Escape Cord Degradation Rates in Port Townsend, WA

Snohomish County Marine Resources Committee
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Robyn Redekopp
Wendy Fisher
Morgan Neal
Donald Velasquez
Stephan Frenzl

Abstract

Derelict fishing and crabbing gear has become a widespread issue throughout Puget Sound. The Northwest Straits Commission has been a leader in removing derelict gear throughout the Sound; however, little scientific information is available about the factors influencing mortality rates from derelict gear. By better understanding the impact and factors involved with derelict gear, we can develop strategic and prioritized removal efforts to minimize the impact on marine resources. This study aimed to determine degradation rates of different types of escape cord (also known as "rot cord") used on Dungeness crab traps in Puget Sound. This study tested three arrangements of escape cord (rings, panels, and hooks) with five different kinds of material, with different thicknesses when feasible. Study results indicate that hemp, jute and sisal degrade more rapidly than cotton cord, and thus would allow for crab to escape earlier from derelict crab traps. However, social and political barriers may be in place that limits commercial, tribal and recreational crab harvesters from using alternative biodegradable materials. Further research on escape cord degradation rates in different marine environments, in addition to developing targeted education and outreach programs among each user group, is needed to improve stewardship of Puget Sound's Dungeness crab and other marine resources.

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Introduction

Derelict fishing and crabbing gear is an issue of concern in many marine waters including Puget Sound. One estimate indicates that 10,000 crabs are killed in derelict crab pots in the shallow waters of Port Gardner alone each year (June, 2006). Simulated lost pots in the Fraser River estuary caught 16 crabs per pot per year on average, and suggested that the loss rate for the Fraser River District due to derelict fishing gear was equivalent to 7 percent of the catch from this area (Breen, 1987).

Crab pots can continue to fish even when the original bait has been depleted (Breen, 1987). Once the pot lures any type of marine life, that animal may act as bait and continue to attract crab. Predation and cannibalism are two major causes of death in derelict pots (Kruse and Kimker, 1993). Other causes of crab mortality may be starvation, suffocation from deposited sediment or dehydration when pots are washed ashore during a storm (Kruse and Kimker, 1993). The average time it takes a crab to die in a derelict pot in is unknown, but likely dependent on the condition of the crab when trapped, the number of crab in the pot, the mix of sexes of crab in the pot, and the current stage of molting of the crab (June, 2006). According to individuals in the Dungeness crab commercial industry, a healthy crab in a net pen will become lethargic and susceptible to predation after three weeks, four weeks being the longest the crabs remain marketable (June, 2006).

For this reason, Washington Department of Fish & Wildlife requires all crab pots to be equipped with escape cord (also called "rot cord") to disable derelict and lost traps so they do not continue to fish. Even if a crab has the chance to escape the pot due to degraded escape cord, the chance of survival can be drastically reduced. The odds that a crab will escape with the energy and ability to survive is likely inversely correlated with the number of days of entrapment (June, 2006).

Clearly, the degradable escape mechanism on a crab pot is critical to the survival of crab inside, should the trap be abandoned or lost. There are three common places where escape cord is typically used on a Dungeness crab pot in Washington State. Recreational crabbers use four strands of escape cord to attach an escape ring or use three loops to close an escape panel to the side of their pot. Commercial crabbers typically use escape cord to connect a rubber strap on one side of the pot to a hook that is stretched over the side and fastened to hold down the bail door. When the escape cord degrades in any of these three arrangements the resulting opening will allow captured crabs to escape.

A study testing effects of biodegradable fasteners and escape panels, conducted in Barbados, found hemp twine to have the most rapid degradation time, as it degraded in 22-26 days. Number six cotton, however, was deemed unsuitable to be used on these fish traps because it failed to degrade in over five weeks' time (Selliah et al., 2001). A summary report to the Alaska Board of Fisheries regarding degradable mechanisms for escape gear found 30 thread cotton twine to last 50-106 days, 42 thread to last 57-119 days and 60 thread to last 57-139 days in Cook Inlet (Kimker, 1990 as cited in Kruse and Kimker, 1993).

