clips from each long-term monitoring site and valuating which video clips were from DG affected or unaffected areas. The biologist was provided information on which long-term monitor site clips represented but not the sampling period or whether the clips were from the DG affected area or the adjacent unaffected control area. Five to ten video clips each ranging from 30 to 90 seconds in length were selected for the best video quality. It was assumed that if sufficient difference existed in the general appearance and species abundance between the DG affected area and the control area the biologist should be capable of discerning the correct identity of the area in each video clip (C=control and NA=net affected). If DG affected habitats recovered over the study period, the differences in the general appearance between the DG affected area and the control should diminish and it should be more difficult for the biologist to correctly guess the identity of each area.

At the derelict crab pot monitoring site, the divers reported on changes in the depth of seabed scour near the pot, reported on changes in eelgrass density inside and outside the DG affected area and reported on habitat use by invertebrates and fish. A biologist reviewed the pre-removal, immediate post-removal and four-month sampling video of the DG affected and unaffected eelgrass habitat and estimated habitat recovery.

Results

Diver Reports

Divers reported that there were dramatic differences in the DG affected habitat compared with the surrounding unaffected or control areas immediately after DG removal in all areas studied. Certainly some of the habitat impacts were due to the actual physical removal of the derelict net. Plants and sessile animals grow on and nearby the derelict gear and are removed and/or dislodged during derelict gear recovery operations. However, divers routinely report that derelict nets tend to move with the tide and current effectively sweeping plants and sessile animals from the seabed. In some cases, derelict nets may be secured to the bottom at one end but sweep in an arc 40 to 60 feet along the seabed on the other end, entangling animals encountered and preventing sessile plants and animals from attaching to the seabed.

At each of the four long-term derelict net monitoring sites divers reported that the DG affected area was very obvious from the surrounding unaffected habitat. The main difference in the affected area was the lack of attached kelp, sessile animals and the presence of essentially bare rock, gravel and sand under where the derelict net had been located. Fish densities tended to be somewhat higher in the DG affected areas than in the adjacent unaffected control areas immediately after DG removal, probably due to a feeding attraction on dislodged prey items.

At the derelict crab pot site, a 3ft wide by 5ft long scour hole approximately 1 foot deep had developed behind the derelict pot and was devoid of eelgrass as was the area immediately under the crab pot. These scour areas are observed fairly frequently next to derelict crab pots in Puget Sound and are believed to be caused by tidal currents creating a vortex to one side of the pot eroding out the seabed. Once the derelict pot was removed the divers reported an obvious area with almost no eelgrass at the pot location and in the depression behind the pot compared with abundant eelgrass in the adjacent area not affected by the derelict pot.

In January and February of 2008, approximately six months after the initial net removals, monitoring dives were conducted at each of the four derelict net locations. Divers again described the general condition of the DG affected and unaffected areas and reported on whether the net affected areas were easily discernable from the surrounding unaffected habitats. Divers also took underwater video in both the net affected and unaffected areas.

Approximately six months (208 days) after net removal, divers monitoring LTM #1 on Lopez Island in January 2008, reported a greater abundance of sea cucumbers (*Parastichopus californicus*), green sea urchins (*Strongylocentrotus droebachiensis*) and smooth pink scallops (*Chlamys rubida*) within the DG affected area than in the surrounding unaffected area. However, divers reported that the net affected area remained obviously different from the unaffected area mainly due to a lack of kelp, encrusting algae, sponges or corals and somewhat fewer sessile invertebrates and fish than in the surrounding unaffected.

At LTM #2 off Foulweather Bluff the six-month (165 days) monitoring dive was conducted in January 2008. Divers reported little, if any, habitat recovery in the net affected areas and the net affected area remained obviously different from the unaffected area mainly due to a lack of kelp and sessile animals.

At LTM#3 off Eagle Point, San Juan Island, the six-month (175 days) monitoring dive was conducted in early February 2008. Divers reported no indication of habitat recovery mainly due to a lack of kelp and sessile animals but the abundance of sea cucumbers and green sea urchins appeared to be somewhat higher in the net affected area than in the unaffected control area, although the lack of kelp may have made the animals easier to see than in the unaffected area that had abundance kelp growth. The net affected area remained obviously different than the adjacent unaffected control area.

At LTM#4 off Cattle Point, San Juan Island, the six-month (175 days) monitoring dive was also conducted in early February 2008. Divers reported no indication of habitat recovery again mainly due to a lack of kelp and sessile animals. The net affected area remained obviously different than the adjacent unaffected control area.

Approximately one year (454 days) after net removal in September 2008, divers monitoring LTM#1 reported significant habitat recovery in the net affected area.

Divers reported that the DG affected area was obvious from the unaffected control area but mainly due to the reduced height of the ribbon kelp (*Alaria marginata*) within the DG affected area. Densities of ribbon kelp, encrusting animals, sessile and mobile invertebrates and fish were similar in the DG affected and unaffected areas.

At LTM#2 off Foulweather the one-year (408 days) monitoring dive was conducted in September 2008. Divers reported extensive patches of ribbon kelp and some bull kelp (*Nereocystis luetkeana*) in the net affected area. The density of bull kelp was lower in the DG affected area but the density of ribbon kelp was similar to the adjacent unaffected control area. The reduced height of the ribbon kelp was obvious in the DG affected area but the relative abundances of sessile and mobile invertebrates and fish were similar. Divers were capable of distinguishing the net affected area from the unaffected control area.

At LTM#3 off Eagle Point on San Juan Island, the one-year (391 days) monitoring dive was conducted in September 2008 and divers reported that it was extremely difficult to distinguish the DG affected area from the unaffected control area. One side of the yellow marker rope was missing and the divers were unable to determine the boundary between the net affected habitat and the unaffected control habitat. Divers reported that the densities and sizes of both ribbon and bull kelp were similar in the net affected and control areas. The bare rock that had been exposed immediately after net removal and was still evident at the six-month sampling period was completely encrusted in algae and small sponges. Sessile invertebrates, primarily anemones (*Metridium* sp.), Puget Sound king crab (*Lopholithodes mandtii*) and juvenile rockfish (*Sebastes sp.*) were observed to be equally abundant in both the net affected and unaffected control areas.

