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Using Biodegradable Materials in Crab Pots to Mitigate Ghost Fishing Effects

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ABSTRACT: The modification of crab traps using biodegradable cotton rope, particularly on panel ropes and trap mouth ropes, aims to reduce the impact of ghost fishing. While the characteristics of cotton rope have been tested in the laboratory, they have not been directly tested in field fishing operations. This research aims to analyze cotton ropes' technical use and damage levels, compare crab catches in control and modified traps, and provide recommendations for fishermen to use modified traps. Experimental fishing involved operating 500 units of modified traps with cotton ropes and 500 units of control traps used by fishermen. The trap operations were conducted over 30 trips in Gebang Mekar, Cirebon Regency, and West Java Indonesia. The results indicate that the modified and control traps use the same operating techniques and damage levels. The crab catches in the modified traps reached 1101 individuals with a total weight of 130.9 kg, not significantly different from the control traps, which reached 1110 individuals with a total weight of 129.8 kg ($p > 0.05$, T-test). Based on technical use, damage levels, and catch results, fishermen can use modified traps made from cotton rope as an effective alternative to prevent ghost fishing in crab trap fisheries.

KEYWORDS: Biodegradable material, Crab trap, Ghost fishing, blue swimming crab.

I. INTRODUCTION

Ghost fishing is an event that occurs in waters where lost fishing gear can continue to catch fish or other biota without being controlled by fishermen [1 – 3]. The fishing gear will continue to function until it is broken or its fishing capacity is gone. Ghost fishing begins with abandoned, lost, or otherwise discarded fishing gear, sometimes known as abandoned, lost, or otherwise discarded (ALDFG) [4 – 6].). World Wildlife Fund [6] states that ALDFG contains marine debris, potentially impacting ocean environmental contamination dramatically. In addition, it influences commercial fish and aquatic animals that are not targeted for fishing. According to Grimaldo *et al*. [7], ghost fishing has imprisoned up to 136,000 marine biotas. Fishing encompasses protected marine biota.

Gillnets and traps are the primary fishing gear contributing to ghost fishing [8]. This is due to the substantial number of collapsible pots lost in the water, as reported by Susanto *et al*. [9]. Each fisherman in Banten Bay loses 100-150 collapsible pots annually. In the Gebang Mekar waters, each fisherman loses an average of 18 monthly pots [10]. In Gebang Mekar, a village where over 90% of the population relies on capture fisheries for income, including the blue swimming crab business [11], the pots used by fishermen consist of three main components: an iron frame, a polyethylene body, and two pot mouths for crab entry. The polyethylene material in these pots is durable, reducing the frequency of replacements; however, polyethylene traps have high breaking strength and take hundreds of years to degrade in the ocean [12 – 13]. This longevity significantly increases the potential for ghost fishing, threatening fish resources and protected marine species [7] – [14].

To mitigate ghost fishing caused by synthetic collapsible pots, incorporating biodegradable materials into one component of the pot is a viable solution. Research by Komarudin [15], Mainnah *et al.* [16], and Athiyyah.*et al*. [17], have tested various types of ropes for their physical and mechanical properties for use in folding traps. Riyanto *et al.* [10] found that cotton rope is biodegradable with good elongation and strength based on tensile tests, outperforming agel and hemp ropes; cotton rope did not undergo significant structural changes after six months of immersion. However, field trials have not yet incorporated cotton materials directly into trap fishing equipment. Therefore, research is needed to modify the rope tying the mouth of the trap with cotton material to evaluate the trap's construction, technical operation, damage levels, and fishing performance, as well as to compare the catches.

II. MATERIALS AND METHODS

An experimental fishing trip with 30 fishing operations utilizing blue swimming crab pot vessels was conducted in the Gebang Mekar waters of the Cirebon Regency in West

Java, Indonesia, during April and May 2023. The fishing locations in the study are shown in Figure 1.