The concentration and species of bacteria, along with other factors, such as salinity and temperature may impact the time for escape cord to degrade (June, 2006). Therefore, it is important to test the time taken to degrade at various locations, seasons, depths and environmental conditions.

The current Washington State regulation for escape cord states "cord must be untreated 100% cotton or other natural fiber no larger than thread size 120 or 1/8 inch." Four of the five types of material used in this study qualify under this Washington State regulation; a cotton/polyester blend was included to demonstrate the necessity of the "natural fiber" component of the regulation. All cord thicknesses meet Washington State regulation.

The purpose of this study was three-fold: 1) to determine existence of difference in degradation times between types of materials; 2) to determine a difference (if any) in degradation times between different thicknesses of the same material; and 3) to determine if/how the arrangement of the escape cord (holding a ring, on a panel corner, or under tension) affects its degradation time. This will be accomplished by establishing the number of weeks it takes five types of escape cord materials (including two thicknesses of hemp and three thicknesses of cotton) to reach failure in three arrangements. Using this data, the effectiveness of the current regulation can be assessed.

Methods

The study was performed at the Port Townsend Marine Science Center (Fort Warden State Park, Port Townsend, Washington) from May 22, 2006 to September 22, 2006.

This study tested all three arrangements of escape cord (rings, panels, and hooks) with eight types of material: jute, sisal, 20 pound hemp, 48 pound hemp, cotton/polyester blend, 40 count cotton, 80 count cotton, and 120 count cotton. Each type of cord material was tested with three replicates (A, B, and C).

Two crab pots and assorted bait boxes were established in the following configurations:

<u>Escape Rings</u>

To test the various cords on escape rings, one pot was equipped with escape rings on the outside of the pot. The layout is shown in Figure 1. Rings were tied with a bowline knot to four corners of a vacant square. Squares on the border of the grid were not used to prevent extra rubbing. A zip tie was used to loosely attach the ring to the pot to both label the type of cord used and to prevent the loss of the ring.

<u>Hook and strap (Commercial) Arrangements</u>

To test the cords in the traditional commercial arrangement, one strand of escape cord was used to connect a rubber strap to a hook. Straps were attached to the outside edge of one crab pot and fashioned across the crab pot with relatively equal tension strengths. Cord was attached to the rubber strap by a bowline knot, and a loop knot attached the hooks. Zip ties labeled cord type and were attached to the square of the pot to which the rubber strap is attached. The layout is shown in Figure 2.

Panel Closure

To test the escape panel closure, bait boxes instead of actual crab pots were used. All boxes were placed in one pot to increase the ease of sampling. Three loops of cord, tied with a bowline knot, were used to attach the top (or bottom) to the side of a bait box. Each box tested up to four samples of cord, two on the lid and two on the bottom. Zip ties attached near the cord label cord type. The layout is shown in Figure 3.

The crab pots were lowered off of a secure pier and tested once a week. Testing consisted of pulling pots out of the water and on to the pier and giving each loop of cord a slight tug (equivalent to approximately 1.5 pounds of force). A cord was considered degraded when the loop broke completely and no longer held metal in place. Water temperature and water salinity were also taken at two meters off the pier at this time. After testing, pots were lowered back in the water and left until the next test.

Colored Legend for Figures (see following pages)

- Jute
- Sisal
- 20 lb. hemp
- 48 lb. hemp
- Cotton/Polyester blend
- 40 thread count cotton
- 80 thread count cotton
- 120 thread count cotton