At LTM#4 off Cattle Pass, San Juan Island the one-year (391 days) monitoring dive was conducted in September 2008. Divers reported the DG affected area remained somewhat discernable from the control area mainly due to the lower height of the ribbon kelp in the net affected area. Divers noted that the densities of ribbon kelp attached to the seabed were similar in both areas, previously bare rock in the net effected area was essentially covered by encrusting organisms and green sea urchins (*Strongylocentrotus droebachiensis*) and sea cucumbers were equally abundant in both areas. Divers noted that fish, primarily kelp greenling (*Hexagrammos decagrammus*) and juvenile rockfish, appeared to be more abundant in the net affected area than in the unaffected control area.

At LTM#5, the derelict crab pot site off Gedney Island, divers conducted a single monitoring dive approximately 4 months (108 days) after the derelict pot was removed. Divers reported the 1-foot deep scour area behind the pot location had completely filled in with a mixture of sand and mud substrate and was level with the surrounding seabed. The location of the removed crab pot and the scour area was still obvious, due mainly to a lower density of eelgrass within the pot affected area. However, divers reported that eelgrass shoots were present within the pot affected area along the edge of the unaffected area. Divers observed that new eelgrass plants were mainly the result of eelgrass plants growing from the roots of established plants in the unaffected control area that were spreading into the edges of the pot affected area. The divers estimated the size of the pot affected area had decreased by one foot in width (from 3 ft to 2 ft) along the 5 ft length of pot scour area, a partial restoration of 30% of the habitat.

Video Tape Review

A total of 125 video clips with a total length of 86 minutes and 13 seconds were reviewed from the four net affected and adjacent control areas over the three sampling periods. Indices of relative abundance (1=absent or rare, 2=moderately abundant and 3=abundant) of four habitat parameters (kelp/seaweed/hydroids, sessile invertebrates, mobile invertebrates and fish) were scored from video clips in both the net affected and control areas immediately after net removal, after approximately six months and approximately one year of recovery. Although subjective, the data suggests that the abundance of plants and animals was generally lower in the net affected area than in the unaffected control area immediately after net removal and six months after net removal but 85 to 97% habitat recovery had occurred after one year.

At each of the four long-term habitat monitoring sites, the relative abundance of the four species groups was lower in the net affected area than in the unaffected control area immediately after net removal (Table 3). Only fish were more abundant in the net affected area than the control area at LTM#1 immediately after net removal and they were probably attracted by the availability of prey items dislodged during the net removal operations. The average abundance index value for the net affected areas at the four monitoring sites was 1.34 (range 1.21 to 1.60) compared with 2.26 (range 2.06 to 2.60) for unaffected control areas. Differences in relative abundance between the net affected areas and the control areas were larger for the kelp/seaweed/hydroid and sessile invertebrate groups than for the mobile invertebrate and fish groups. Overall average percent differences in relative abundant among the four species groups between net affected areas and control areas immediately after net removal ranged from 38% at LTM#3 to 46% at LTM#2 and averaged 41% over all four monitoring sites.

Approximately six months after net removal, the average relative abundance index for the four species groups over the four long-term monitoring site was identical to the immediate post-net removal period for the unaffected control area with an average score of 2.26 (range 2.0 to 2.54) but increased about 15% for the net affected area from 1.34 (range 1.21 to 1.60) immediately after net removal to 1.55 (range 1.30 to 1.90) (Table 3). Generally, the largest differences in relative abundance indices between the net affected area and the control area among the four sites continued to be in the kelp/seaweed/hydroid and sessile invertebrate groups. Average overall percent differences in relative abundant among the four species groups between net affected areas and control areas decreased somewhat but still ranged from 25% at LTM#3 to 37% at LTM#2 and averaged 31% over all four monitoring sites.

Approximately one year after net removal, the average relative abundance index for the four species groups over the four long-term monitoring site was 2.64 (range 2.50 to 2.88) for the unaffected control area up 17% from the 2.26 relative abundance index scored immediately after net removal and six months after net removal (Table 3). The average relative abundance index over the four species groups and four monitoring sites for the net affected area (avg. 2.47 range 2.15 to 2.71) an increase of 59% over the 1.55 value at six months after net removal and 97% over the 1.34 value immediately after net removal. The largest increases in relative abundance indices in the net affected area among the four species groups occurred in the kelp/seaweed/hydroid (101%) and sessile invertebrate species groups (83%) between the six-month sampling period and the one-year sampling period. Average overall percent differences in the four monitoring sites in relative abundant among the four species groups between the net affected areas and control areas decreased to an averaged of 6 % with a range of 3% at LTM#4 to 14% at LTM#1.

The relative abundance scoring for the four species groups at each of the four derelict net removal monitoring sites indicates that there was an immediate negative impact on the net effected habitat at each monitoring site and little habitat recovery after six months but near complete habitat recovery after one year. The greatest improvement occurred in the relative abundance of kelp/seaweed/hydroid and sessile invertebrate abundance but increases in mobile invertebrate abundance and fish use of the net affected area also occurred, particularly after one year post-net removal.

A total of 94 video clips totaling 59 minutes and 32 seconds were reviewed without knowing whether they were taken from net affected areas or unaffected control areas. The reviewer was aware of from which long-term monitor areas the video clips were taken but not the monitoring time period. The reviewer was allowed to review each clip once and then make an assessment of whether the clip was taken in a net affected area or in an unaffected control area. The results were grouped by long-term monitor site and monitoring period and the number of correct versus incorrect estimates tallied.

Immediately after net removal over all four monitoring sites, the reviewer correctly identified 30 (88%) and incorrectly identified the location of 4 (12%) out of 34 video clips reviewed (Table 4). For LTM#3 and LTM#4, the reviewer correctly identified the location of all of the video clips. For the other two monitoring locations, the reviewer incorrectly identified the location of 2 out of eight video clips at LTM#1 and two out of 10 video clips at LTM#2. Out of the four errors made from clips taken immediately after net removal, three errors occurred when the reviewer mistook unaffected control habitat for net affected habitat and only once when net affected habitat was mistaken for control habitat.