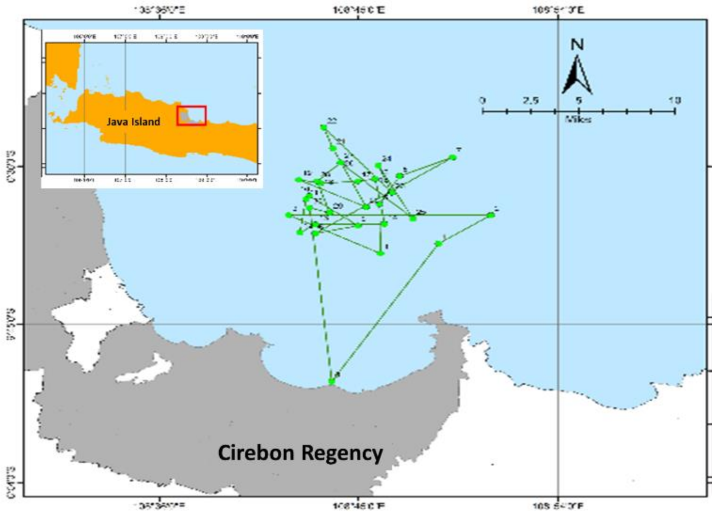


Figure 1. Experimental fishing location for 30 trips in the study

Fishing experiments were conducted to evaluate the effectiveness of various fishing pots in capturing blue swimming crabs. A total of 1000 collapsible pots were used, with 500 made of polyethylene serving as the control group and 500 modified with a 1-1.5 mm diameter cotton rope on the mouth panel. The pot frame used in Gebang Mekar is made of stainless steel, measuring 0.4 cm in diameter and weighing 410 grams. The collapsible pot has two doors without escape openings, and its body is made of synthetic or plastic material woven into a net-like structure (Figure 2a). The redesigned collapsible pot is secured at the bottom of the opening with cotton rope, woven around the left, right, and front edges with 3-4 loops (Figure 2b).

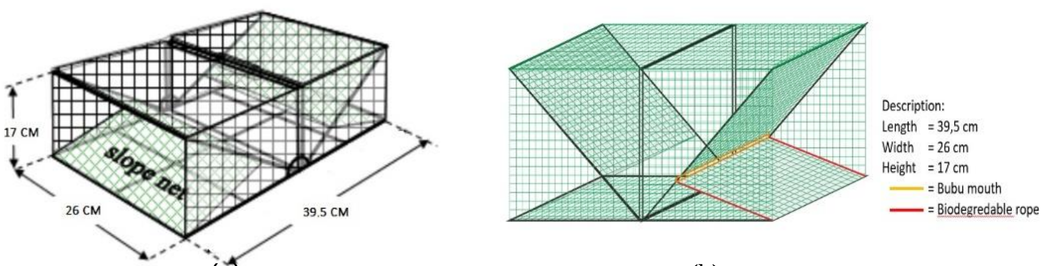


Figure 2. Construction of the trap used, control trap made from polyethylene (a) and modified trap made from cotton twine (b)

Pots are deployed using a longline system with a distance of approximately 10 m between each unit, based on the fishermen's setup. The fishing process utilizes a wooden boat of less than 5 GT, equipped with an inboard engine. The boat measures 7 meters in length, 2 meters in width, and 1 meter in height. Reaching the fishing area (DPI) takes about 2 hours. Upon arrival, the trap fishing equipment is set up for about 1 hour, with the traps arranged in a zig-zag pattern. The catch is sorted into baskets according to the treatment, separating the blue swimming crab as the main catch from the by-catch and then recording by number, type, and weight for each treatment. The capture operation process is illustrated in Figure 3.

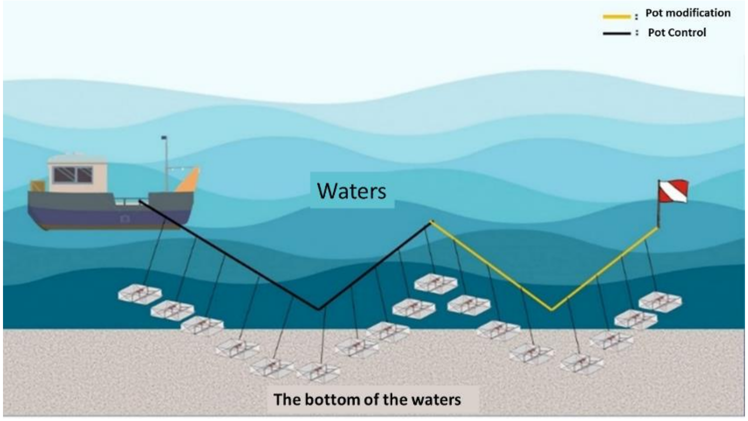


Figure 3. Illustration of a series of control and modified pots during fishing trials

The pot fishing gear was set early at 05:00 AM and left to soak for 24 hours. The following day, the hauling process took 2-3 hours. The water depth in the fishing area ranged from 3 to 11 meters, and it was located 2 hours from PPI Gebang Mekar. The seabed was muddy [18] - [11]. Environmental parameters such as temperature, pH, and water salinity were measured during the study.