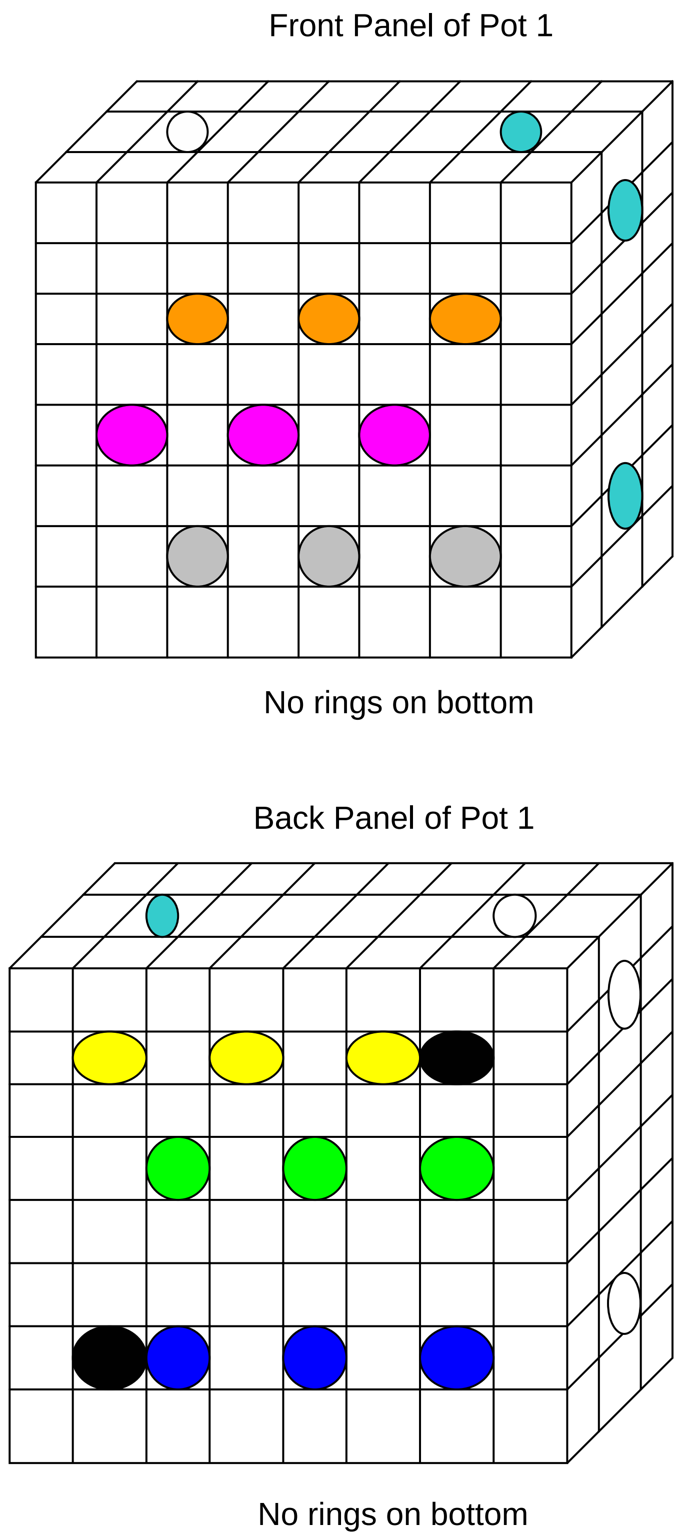

Figure 1. Arrangement of cords attached to escape rings.