The reviewer correctly identified 23 (92%) and incorrectly identified 2 (8%) the locations of 25 video clips taken approximately six months after net removal at the four monitoring sites (Table 4). For LTM#1 and LTM#2 all of the clips reviewed were correctly identified and there was one incorrect identification each on LTM#3 and LTM#4, in both cases video clips shot in the unaffected control areas were incorrectly identified as being from the net affected areas.

Of the 35 video clips reviewed from the four monitoring sites taken approximately one year after net removal the reviewer identified the location of 17 (49%) video clips correctly and 18 (51%) incorrectly. The reviewer incorrectly identified the majority of the video clip locations at LMT#2 (five out of nine incorrect) and LTM#3 (seven out eleven incorrect), had equal correct and incorrect location identifications (three out of six) at LTM#1 and correctly identified the location of six out of nine video clips at LTM#4. The reviewer indicated that many of the identifications were simple guesses and the video clips from the net affected and unaffected control areas were nearly impossible to differentiate.

Video tape review of LTM# 5, the derelict crab pot location, supported the divers report of some habitat recovery four months after pot removal. Although the pot location and the 3 x 5 ft scour area behind the pot were obvious in the video tapes reviewed immediately after pot removal due to lack of eelgrass and the darker color of the sediment, it was difficult to accurately estimate the degree of eelgrass recovery four months after removal from video tape clips. The filling of the scour hole reported by the divers was not obvious from the video tape, although, the sediment color was uniform through both the pot affected and unaffected areas. Although it was not possible to compare counts of eelgrass plants from the two monitoring periods using the video tapes, both the pot location and the scour area appeared smaller in the video clips reviewed taken four months after pot removal. Diver counting eelgrass plants via a standardized grid inside and outside of the pot affected area during both monitoring periods would have been a preferable method to assess eelgrass habitat recovery.

Divers found no new derelict fishing gear at the four net monitoring sites or at the derelict crab monitoring site during the study.

Conclusion

All three methods of assessing habitat recovery employed in the study (diver reports, video review of species abundance, and video clip review for net affected and control source location) provided corroborating evidence that marine habitats are negatively impacted by the presence and removal of derelict fishing gear but nearly complete habitat recovery probably occurs within one year or one marine growing season after DG removal.

The impacts of derelict fishing gear are many and varied depending upon the type of fishing gear lost and the type of habitat impacted. Derelict nets can cover marine habitats denying access to marine plants and animals. Derelict nets and leadlines can sweep the bottom or strum in place dislodging encrusting organisms and sessile animals. Exposed nets and operating crab pots can entangle or capture and kill target and non-target species. Divers report derelict nets accumulate soft sediments that suffocate underlying organisms. Derelict crab pots can impede eelgrass growth and currents around derelict pots can scour the seabed dislodging eelgrass in a far greater area than the pot footprint alone. Derelict gear induced negative habitat impacts probably result in reduced service functions within these habitats. Although some habitat damage likely occurs during derelict net removal operations as living plants and animals on the nets are dislodged or removed with the derelict gear, based on the results of this study substantial habitat recovery probably occurs with one year of derelict gear removal.

Although changes in the service functions of the habitat were not directly measured in the study, changes in relative abundance of the four species groups assessed probably reflects changes in value of these service functions over the habitat recovery period. Based on divers observations and reviews of underwater video, the difference between species abundance in the net affected areas and the unaffected adjacent control areas decreased from 41% immediately after net removal to 31% six months post-net removal to 6% one year after net removal.

Divers reported partial habitat recovery in shallow water eelgrass habitat four months after derelict crab pot removal. The current scour depression behind the pot had completely filled in with sediment, leveling the seabed with the surrounding habitat and eelgrass from the adjacent unaffected habitat had spread into the affected area decreasing the obvious pot impact area by about 30%. The area surrounding the pot affected habitat had high eelgrass density and based on the partial recovery in the pot affected area after four months, it is likely the pot affected area will make a full recovery after several growing seasons.

Seasonality may have had an influence on the timing of habitat recovery in the study. The derelict nets were removed between late June and late August 2007. The six month post-net removal monitoring was conducted in January and early February 2008 during winter when marine plant growth is minimal. The one year post-net removal monitor was conducted in September 2008, at the end of the summer when marine plants had a full season of growing opportunity in the net affected areas. It is possible that some habitat recovery from derelict fishing gear removal may occur in less than one year if removal operations are carried out prior to the start of the spring/summer growing season.

Divers found no additional lost fishing gear at any of the sites during the monitoring dives supporting fisher's and fishery managers' observations that many fewer nets are presently being lost in Puget Sound and San Juan Islands due to reductions in fishing effort and improvements in equipment and methods.

Recommendations

Further research such as this would prove beneficial particularly if larger areas of habitat over several years were monitored. Considering the NWSI estimates there are thousands of derelict nets covering potentially 1,000s of acres of diverse habitats in Washington waters and thousands of derelict crab pots in shallow waters where eelgrass may be present, this study adds undeniable evidence of the importance of DG removal and subsequent natural habitat recovery. The absence of newly lost fishing gear during the project supports the hypothesis that most of the derelict fishing gear (particularly nets) problem in Washington State is a legacy issue from the 1950s through the 1980s when most of this gear was lost. With the reduction in net fishing effort, improvements in gear and methods and a no-fault lost gear reporting program in place, future net loss and impacts should be minimal and the removal of this historical derelict fishing gear will make an immediate and permanent improvement to the marine habitat in Washington State.

Table 1: Derelict gear chosen for habitat monitoring, locations, minimum and maximum depth (feet), type of habitat, length and width (feet) and descriptions.