The experimental design was a one-factor, completely randomized design (CRD) with two treatment levels: control and modified traps. Systematic randomization was applied to ensure equal opportunities, aligning with the fishermen's usual practices when operating pot fishing equipment. The trap placement scheme during operation included B1 (control pot) and B2 (modified pot), as shown in Table 1.

Table 1. Randomization design and trap formation during experimental fishing

Trips number	Pot	
	Control	Modification
1 and 16	B1	B2
2 and 17	B2	B1
3 and 18	B1	B2
4 and 19	B2	B1
5 and 20	B1	B2
6 and 21	B2	B1
7 and 22	B1	B2
8 and 23	B2	B1
9 and 24	B1	B2
10 and 25	B2	B1
11 and 26	B1	B2
12 and 27	B2	B1
13 and 28	B1	B2
14 and 29	B2	B1
15 and 30	B1	B2

Note: B1: pot control
B2: pot modification

During hauling, the catch is collected in baskets, with the main catch and by-catch separated for each treatment. The catches are then sorted by type, and the number, weight, and size are recorded. The carapace length and width are measured for the blue swimming crabs to compare the relationship between height and width for each treatment.

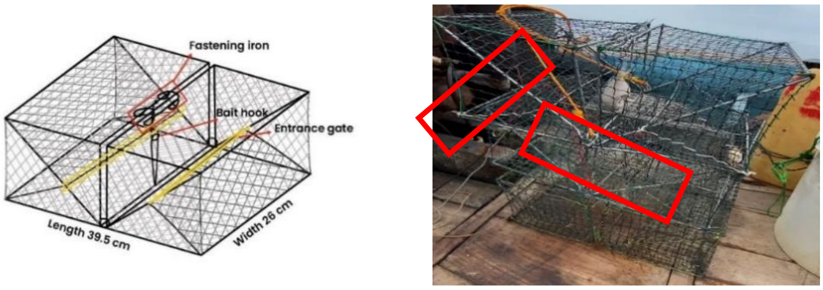
The technical usage of pot fishing gear and the assessment of damage levels to control and modify pots made from cotton twine were analyzed descriptively. Observations were conducted during the pre-catch process, including setting and hauling the fishing gear, stacking it during operation, and cleaning it. Post-catch conditions were also observed and visualized with pictures.

A Completely Randomized Design (CRD) was employed with statistical analysis to assess differences in the number and types of catches. The catches were identified by their common and scientific names and grouped according to species captured by the control and modified trap fishing gear. Descriptive analysis obtained from the results of the first and second objectives was then carried out in a literature study to produce a recommendation regarding the application of biodegradable materials in blue swimming crab pots for sustainable fisheries.

III. RESULTS AND DISCUSSION

The technical operation and level of damage to modified pots (cotton rope) and control pots (polyethylene)

The collapsible pot fishing instrument employed is rectangular in design, measuring 39.5 cm long, 26 cm wide, and 17 cm high, having two entrance slots or sides to the pot mouth. The collapsible pot frame comprises galvanized iron and zinc, while polyethylene is the net that forms the pot body. The collapsible pot includes an iron bait hook and a fishing rod trap cover. Figure 4 depicts the construction of the collapsible pot and modified elements.



(a) (b)

Figure 4. (a) Collapsible pot specifications, (b) Modified pot parts

The modified and control pots used have the same shape, size, and quantity (500 units of control pots and 500 units of modified pots), but the difference is in the panel rope at the mouth of the trap and the panel rope at the side of the mouth of the pot which uses cotton rope.

The level of damage to modified and control pots tends to be the same, namely the categories of light damage and moderate damage; both types of damaged pots can still be repaired and reused. The number of modified pots damaged was 44 units, with details of 21 units of dropped-out cotton rope, seven uni-free coil cotton rope, 15 damaged on the net body, and 1 unit of damaged pot frame (broken). Meanwhile, 34 pots were damaged in the control pots, with details of 10 units dropped out panel ropes, 22 units damaged in the net body, and two units damaged in the pot frame (broke). Details can be seen in Figure 5.

