

SHORT COMMUNICATION

Improved Design Fixed Stake Trap With PVC Poles and Suitable Mesh Size Net Enables Sustainable White-Spotted Spinefoot, *Siganus canaliculatus* (Park, 1797) Fisheries in Luwu District, South Sulawesi

IRMAN HALID*, HARFIKA SARI BASO

Department of Fisheries, Andi Djemma University, Palopo, Indonesia

*E-mail: irmanhalid@unanda.ac.id | Received: 23/08/2021; Accepted: 26/03/2022

©Asian Fisheries Society

Published under a Creative Commons
license

E-ISSN: 2073-3720

<https://doi.org/10.33997/j.afs.2022.35.1.009>

Abstract

The traditional fixed stake trap made typically of wooden poles and thinly interwoven bamboos walls have been used for generations as fishing gear in coastal regions of South Sulawesi Province, Indonesia. In the 1980s, bamboo slats were replaced with nets of various mesh sizes as they became readily available, and currently, in the research area, no bamboo is used. Each unit of the wooden structure is made of around 300 poles that must be replaced three to four times annually and is becoming difficult due to the scarcity of wood and the high cost. Thus, this research aims to provide a feasible solution using PVC pipes and a suitable size mesh net for sustainable fisheries management of white-spotted spinefoot, *Siganus canaliculatus* (Park, 1797). The study was done in Karang-karangan village located on the coast of Luwu Regency where white-spotted spinefoot is the main fishing livelihood activity of fishers. The mesh size of the net used was 2.60 cm, and the results showed that the newly designed fixed stake trap unit made of PVC has been durable for the last 2.2 years and is expected to last at least 5 years. Compared to the traditional wood structure, there are no barnacles attached to the PVC pipes. The net size used allows smaller fish below 8.6 cm in length to escape, thus making white-spotted spinefoot fisheries sustainable. The estimated cost of using wood for 5 years is IDR60 million (USD4200), while PVC only requires around IDR15 million (USD1050).

Keywords: wooden fixed stake trap, fishing gear, suitable fishing mesh size, *Siganus*, sustainable fisheries

Introduction

The fixed stake trap has been used for generations as fishing gear in various coastal regions in Indonesia. In Bone Regency, the use of fixed stake traps is increasing due to their effectiveness. The fixed stake trap is also popular in Pitumpanua, Wajo Regency, and Bontomanai District, Selayar Islands Regency. In the coastal area of Karang-karangan village, the fixed stake trap is used mainly for white-spotted spinefoot, *Siganus canaliculatus* (Park, 1797), which is in great demand because it has a savoury taste.

The white-spotted spinefoot in Luwu Regency, spawns four times in one season, which lasts for 3 to 4 months, and the fish caught are generally gonadally mature. In general, fishing activities in Bone Bay and Luwu Regency are currently taking place freely (open

access) without clear rules and controls. Thus, all fishers in the coastal areas of the regency are free to access fish resources without any restrictions on fishing gear. This situation is similar to other places in Indonesia (Halim et al., 2020; Retnoningtyas et al., 2021). Fishers tend to catch anytime and anywhere, including young fish not suitable to be caught. The utilisation and management of fishery resources should be considered essential for sustainable fisheries (Chen et al., 2020; Zacardi et al., 2020; Zeng et al., 2021). Thus, proper fisheries resource management should be enforced to achieve sustainable fisheries goals, namely economic growth, equitable welfare distribution and improvement of environmental quality.

The use of the fixed stake trap has been modified over time. Since the 1930s, at first, fishers used gear made

from wood and bamboo. The wood was used for the poles, while the thinly woven bamboo slats served as the walls. Later, in the 1980s, bamboo was replaced by various mesh size nets, which became readily available. *Siganus canaliculatus* was the main target species. However, timber is becoming scarce as previously bamboo had become harder to obtain, and wood must be imported from outside the region, which is a relatively complicated and costly process. The scarcity of timber could be overcome by modifying the gear pole by using PVC pipes. PVC pipes as a substitute for wooden poles are an alternative proposed in this work and have not been used by fishers. In addition, the mesh size of the net was changed to allow the small white-spotted spinefoot to escape from the trap. Thus, this research expects to

provide a solution to establish a model applicable for the sustainable management of white-spotted spinefoot resources.