GEAR ID	GEAR TYPE	LOCATION	LAT(N)	LONG(W)	DEPTH MIN(ft)	DEPTH MAX(ft)	HABITAT	LENGTH(ft)	WIDTH(ft)	DESCRIPTION
3969	Gillnet	Lopez Island	4824.999	12250.535	52	77	Moderate relief, rocky reef	1000	60	LT MONITOR #1
3974	Gillnet	Foulweather Bluff	4756.769	12237.007	41	45	Low relief, rock, gravel and kelp	500	80	LT MONITOR #2
3957	Gillnet	San Juan Is., Eagle Point	4827.452	12302.165	57	85	High relief, rocky reef face near kelp forest	300	50	LT MONITOR #3
3971	Gillnet	San Juan Is., Cattle Point	4826.971	12300.282	41	90	Large boulders on sand slope	1000	80	LT MONITOR #4
4602	Crab Pot	Port Gardner, Gedney Is.	4800.651	12218.467	23	23	Sand, mud, eelgrass	NA	NA	LT MONITOR #5. Crab pot with eroded hole behind it.

Table 2: Survey intervals for the chosen habitat locations.

LTM#1 GEAR ID 3969	Survey Date	6/21/2007 Net removal and initial survey	1/15/2008 ≈6 month survey	9/17/2008 ≈1 year survey
	Elapsed time since net removal (days)		208	454
	Elapsed time since 6 month survey (days)			246
LTM#2 GEAR ID 3974	Survey Date	8/7/2007 Net removal and initial survey	1/19/2008 ≈6 month survey	9/18/2008 ≈1 year survey
	Elapsed time since net removal (days)		165	408
	Elapsed time since 6 month survey (days)			243
LTM#3 GEAR ID 3957	Survey Date	8/23/2007 Net removal and initial survey	2/14/2008 ≈6 month survey	9/17/2008 ≈1 year survey
	Elapsed time since net removal (days)		175	391
	Elapsed time since 6 month survey (days)			216
LTM#4 GEAR ID 3971	Survey Date	8/23/2007 Net removal and initial survey	2/14/2008 ≈6 month survey	9/17/2008 ≈1 year survey
	Elapsed time since net removal (days)		175	391
	Elapsed time since 6 month survey (days)			216
LTM#5 GEAR ID 4602	Survey Date	6/25/2008 Pot removal and initial survey	10/11/2008 ≈4 month survey	N/A
	Elapsed time since pot removal (days)		108	N/A

Table 3: Average relative abundance index scores for four groups of plants and animals in net affected and adjacent control areas at four long-term habitat monitor sites immediately after derelict net removal, six months and one year. (abundance indices are 1=absent of rare, 2=moderately abundant and 3=abundant).

					Average Score					
LTM	Period	Category	# Samples	Total Time (sec)	Kelp/Seaweed/ Hydroid	Sessile Inverts	Mobile Inverts	Fish	Total	% Diff
1	Immediate Post-Removal	Control	4	195	2.50	2.25	2.25	1.25	2.06	
		Net Area	4	167	1.25	1.00	1.25	1.50	1.25	
		Difference			1.25	1.25	1.00	-0.25	0.81	39%
	6-Month Post-Removal	Control	3	107	1.67	2.00	2.67	1.67	2.00	
		Net Area	5	121	1.00	1.20	1.60	1.40	1.30	
		Difference			0.67	0.80	1.07	0.27	0.70	35%
	1-Year Post-Removal	Control	6	211	2.67	2.67	2.50	2.17	2.50	
		Net Area	5	174	2.40	2.60	2.00	1.60	2.15	
		Difference			0.27	0.07	0.50	0.57	0.35	14%
2	Immediate Post-Removal	Control	7	354	2.57	2.86	2.14	1.43	2.25	
		Net Area	6	284	1.17	1.00	1.50	1.17	1.21	
		Difference			1.40	1.86	0.64	0.26	1.04	46%
	6-Month Post-Removal	Control	4	170	2.50	2.50	2.00	1.75	2.19	
		Net Area	4	183	1.00	1.25	1.75	1.50	1.38	
		Difference			1.50	1.25	0.25	0.25	0.81	37%
	1-Year Post-Removal	Control	5	238	2.80	2.60	2.40	2.20	2.50	
		Net Area	5	236	2.60	2.60	2.40	2.00	2.40	
		Difference			0.20	0.00	0.00	0.20	0.10	4%
3	Immediate Post-Removal	Control	5	152	3.00	2.60	2.40	2.40	2.60	
		Net Area	5	180	1.20	1.60	1.60	2.00	1.60	
		Difference			1.80	1.00	0.80	0.40	1.00	38%
	6-Month Post-Removal	Control	6	230	2.83	2.67	2.33	2.33	2.54	
		Net Area	5	242	1.60	1.80	2.20	2.00	1.90	
		Difference			1.23	0.87	0.13	0.33	0.64	25%
	1-Year Post-Removal	Control	4	207	3.00	2.75	3.00	2.75	2.88	
		Net Area	7	267	2.71	2.86	2.57	2.71	2.71	
		Difference			0.29	-0.11	0.43	0.04	0.17	6%
4	Immediate Post-Removal	Control	6	265	3.00	2.33	1.67	1.50	2.13	
		Net Area	6	206	1.33	1.33	1.33	1.17	1.29	
		Difference			1.67	1.00	0.33	0.33	0.84	39%
	6-Month Post-Removal	Control	6	237	2.83	2.83	1.83	1.67	2.29	
		Net Area	6	248	1.50	1.67	1.83	1.50	1.63	
		Difference			1.33	1.17	0.00	0.17	0.66	29%
	1-Year Post-Removal	Control	6	273	3.00	2.67	2.67	2.33	2.67	
		Net Area	5	231	2.60	2.80	2.60	2.40	2.60	
		Difference			0.40	-0.13	0.07	-0.07	0.07	3%
All	Immediate Post-Removal	Control	22	966	2.77	2.51	2.11	1.64	2.26	
		Net Area	21	837	1.24	1.23	1.42	1.46	1.34	
		Difference			1.53	1.28	0.69	0.19	0.92	41%
	6-Month Post-Removal	Control	19	744	2.46	2.50	2.21	1.85	2.26	
		Net Area	20	794	1.28	1.48	1.85	1.60	1.55	
		Difference			1.18	1.02	0.36	0.25	0.70	31%
	1-Year Post-Removal	Control	21	929	2.87	2.67	2.64	2.36	2.64	
		Net Area	22	908	2.58	2.71	2.39	2.18	2.47	
		Difference			0.29	-0.04	0.25	0.18	0.17	6%

Table 4: Number of correct and incorrect assessments of whether video clips were of net affected or adjacent control areas at four long-term habitat monitor sites immediately after derelict net removal, six months and one year. (assessment codes C=control area, NA=net affected area).