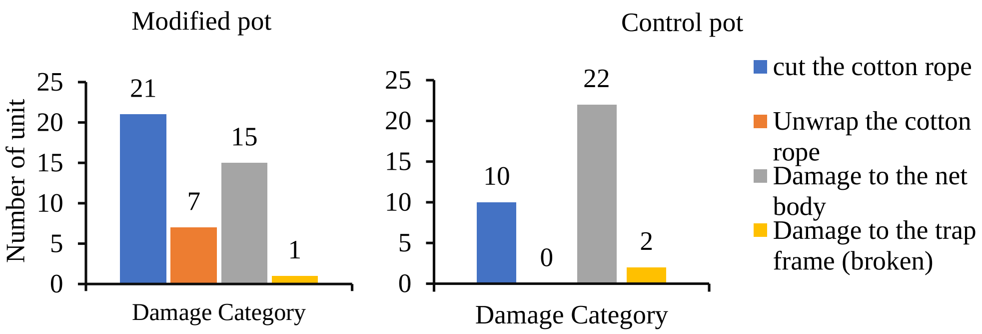


Figure 5. Details of damage to modified traps and control traps

The technical operation of modified and control pots is generally the same; they are installed by dropping them in the fishing area, as determined by the fisherman in Gebang Mekar. Modified and control pots are assembled into a series of main ropes and installed using a longline system. According to Nabiu *et al.* [19], two pot installation systems are usually used: single and longline. Damage to pots was categorized into 4, namely broken panel ropes, unwound panel ropes, damage to the net body, and damage to the iron frame. Poor maintenance by fishermen causes damage to pot fishing gear; pots are usually placed or pounded on the boat after operation, so they are quickly damaged by sunlight or rain [20]. The level of damage to modified pots and control traps is classified as mild and moderate because damaged pots can still be repaired and used again by fishermen. Damaged fishing gear is then repaired if possible. If it is impossible to fix, fishermen abandon the fishing gear on the banks of the Gebang Mekar River [21].

Catch composition of modified and control pots

Table 2 shows types, quantities, and weights caught from control and modified pots during the trial. Control pots obtained ten types with a total number of 6165 fish and a total weight of 251.21 kg. Meanwhile, there were nine types of modified pots with a total of 6545 fish and a total weight of 261.15 kg. The pot catch comprises the primary target catch, specifically the crab species Portunus pelagicus, as well as incidental catches of baby crab (*Charybdis anisodon*), mantis shrimp (*Harpiosquilla raphidea*), snails (*Cypraea sp*), cuttlefish (Sepia aculeata), tiger snails (*Babylonia spirata*), grouper (*Epinephelus sexfaxciatus*), rabbitfish (*Siganus javus*), scallop fish (*Terapon theraps*), and sickle fish (*Drepane puncata*). The findings of Sidik *et al.* [22] and Komarudin [15] indicate that fish pot captures consist of over 12 species, including both main and secondary catches. The primary focus is on the green crab, which holds significant economic importance [23]. The composition of the catch in both types of pots can be seen in Table 2.

Table 2. Catch composition of control and modified pots

Species		Treatment							
		Control pots				Modified pots			
		Number of Individuals	(%)	Weight (kg)	Percentage (%)	Number of Individuals	(%)	Weight (kg)	(%)
Blue swimming Crab	*Portunus pelagicus*	1.110	18	129.8	51,7	1.101	16,8	130.9	50,1
Baby Crab	*Charybdiys anisodon*	3.491	56,6	67.1	26,7	3.851	58,8	77.02	29,5
Mantis Shrimp	*Harpiosquilla raphidea*	320	5,2	12.3	4,9	352	5,4	14.2	5,5
Snail	*Cypraea sp*	1.095	17,8	32.5	13	1.075	16,4	32	12,3
Cuttlefish	*Sepia aculeata*	34	0,6	2,2	0,9	22	0,3	0.9	0,4
Tiger Snail	*Babylonia spirata*	60	1	1.8	0,7	112	1,7	3.3	1,3
Grouper	*Epinephelus sexfaxciatus*	40	0,6	3.9	1,6	23	0,4	2	0,8
Rabbitfish	*Siganus javus*	8	0,1	0.85	0,3	3	0,05	0.12	0,05
scallop fish	*Terapon theraps*	6	0,1	0.55	0,2	6	0,1	0.48	0,2
Sickle fish	*Drepane puncata*	1	0,02	0.08	0,03	0	0	0	0
Total		6.165		251.21		6.545		261,15	