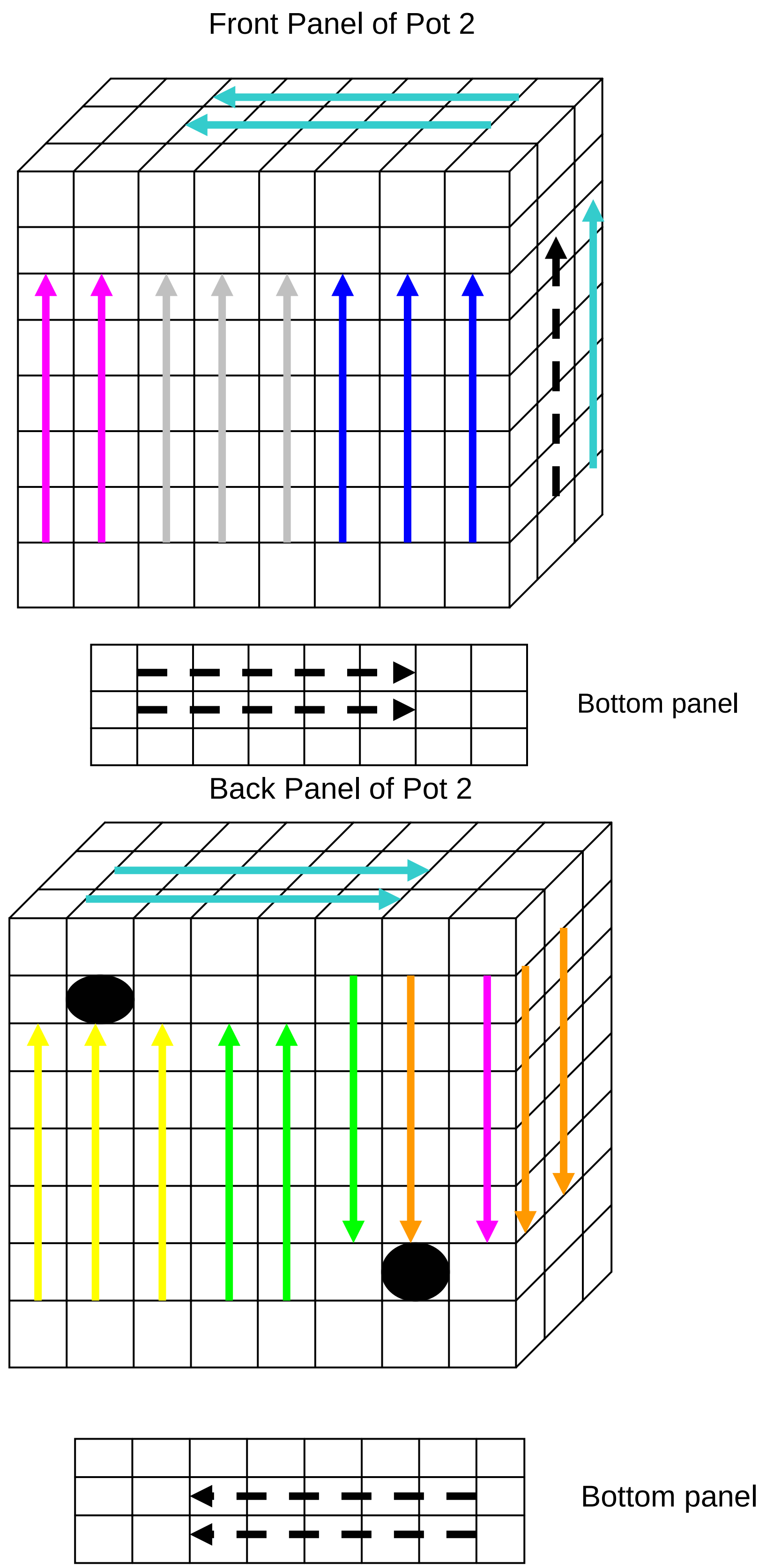

Figure 2. Arrangement of cords attached to straps and hooks.

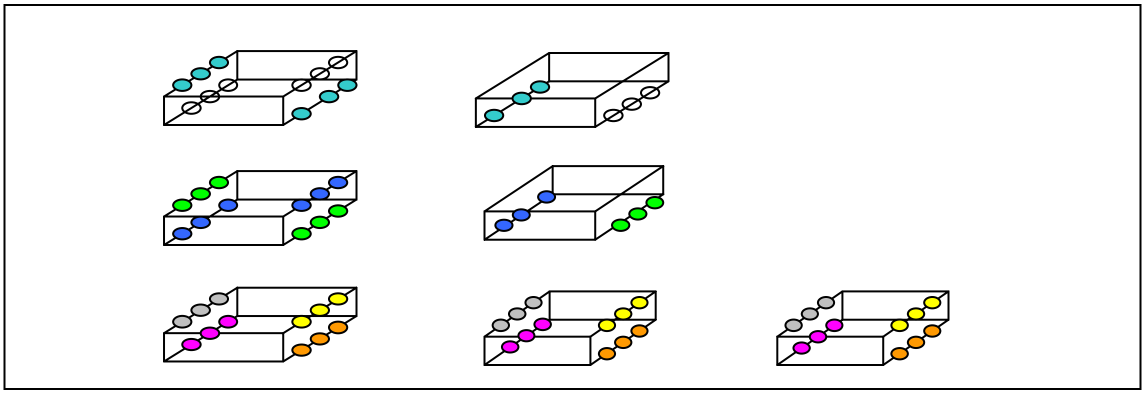

Figure 3. Arrangement of cords attaching panels of the bait boxes.