LTM #1

Immediate Post-Removal			Six Month Post-Removal			One Year Post-Removal		
Clip #	Guess	Correct (+) Incorrect (-)	Clip #	Guess	Correct (+) Incorrect (-)	Clip #	Guess	Correct (+) Incorrect (-)
1	C	+	1	NA	+	1	C	-
2	NA	+	2	C	+	2	C	+
3	C	+	3	C	+	3	C	+
4	C	-	4	C	+	4	NA	-
5	NA	+	5	NA	+	5	NA	+
6	C	+		Correct	5	6	NA	-
7	NA	+		Incorrect	0		Correct	3
8	C	-					Incorrect	3
	Correct	6						
	Incorrect	2						

LTM#2

Immediate Post-Removal			Six Month Post-Removal			One Year Post-Removal		
Clip #	Guess	Correct (+) Incorrect (-)	Clip #	Guess	Correct (+) Incorrect (-)	Clip #	Guess	Correct (+) Incorrect (-)
1	NA	+	1	NA	+	1	NA	+
2	NA	+	2	C	+	2	C	-
3	C	+	3	NA	+	3	NA	-
4	C	+	4	C	+	4	C	-
5	NA	+	5	C	+	5	C	+
6	C	-	6	NA	+	6	C	-
7	NA	+		Correct	6	7	NA	+
8	C	+		Incorrect	0	8	NA	+
9	NA	+				9	NA	-
10	NA	-					Correct	4
	Correct	8					Incorrec	5
	Incorrect	2						

LTM#3

Immediate Post-Removal			Six Month Post-Removal			One Year Post-Removal		
Clip #	Guess	Correct (+) Incorrect (-)	Clip #	Guess	Correct (+) Incorrect (-)	Clip #	Guess	Correct (+) Incorrect (-)
1	NA	+	1	C	+	1	NA	-
2	NA	+	2	C	+	2	C	-
3	C	+	3	NA	+	3	NA	-
4	C	+	4	NA	+	4	NA	+
5	NA	+	5	C	-	5	C	-
6	C	+	6	NA	+	6	C	+
7	NA	+		Correct	5	7	C	+
8	C	+		Incorrect	1	8	C	-
	Correct	8				9	NA	+
	Incorrect	0				10	NA	-
						11	NA	-
							Correct	4
							Incorrect	7

LTM#4

Immediate Post-Removal			Six Month Post-Removal			One Year Post-Removal		
Clip #	Guess	Correct (+) Incorrect (-)	Clip #	Guess	Correct (+) Incorrect (-)	Clip #	Guess	Correct (+) Incorrect (-)
1	C	+	1	NA	+	1	NA	+
2	NA	+	2	C	+	2	C	+
3	C	+	3	C	+	3	NA	-
4	NA	+	4	NA	+	4	NA	+
5	C	+	5	NA	+	5	C	+
6	NA	+	6	NA	+	6	C	+
7	C	+	7	C	-	7	C	+
	Correct	8	8	NA	+	8	C	-
	Incorrect	0		Correct	7	9	NA	-
				Incorrect	1		Correct	6
							Incorrect	3

All

Immediate Post-Removal		Six Month Post-Removal		One Year Post-Removal	
Correct	30	Correct	23	Correct	17
Incorrect	4	Incorrect	2	Incorrect	18