Materials and Methods

The field research was carried out for 7 months, starting May to November 2019 on the coast of Karang-karangan Village, Luwu Regency, 3°6'27.19"-3°8'37.81"S and 120°14'4.35"-120°17'36.17"E. The project began with preparing PVC pipes and nets, the primary fixed stake trap material. The PVC pipes of various sizes were used to construct the different parts of the fishing gear, namely crib, body 1, body 2, wing, scoop net and the main fence (Fig. 1). The measurements of the fixed stake trap unit are shown in Table 1.

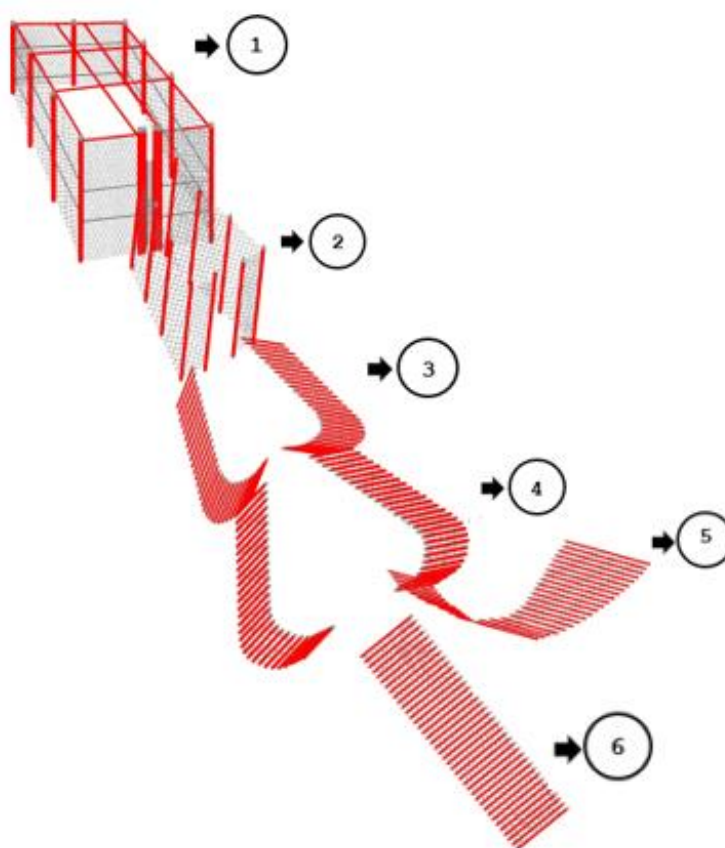


Fig. 1. Design of the fixed stake trap consisting of the crib (1), body 1 (2), body 2 (3), wing (4), scoop net (5) and main fence (6). The poles used are shown in red.

Table 1. Specifications of the fixed stake trap constructed for white-spotted spinefoot *Siganus canaliculatus*.

Component	Length	Number of poles	Height	Slope	Opening width
Crib	4.75 m	14	3.15 m	-	7 cm
Body 1	4 m (left/right)	8 (4 left/4 right)	2.50 m	35°	20 cm
Body 2	10 m (left/right)	20 (10 left/10 right)	2.50 m	35°	40 cm
Wing	35 m (left/right)	70 (35 left/ 35 right)	2.50 m	45°	75 cm
Scoop net	35 m	35	2.50 m	65°	80 cm
Main fence	110 m	110	2.50 m	Perpendicular to the shoreline	75 cm

The PVC pipes were filled with cement, sand and iron. Likewise, the mesh sizes were adjusted for the different parts of the trap. The used mesh size for crib, body 1 and body 2 was 1.25 cm, 1.5 cm for the wing, scoop net and main fence. After the preparations of the material, the fixed stake trap unit was installed at the fishing ground location, where the water depth was 2.75 m and 1.25 m during the highest and lowest tide, respectively. The distance from the coastline was about 1 nautical mile (1.870 m) and the area was sandy coral rubble substrate.

The fixed stake trap unit was monitored for its robustness. The catch data from the newly constructed fixed stake trap was recorded daily for 5 months. Although besides white-spotted spinefoot, there were other fish species caught in Karang-karangan, but they were insignificant in numbers. In addition, 25 fishers were interviewed for feedback on PVC pipes for fixed stake trap construction and operation and the mesh size change.



Fig. 2. Aerial picture of fixed stake trap constructed with the use of PVC pipes and mesh net.