Results

Table 1 below shows the date of full degradation (Date) and the number of days that passed prior to full degradation (# days) for each cord type and replicate in each of the three placement configurations. DNF indicates that sample did not fully degrade during the experiment.

Table 1.

Ring Placement			Hook Placement			Panel Placement		
Cord Type	***Date***	***# days***	***Cord Type***	***Date***	**# days**	***Cord Type***	***Date***	**# days**
Jute A	7/24	64	Jute A	7/24	64	Jute A	7/24	64
Jute B	7/24	64	Jute B	8/7	78	Jute B	7/31	71
Jute C	7/24	64	Jute C	7/24	64	Jute C	7/24	64
Sisal A	7/17	57	Sisal A	7/17	57	Sisal A	7/14	54
Sisal B	7/14	54	Sisal B	7/17	57	Sisal B	7/14	54
Sisal C	7/14	54	Sisal C	7/17	57	Sisal C	7/4	44
Hemp20# A	7/14	54	Hemp20# A	7/17	57	Hemp20# A	7/4	44
Hemp20# B	7/14	54	Hemp20# B	7/17	57	Hemp20# B	6/27	37
Hemp20# C	7/14	54	Hemp20# C	7/4	44	Hemp20# C	6/27	37
Hemp48# A	7/14	54	Hemp48# A	7/17	57	Hemp48# A	6/20	30
Hemp48# B	6/20	30	Hemp48# B	7/17	57	Hemp48# B	6/20	30
Hemp48# C	6/27	37	Hemp48# C	7/24	64	Hemp48# C	6/20	30
CottonPoly A	DNF		CottonPoly A	DNF		CottonPoly A	DNF	
CottonPoly B	DNF		CottonPoly B	DNF		CottonPoly B	DNF	
CottonPoly C	DNF		CottonPoly C	DNF		CottonPoly C	DNF	
Cotton40 A	7/31	71	Cotton40 A	7/24	64	Cotton40 A	7/24	64
Cotton40 B	7/31	71	Cotton40 B	7/17	57	Cotton40 B	7/31	71
Cotton40 C	7/24	64	Cotton40 C	7/31	71	Cotton40 C	7/31	71
Cotton80 A	9/4	106	Cotton80 A	8/7	78	Cotton80 A	8/28	99
Cotton80 B	8/28	99	Cotton80 B	8/21	92	Cotton80 B	8/21	92
Cotton80 C	9/4	106	Cotton80 C	8/28	99	Cotton80 C	8/28	99
Cotton120 A	9/9	111	Cotton120 A	9/15	117	Cotton120 A	8/28	99
Cotton120 B	9/9	111	Cotton120 B	8/21	92	Cotton120 B	8/28	99
Cotton120 C	9/9	111	Cotton120 C	9/15	117	Cotton120 C	8/21	92