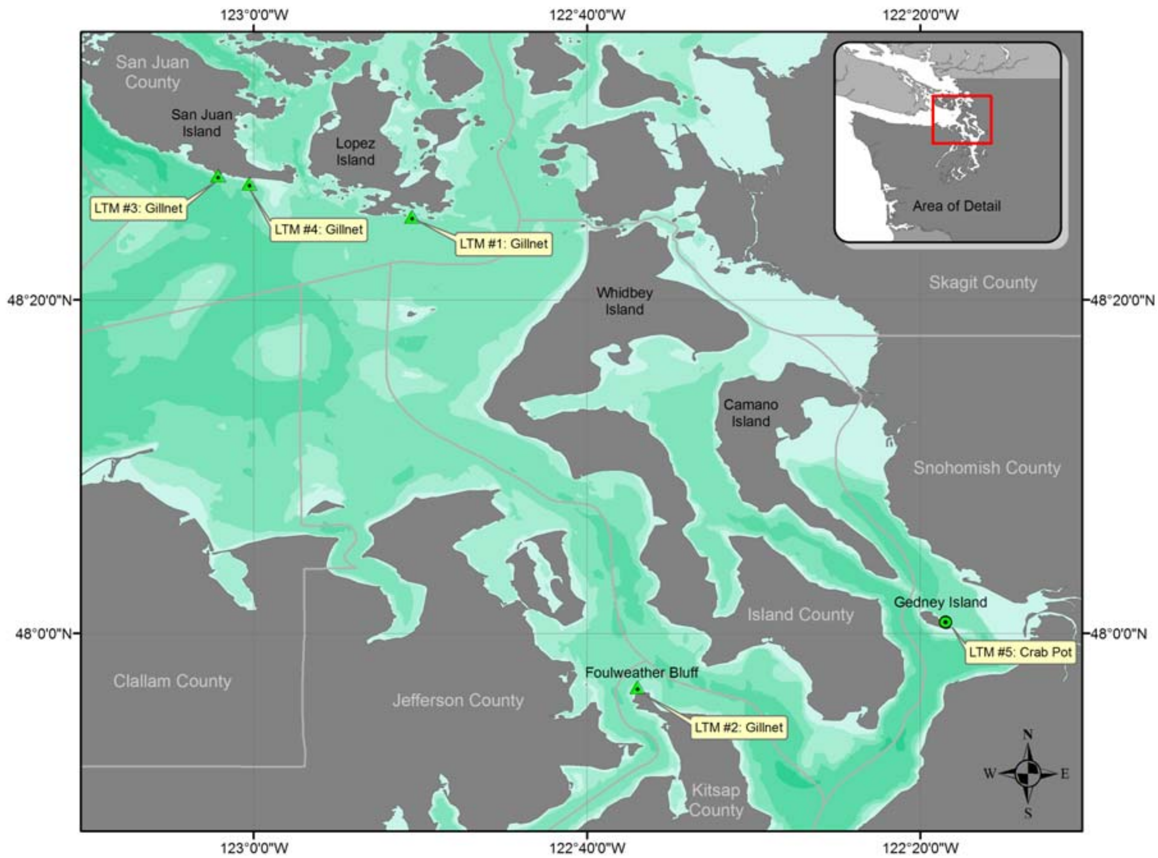

Figure 1: The location the five long-term derelict fishing gear monitoring areas in Puget Sound the San Juan Island.

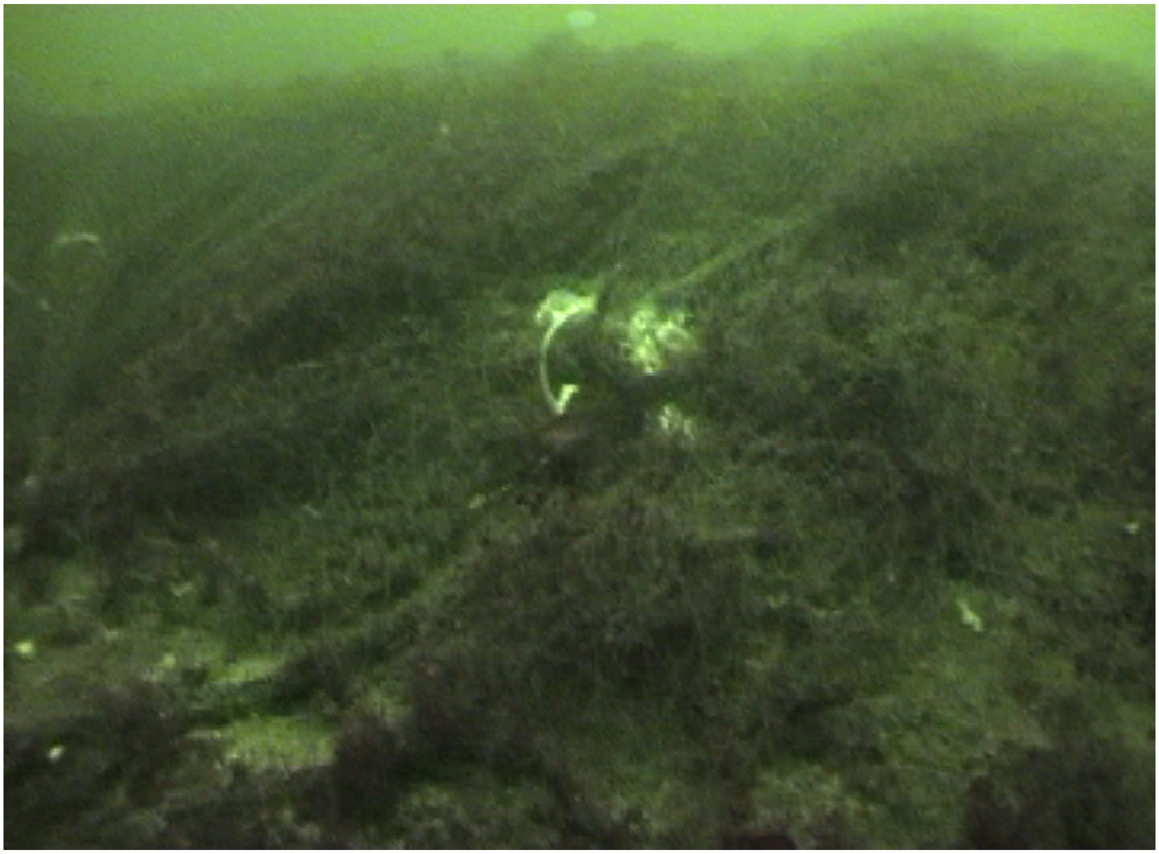

Figure 2: A video frame clip from a derelict gillnet with an entangle dead seabird on the seabed at Long-Term Monitoring site #3 Eagle Point, San Juan Island.