Collapsible pot catches are grouped into main catch and bycatch. Based on fishermen's interviews, crab is the main catch and greatly contributes to fishermen's opinions. According to Yusfiandayani dan Sobari [24], crabs are a highly sought-after export commodity due to their growing market demand and high value. The blue swimming crab as a main target species can be seen in Figure 6.

(a) (b)

Figure 6 . Blue swimming crab as a target catch (a) Male (b) Female

The total number and weight of crabs in control and modified fish pots during the study did not have significant differences. The total number of crabs in the control pots was 1110, weighing 129.75 kg. Meanwhile, the total number of crabs in the modified trap was 1101, weighing 130.94 kg. Proportion of types of sex crabs during the research, there were more female crabs than male crabs. The type, number, and weight of crabs in the control and modified pots can be seen in Table 3.

Table 3. Number, carapace length and weight of BSC catch during the research

Treatment	Type of Catch	Number of Individuals	Total Weight of Catch (grams)	Average Carapace Length (cm)	Average Carapace Width (cm)
Control pots	Male Crab	330	37.385	4.99	12.08
	Female Crab	780	92.373	5.46	12.47
Total		1,110	129.758		
Modified pots	Male Crab	308	36.151	5.28	12.07
	Female Crab	793	94.796	5.44	12.48
Total		1,101	130.947		

The study captured 1110 crabs (Portunus pelagicus) using customized pots. Among these, there were 780 females and 330 males. One thousand one hundred-one individuals were recorded within the control pots, consisting of 793 females and 308 males. The female-to-male crab ratio is significantly high. Widigdo *et al.* [25] found that the disparity in the sex ratio of captured crabs is caused by alterations in individual crab behavior when seeking appropriate habitat, the impact of fishing, and mortality. According to a study by Dineshbabu *et al.* [26], female crabs migrate to areas with elevated salinity to reproduce during specific seasons. During the spawning season, female crabs dominate the high seas area. The disparity in the male-to-female ratio of crabs must be taken into account. The excessive capture of female crabs threatens the sustainability of crab populations as it can lead to a decline in their numbers or disrupt the stock-recruitment process in the region [27].

The maximum weight of the crab catch was 6.81 kg in the modified pot during fishing trip 24, while the minimum weight was 2 kg during fishing trip 3. On trip 1, the control pot yielded the highest crab capture, weighing 7.37 kg, while the lowest catch of 1.43 kg was recorded on trip 3. The maximum number of crab captures in modified traps occurred during the 24th trip, with 59 individuals. Conversely, the minimum number of crab captures was seen during the second trip, with only 19 individuals. On the 21st trip, the control trap caught the most crabs, totaling 54. On the 3rd trip, the control trap caught the fewest crabs, totaling 16. As per the findings of Wahyu *et al.* [27], the unpredictable dispersion of crabs in the aquatic environment directly impacts the monthly catch of crab fishermen. An increased degree of crab exploitation will significantly impact the population of crabs in the ocean, mainly if young crabs are collected. This is because it can hinder the rate at which new crab populations can replenish themselves [28]. In addition to water stock considerations, environmental factors such as weather, currents, and waves also impact the catch's magnitude [29].

There was no statistically significant difference ($p > 0.05$, t-test) in the number and weight of main catch of blue swimming crab between the control and modified groups. These findings suggest that the data variance is homogeneous, indicating no substantial change in the quantity and weight of catches between the control and modified pots [30].

Apart from the main catch, in field trials we also obtained bycatch such as baby crab (*Charybdis anisodon),* mantis shrimp (*Harpiosquilla raphidea)*, snails (*Cypraea sp)*, cuttlefish (*Sepia aculeata)*, tiger snails (*Babylonia spirata)*, grouper fish (*Epinephelus sexfasciatus)*, rabbitfish *(Siganus javus*), scallop fish (*Terapon theraps)* and sickle fish (*Drepane punctata*). The total weight of bycatch in the control pot was 121.5 kg with a total of 5055 fish, while in the modified pot, it was 130.3 kg with a total of 5444 fish. The most extensive bycatch, both in terms of quantity and weight, for both types of pots was *Charybdis anisodon*. The bycatch yield of modified pots was greater than that of control pots, but the comparison of bycatch yields of the two types of traps was not significant different. Bycatch results based on the total weight of each fishing trip is shown in Figure 7.