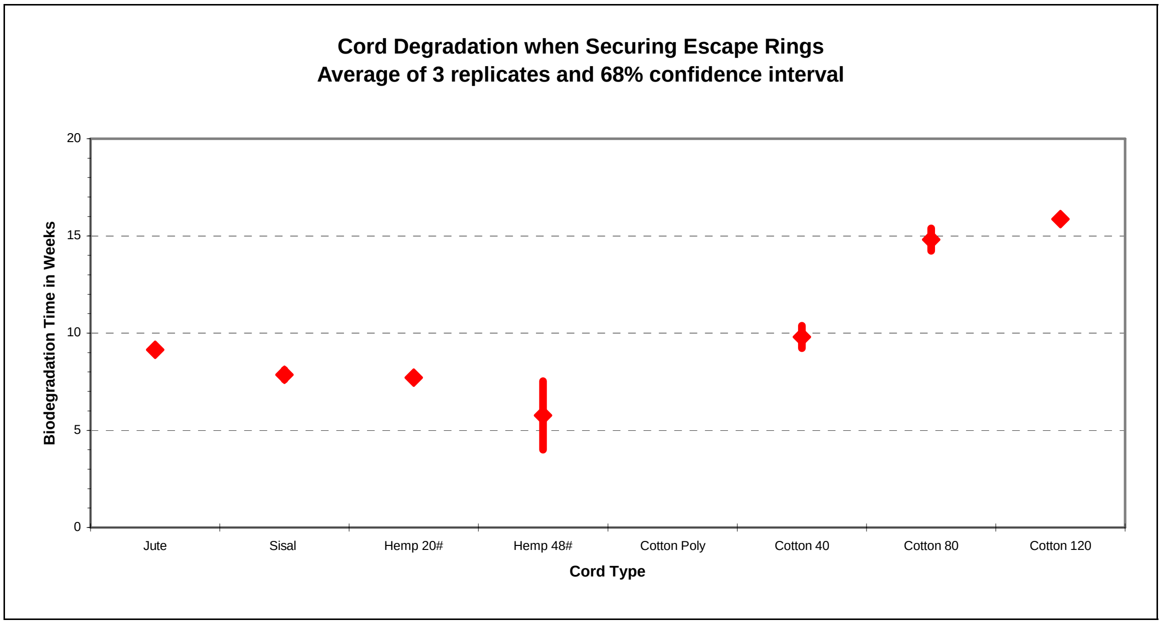

Figure 4. Graph showing results of various cords in the escape ring arrangement.

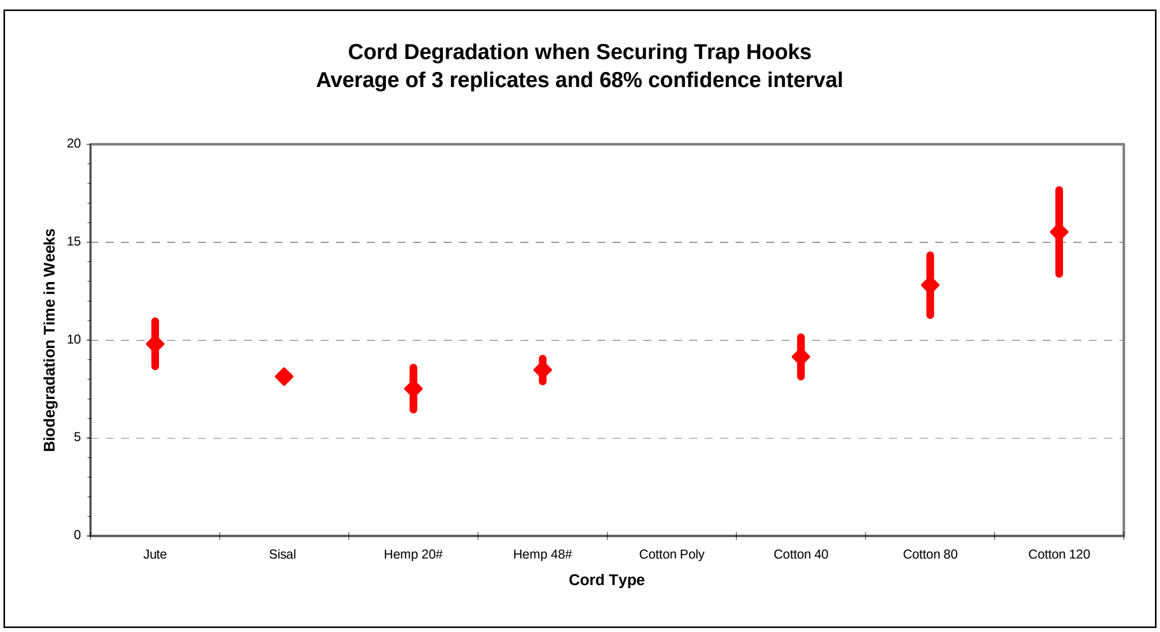

Figure 5. Graph showing results of various cords in the strap and hook arrangement.