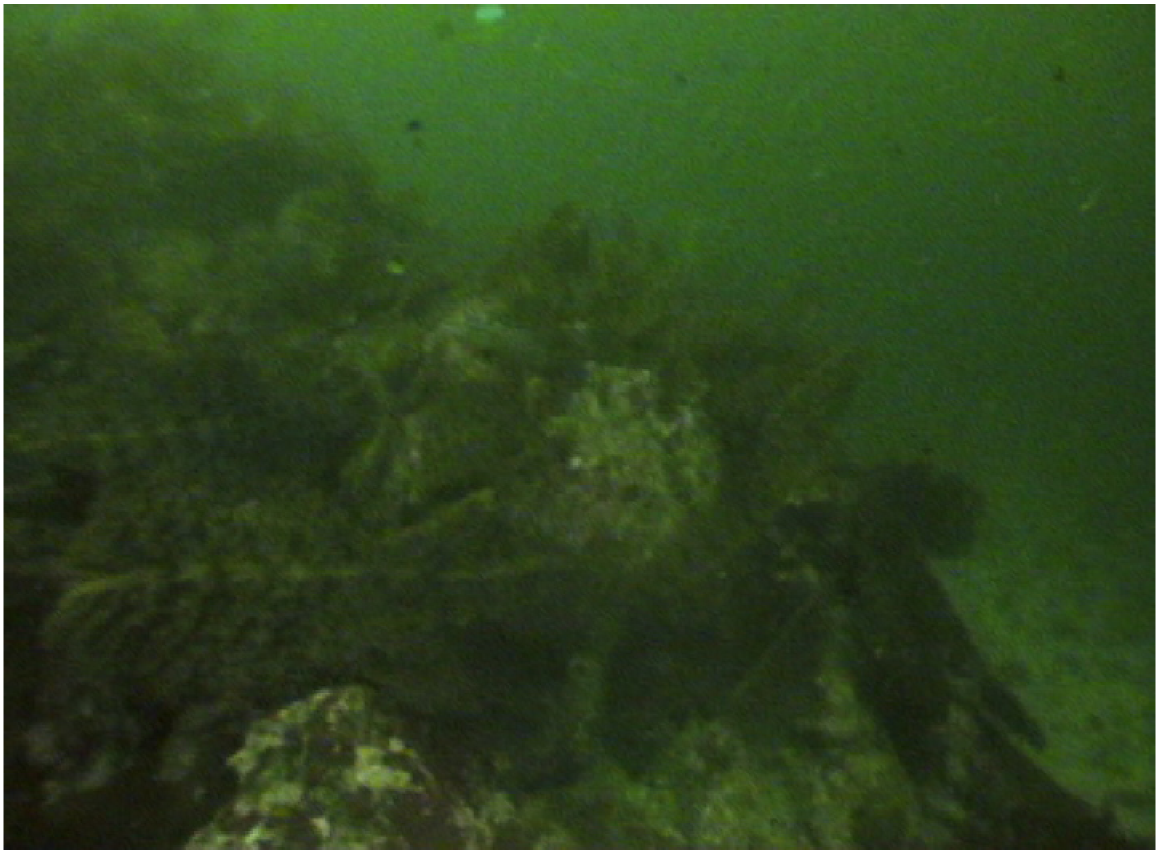

Figure 3: A video frame clip showing attached plants and animals on the seabed from an unaffected "control" area adjacent to the net affected area at Long-Term Monitoring site #3 Eagle Point, San Juan Island.

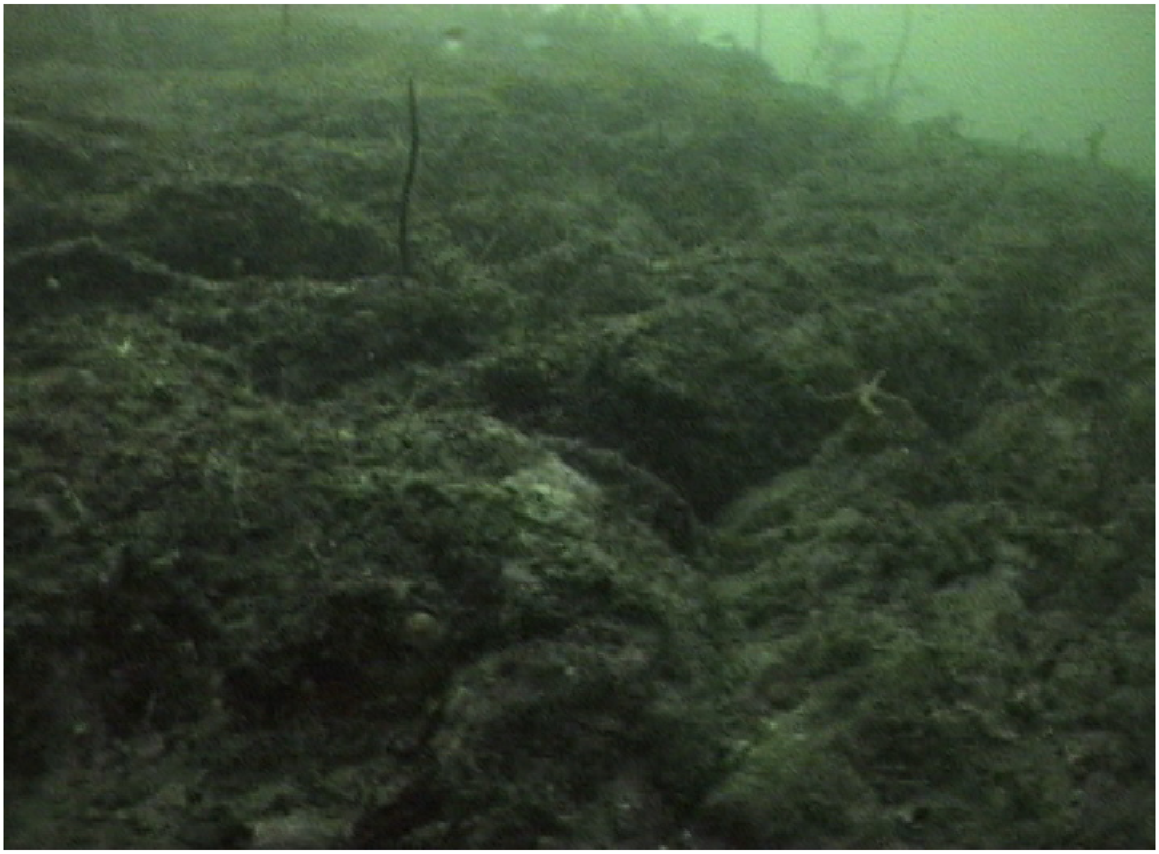

Figure 4. A video frame clip showing the net unaffected area immediately after derelict net removal at Long-Term Monitoring site #3 Eagle Point, San Juan Island.