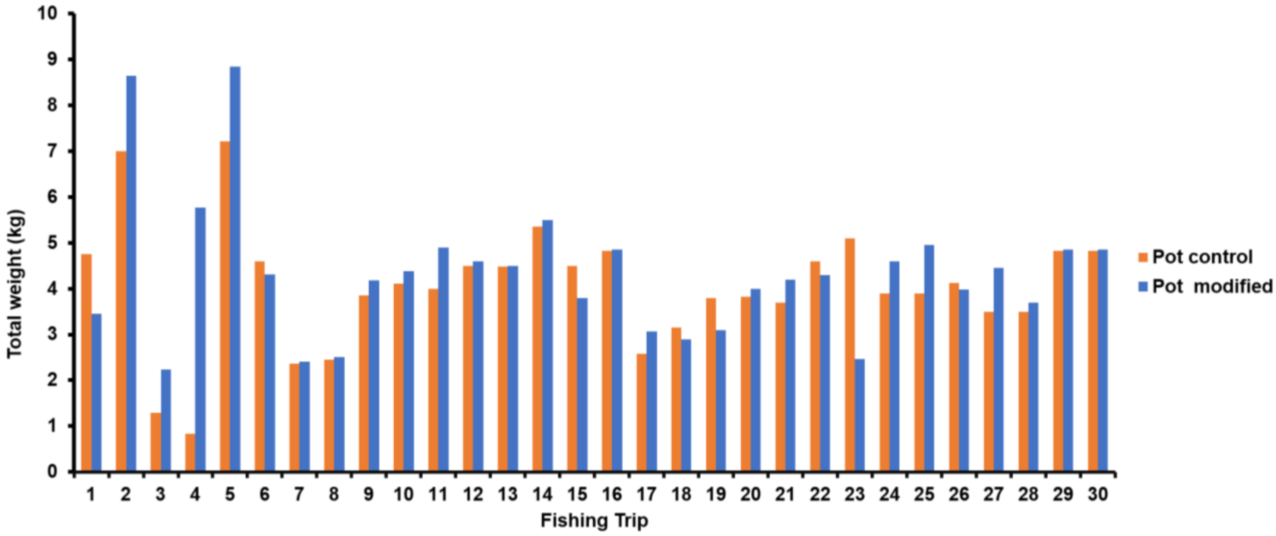


Figure 7. Weight of bycatch per trip.

Recommendations for the application of *biodegradable materials* in crab pot fisheries

Based on the results of technical tests on the use and level of damage to modified traps using cotton rope, there are no difficulties in terms of use and technical operation, and the trap can be operated well by fishermen. The level of damage to modified traps is included in the categories of light damage and moderate damage, which means traps Damaged modifications can still be repaired and reused. Repairing damaged modified traps has difficulties that differ from fishing control traps. Fishing *performance* can be seen from the catches in modified and control traps; the main catch (crab) after the comparison test (T-Test), both in quantity and weight, did not significantly differ. Regarding bycatch (HTS), the two types of traps do not differ in type, quantity, and weight. Because it is a modified bubu on a rope panel, rope Cotton can be used in folding traps to prevent *ghost fishing* in crab trap fisheries. The similarities between the two types of traps can be seen in Table 4.

Pots or traps are often constructed using polyethylene, a type of plastic rope, which is shaped into a fish pot. Polyethylene-based materials possess exceptional tensile strength and exhibit an extended degradation period in aquatic environments. Consequently, when entangled in lost, discarded, or abandoned pots, these materials pose a significant threat to the survival of marine organisms. Hence, it is imperative to enhance pot or trap fishing gear by employing biodegradable materials that are technically feasible and resistant to damage while exhibiting excellent fishing capabilities.