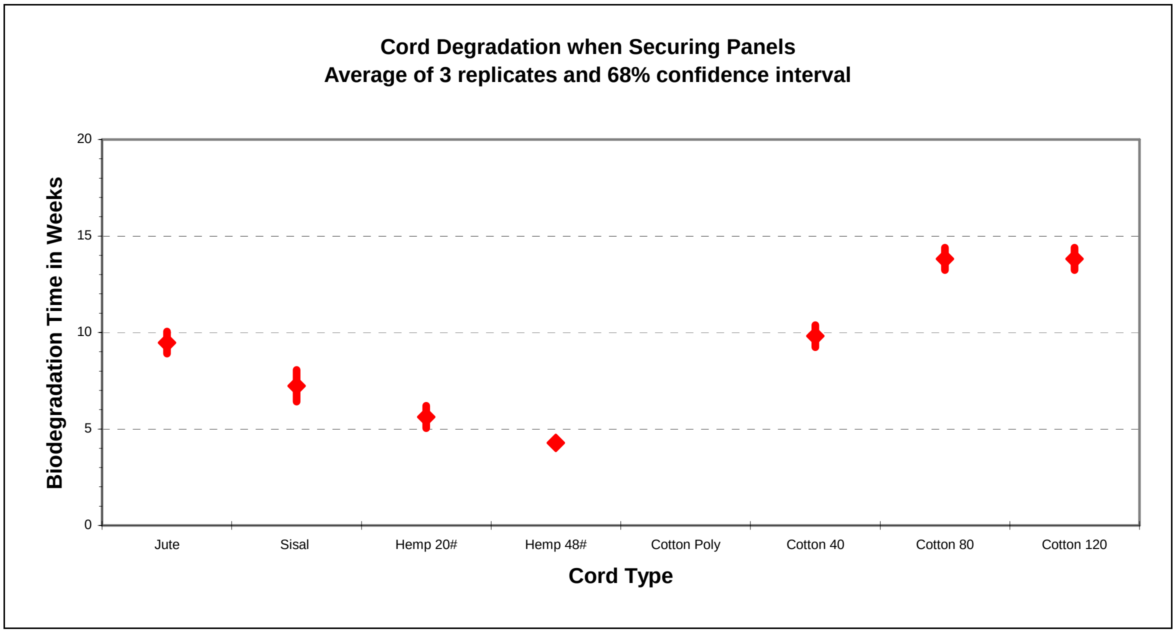

Figure 6. Graph showing results of various cords in the panel arrangement.

Figure 7. The front panel of pot number 1, with the rings. All the natural cords have disintegrated and the color-coded zip ties show the original placement of the cords.

Figure 8. The back panel of pot number 1, with the rings. The rings with the cotton polyester cord have blue zip ties and are in the lower left quarter of the pot. All the natural cords have disintegrated and the color-coded zip ties show the original placement of the cords.

Figure 9. The front side of pot number 2, with the rubber straps. The cotton polyester cords are still present, and are on straps in the upper right quarter of the pot. All the natural cords have disintegrated and the color-coded zip ties show the original placement of the cords.

Figure 10. The back side of pot number 2. All the natural cords have disintegrated and the color-coded zip ties show the original placement of the cords.

Discussion

Compliance with the current escape cord regulation should be the immediate priority as suggested by recent studies conducted of derelict crab traps in Puget Sound waters. There are a significant number of illegal pots still being deployed, by both commercial and recreational crabbers. A 2006 summary of recovered traps in Port Susan revealed that 43% of commercial traps and 24% of recreational traps did not have escape cord (Natural Resource Consultants, 2006). A similar survey of recovered traps in Port Gardner in 2005 revealed that 26% of commercial traps and 15% of recreational traps did not have escape cord (Natural Resource Consultants, 2005). At least some of these violations are probably due to crabbers using cord which they believe will qualify as escape cord, but which is in fact synthetic and not biodegradable. Education efforts should address both the rationale for the escape cord regulation and also how to determine whether cords are natural or synthetic. In the field, discrimination between these two categories usually involves setting fire to the end of a dry piece of cord to see if it burns (natural fiber) or melts (synthetic).