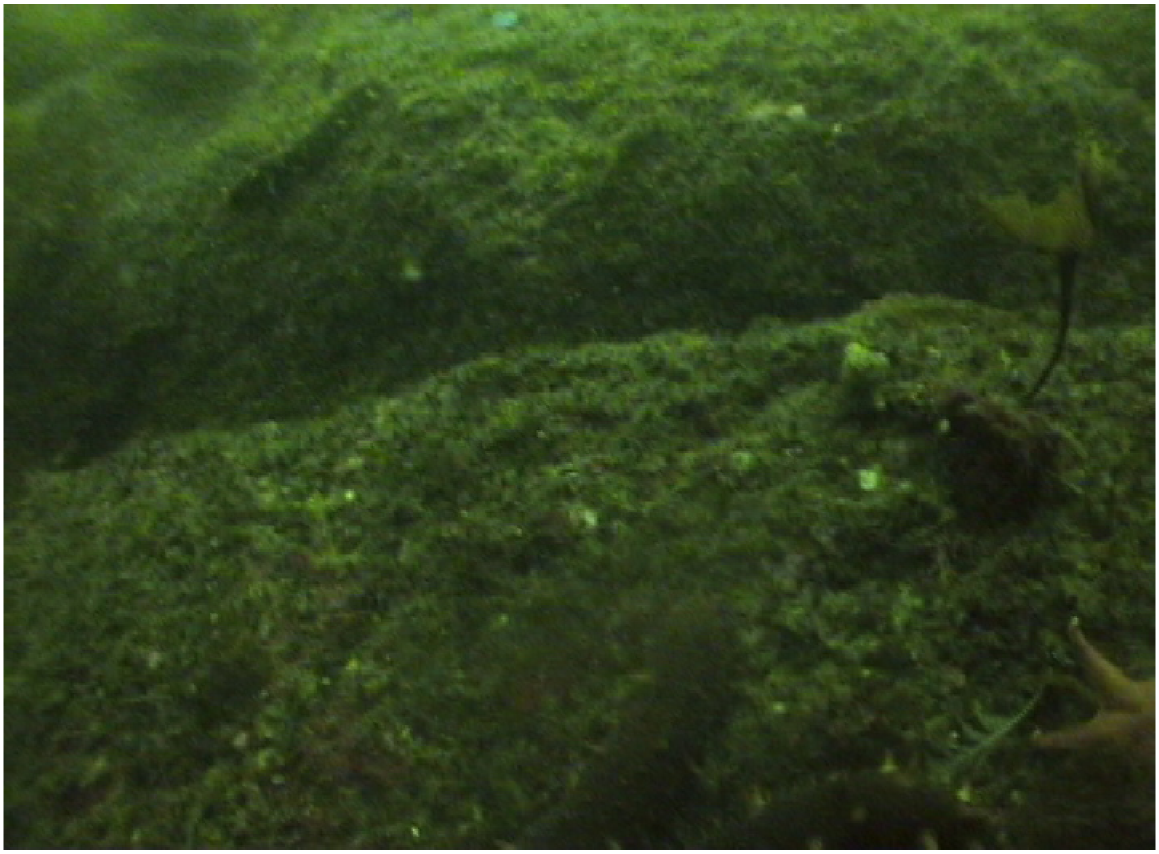

Figure 5. A video frame clip showing the net unaffected area approximately six months after derelict net removal at Long-Term Monitoring site #3 Eagle Point, San Juan Island.

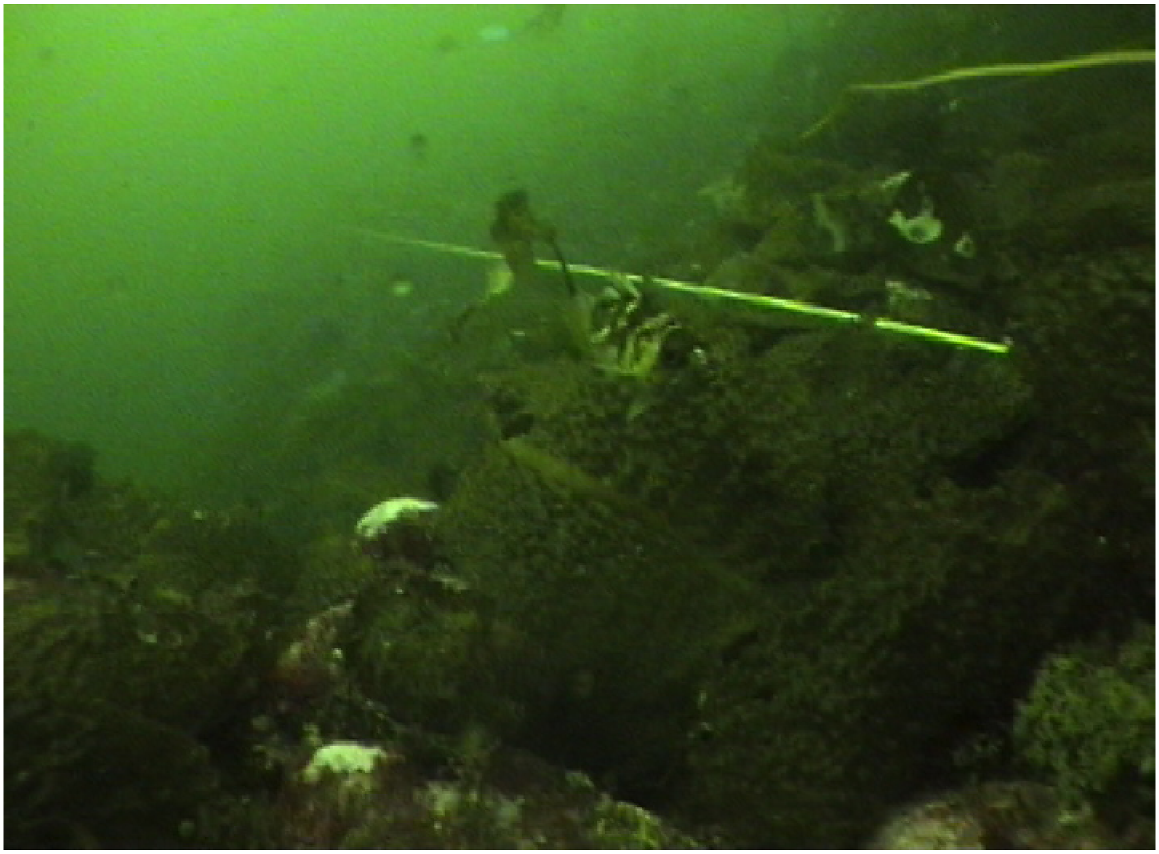

Figure 6. A video frame clip showing the net unaffected area approximately one year after derelict net removal at Long-Term Monitoring site #3 Eagle Point, San Juan Island. (Note: yellow marker rope delineating net affected area in foreground).