Table 3. Table recommendation indicators

Recommendation Indicators	Treatment	
	Control pots	Modified pots
Construction	✓	✓
Operational Technical	✓	✓
Damage Level	✓	✓
Repair Time	✓	✓
Catch	✓	✓

Cotton rope is suitable for constructing pots to prevent ghost fishing when the pots are lost in the waters. This is because cotton is a biodegradable substance that exhibits a superior level of tensile strength compared to other natural fibers, as confirmed by laboratory experiments conducted by Athiyyah *et al*. [17]. An experiment was conducted to directly compare biodegradable materials, precisely cotton rope, in folding traps with the control traps commonly employed by fishermen. From a technical standpoint, fishermen can utilize traps that have been changed with biodegradable material on the rope panels and trap mouths to mitigate ghost fishing in crab trap fisheries. These modifications can impact the traps' usage, damage levels, fishing performance, and capture rates.

CONCLUSIONS

The technicalities for using modified and controlled pots in construction and technical operation are similar; the level of damage to both types of pots fall into the same category: lightly damaged and moderately damaged. However, both types of traps can still be repaired and reused. The repair time for control and modified pots tends to be the same. A comparison of crab catches in control and modified pots showed that they were similar in weight and quantity.

The weight and type of bycatch in control and modified traps are similar: baby crab, mantis shrimp, snail, cuttlefish, tiger snail, grouper, rabbitfish, scallop fish, and sickle fish. Cotton rope, as a biodegradable material, can be used in blue swimming collapsible pots because it does not affect pots or capture performance and degrades more quickly.

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REFERENCES

1. Wijaya DP, Reppie E, Manoppo L, Telleng ATR. 2016. Ghost fishing in trap fisheries in the waters Sario overfill Manado Bay, North Sulawesi Province. J. Sci. Tech. Fish. Catch. 2(3):109–112.
2. Diniah, Komarudin D, Puspito G, Iskandar MD. 2021. Usage chitosan on a rope agel as material tool friendly fisherman environment. In Proceedings of the National Seminar on the Sixth Results Study Fisheries and Marine. FPIK.
3. Raifeartaigh PO. 2021. Bio-based and biodegradable nets could be the solution to “ghost nets” jeopardizing sea life. Phys.org:2. [Downloaded 2023 Feb 11]. Available at: https://phys.org/news/2021-05-bio-based-
4. FAO. 2016. Report of the: Expert Consultation On The Marking Of Fishing Gear. Volume ke-1157. Rome.
5. Stelfox M, Hudgins J, Sweet M. 2016. A review of ghost gear entanglement amongst marine mammals, reptiles and elasmobranchs. Mar. Pol. Bul. 111(1–2):6– 17.
6. WWF. 2020. Stop Ghost Gear: The most deadly form of marine plastic debris. Glands.
7. Grimaldo E, Herrmann B, Jacques N, Kubowicz S, Cerbule K, Su B, Larsen R, Vollstad J. 2020. The effect of long-term use on the catch efficiency of biodegradable gillnets. Mar. Pol. Bul. 161:1-12.
8. Kim S, Kim P, Lim J, An H, Suuronen P. 2016. Use of biodegradable driftnets to prevent ghost fishing: physical properties and fishing performance for yellow croaker. *Anim Conserv*. 19(4):309–319. doi:10.1111/acv.12256.
9. Susanto A, Syafrie H, Nurdin HS, Irnawati R. 2022. *Lost Gear on Blue Swimming Crab Fisheries in Banten Bay : Case of Abandoned , Lost or Discarded Fishing Gear* by: 13(2):233–241.
10. Riyanto M. Dwi PY, Riki S. 2022. Reducing Ghost Fishing Impact On Small-Scale Pot Fisheries. Project FAO Report. Faculty Of Fisheries and Marine Sciences. December.
11. Putri dan Ilpah. 2019. Effectiveness of the Composition of the Catch of Folding Traps (Fish Traps) at the Gebang Mekar Fish Landing Base (PPI) Cirebon Regency. 51(6):204–213.
12. Good TP, June JA, Etnier MA, Broadhurst G. 2010. Derelict fishing nets in Puget Sound and the Northwest Straits: Patterns and threats to marine fauna. *Mar Pollut Bull*. 60(1):39–50.
13. Tallo. 2015. Design and Construction of Folding Traps in an Effort to Increase the Effectiveness and Efficiency of Catching Mangrove Crabs in an Environmentally Friendly Way. 3(7):59–78.
14. Kim P, Kim S, Jeong S, Lee K, Oh W. 2020. Physical properties of biodegradable fishing net in accordance with heat-treatment conditions for reducing ghost fishing. Turk. J. Fish. Aquat. Sci. 20(2):127–135.
15. Komarudin D. 2019. Characteristics fiber agel and flax have chitosan as material tool fishing. Doctoral Thesis. IPB University.
16. Mainnah M, Diniah ., Iskandar BH. 2016. *Combination Of Pineapple Leaf Fiber And Chitosan For Eco-Friendly Fishing Gear Materials*. *Mar Fish J Mar Fish Technol Manag*. 7(2):149–159.
17. Athiyyah. R, D. Simbolon, D. Komarudin MR. 2023. Evaluating Potential Biodegradable Twine for Use in the Blue Swimming Crab Collapsible Pots. *Eng Technol J*. 08(11):3018–3025.
18. Pradenta GB, Wibowo P, Asriyanto. 2014. Comparison of catches of folding traps with modified folding traps against catches of mangrove crabs (Scylla serrata) in the Sayung mangrove ecosystem, Demak. *J Fish Resour Util Manag Technol*. 3(2):37–45.
19. Nabiu NLM, Zamdial Z, Yosandri A, Hanibal L. 2023. Technical Analysis and Productivity of Folding Fishing Equipment in Pasar Bengkulu Village, Sungai Serut District, Bengkulu City. *J Laot Ilmu Kelaut*. 5(1):91.
20. Dollu E., Najamuddin, Nelwan AF. 2017. Modification of the construction bottom Traps Operated in waters warsalelang Alor district of East Nusa Tenggara Province. *J IPTEKS PSP*. 4(7):95–107.
21. Prihatin. 2022. Estimated Potential of Abandoned, Lost, Discarded Fishing Gear Fishing Units for Fishing Traps at Gebang Fish Landing Base. 8.5.2017:2003–2005. www.aging-us.com.
22. Sidik F, Sueb Z, Iskandar MD. 2023. The Effect of Differences in the Number of Fish-trap Mouths on Catch Results in Seribu Islands Waters. *ALBACORE J Penelit Perikan Laut*. 5(1):071–079.
23. Jayanto BB, Kurohman F, Boesono H, Prihantoko KE. 2018. Analysis of crab catches on funnel 2 and