The data from this experiment indicates that hemp takes the least amount of time to degrade (4-8 weeks), then sisal (7-8 weeks), then jute (8-10 weeks), then cotton (9-16 weeks depending on thickness). Alaska has a regulation requiring 60 count cotton cord or smaller be incorporated as escape cord on Dungeness crab pots which has been in effect since 1991. It is noteworthy that data from studies performed in Cook Inlet, Alaska with 60 count cotton cord indicated an average degradation time of 80 days (Alaska Department of Fish and Game, 2006). That 80 day degradation time falls neatly between the observed average degradation times for 40 count and 80 count cotton cord examined in this study. The vast majority of escape cord currently in use in the Puget Sound Dungeness crab fishery is 120 count cotton and it takes *at least* 9 weeks to degrade under the conditions similar to this experiment.

Using the counts of crab killed by simulated lost traps in British Columbia (Breen, 1987), one can estimate the number of Dungeness crab killed per trap lost. Lost traps with cotton escape cord that meets the current Washington State regulation would retain crab for 9-16 weeks and kill 1 to 3 crabs per trap before biodegradation disables the trap. Lost traps with hemp escape cord that meets the current Washington State regulation would retain crab for 4-8 weeks and kill less than 1 crab per trap before biodegradation disables the trap. Traps without any escape cord would kill approximately 9 crabs in the first year and continue to entrap and kill crabs until other portions of the pot corrode and fail.

This study indicates that other natural materials degrade more rapidly than cotton cord, and thus would allow for crab to escape earlier from derelict crab traps. However desirable this may be, the public acceptance of these alternative cords may be limited because of limited availability and/or the increased risk of losing crab when they are not replaced in a frequent and timely fashion. If cord unintentionally breaks on an active commercial pot while it is fishing, the loss to the crabber *could* be up to 40 legal crabs. At $2.00 per pound and 1.8 pounds per crab, that represents a loss of up to $144.

In general across the cord types, the commercial configuration (hook under tension) takes slightly longer to degrade (by a week or two) compared to the ring or panel configuration. The ring and panel configurations were generally equivalent in degradation rates. One hypothesis for this difference might be that cords under tension will have tightly packed fibers. This would provide less space between the fibers for degradation to occur and therefore lengthen the time for full degradation.

In the reality of commercial fishing, escape cord attached to the hook and strap arrangement is stretched and released each time the trap is deployed. This was not done during this experiment. Stretching and releasing the cord on a regular basis may actually cause the cord to break before it is fully degraded, and one might expect cords to break more rapidly than Table 1 from this study would suggest (Alaska Department of Fish and Game, 2006).

It would be interesting to repeat this experiment at depths and locations which represent the full range of these key environmental variables to see how they might affect the degradation time of the various cords. Fishery managers in Alaska have theorized that warmer water temperatures decrease the degradation time of the cord (Alaska Department of Fish and Game, 2006). Others have theorized that lower dissolved oxygen concentrations would promote increased degradation times because anaerobic bacteria generally are less able to break down complex organic molecules.

Marine water temperatures ranged from 10.3 – 12.2 °C and salinity ranged from 25.6 – 30.7 ppt during the course of the experiment. Preliminary dissolved oxygen measurements taken by the Washington Department of Ecology in 30 feet of water in Port Townsend Bay during this time ranged from 7.5 – 12.2 mg/l.

To determine the ranges of these environmental variables that Puget Sound crab traps would encounter, environmental monitoring data collected by the Washington Department of Ecology in Possession Sound was consulted. Here an assumption was made that the majority of crab traps are deployed at depths from 6 feet to 300 feet of water. The data indicates that crab traps deployed in these waters will likely experience temperatures ranging from 7.9 – 17.2 °C; salinities from 12.9 – 30.9 ppt; and dissolved oxygen readings from 3.5 – 12.5 mg/l during the fishing season.

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Donald Velasquez

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