funnel 4 trap fishing gear in Rembang Waters. *J Perikan Tangkap*. 2(1):6–11.
24. Yusfiandayani R, Sobari MP. 2011. Bio-Technique Aspect of Blue Swimming Crab Resources Utilization in Banten Bay Water. *J Teknol Perikan dan Kelaut*. 1(2):71–80.
25. Widigdo B, Rukisah, Laga A, Hakim AA, Wardiatno Y. 2017. Carapace length-weight and width-weight relationships of Scylla serrata in Bulungan District, North Kalimantan, Indonesia. *Biodiversitas*. 18(4):1316–1323.
26. Dineshbabu AP, Sreedhara B, Muniyappa Y. 2007. Fishery and stock assessment of Portunus sanguinolentus (Herbst) from south Karnataka coast, India. *J Mar Biol Ass India*. 49(2):134–140.
27. Wahyu R, Taufiq-SPJ N, Redjeki S. 2020. Relationship between Carapace Width and Weight of the Crab Portunus pelagicus, Linnaeus, 1758 (Malacostraca: Portunidae) in Sambiroto Pati Waters, Central Java. *J Mar Res*. 9(1):18–24.
28. Zairion YW, Mennofatria B, Achmad F. 2015. Reproductive biology of the blue swimming crab portunus pelagicus (Brachyura: Portunidae) in east Lampung waters, Indonesia: Fecundity and reproductive potential. *Trop Life Sci Res*. 26(1):67–85.
29. Imaduddin A, . Z, Iskandar MD. 2019. Use of Earthworm Bait Attractor (Lumbricus Rubellus) on Floating Bagan Catches in Palabuhanratu Bay. *Albacore J Penelit Perikan Laut*. 3(1):1–11.
30. Harahap YA, Wibowo BA, Boesono H. 2013. Analysis of differences in fishing time with branjang fishing gear on catches in Rawapening Waters, Banyubiru District, Semarang Regency. *J Fish Resour Util Manag Technol*. 2(3):172–181.