Table 2. Range of length and weight of the main catch of white-spotted spinefoot *Siganus canaliculatus* from the fixed stake trap.

Month of 2019	Minimum length(cm)	Maximum length(cm)	Mean (cm)	Standard error(cm)	Minimum weight(g)	Maximum weight(g)	Mean (g)	Standard error(g)	Number of fish
July	9.4	19.2	14.30	4.90	11.5	97.0	54.25	42.75	258
August	11.5	20.0	15.75	4.25	21.0	133.0	77.00	56.00	90
September	9.8	19.3	14.55	4.75	11.5	106.0	58.75	47.25	226
October	8.8	16.7	12.75	3.95	8.0	49.0	28.50	20.50	243
November	8.6	14.6	11.60	3.00	7.5	43.5	25.50	18.00	41

Besides the durability of using PVC, there were no organisms attached to the PVC poles over 2.5 years. The use of wood resulted in biofouling within 1 month with barnacles (*Balanus* sp.) as the dominant species. Previous studies have also reported the attachment of barnacles to wooden poles (Treu et al., 2019; Esfandiar et al., 2020; Rubal et al., 2021). The leading

Results and Discussion

Interviews with fishers revealed that approximately 300 logs were used to construct a fixed stake trap unit in the past. The maximum endurance of the wood in marine waters was 4 months. Hence, fishers generally replace their fixed stake trap poles annually between three to four times. Thus, between 900 to 1200 logs were used to construct one fixed stake trap in a year. The PVC pipes as a substitute for wood in the construction of fixed stake trap poles were still intact after 2.2 years (Fig. 2), and expected to be durably for 5 years. To avoid pollution, PVC pipes that are no longer suitable for use will be transported ashore for other purposes such as fence posts for plants.

Table 2 indicates that the fixed stake trap allows small white-spotted spinefoot with the size of less than 8.6 cm to escape this fishing gear. The length class interval and number of fish data are shown in Table 3.

cause of biofouling is the attraction to the oil content in the wood. The barnacles stick to the wood's surface and the crevices. The speed of the biofouling process is associated with the different materials or structures submerged in the sea (Shevalkar et al., 2020; dos Santos et al., 2020; Luoma et al., 2021).

Table 3. Length class interval of *Siganus canaliculatus* caught in the fixed stake trap from July to November 2019.

Length class interval (cm)	Number of fish	Length class interval (cm)	Number of fish
8.6-8.9	62	14.3-14.6	104
8.9-9.2	110	14.6-14.9	86
9.2-9.5	154	14.9-15.2	88
9.5-9.8	147	15.2-15.5	91
9.8-10.1	186	15.5-15.8	111
10.1-10.4	203	15.8-16.1	89
10.4-10.7	253	16.1-16.4	59
10.7-11.0	295	16.4-16.7	72
11.0-11.3	428	16.7-17.0	41
11.3-11.6	324	17.0-17.3	64
11.6-11.9	322	17.3-17.6	46
11.9-12.2	285	17.6-17.9	35
12.2-12.5	259	17.9-18.2	34
12.5-12.8	249	18.2-18.5	23
12.8-13.1	168	18.5-18.8	20
13.1-13.4	167	18.8-19.1	16
13.4-13.7	130	19.1-19.4	15
13.7-14.0	117	19.4-19.7	10
14.0-14.3	105	19.7-20.0	8

Compared with the mesh size of fixed stake traps operating in other areas (Table 4), this study's gear design can be categorised as environmentally friendly fishing based on FAO criteria 1995 (Karim et al., 2020). In other places, as indicated in Table 4, the fixed stake trap is used to catch different species such as flower crab, *Portunus pelagicus* (Linnaeus, 1758), banana prawn, *Peneus merguensis* de Man, 1888, and sunrise goatfish, *Upeneus sulphureus* Cuvier, 1829, (Tenriware et al., 2018) in Mandar Bay. In South Sulawesi, the fish caught were orange-spotted grouper, *Ephinephelus coioides* (Hamilton, 1822), malabar grouper, *Ephinephelus mallabaricus* (Bloch & Schneider, 1801), honeycomb grouper, *Ephinephelus merra* (Bloch, 1793), white-spotted grouper, *Ephinephelus caeruleopunctatus* (Bloch, 1790),

brown-marble grouper, *Ephinephelus fuscoguttatus* (Forsskål, 1775), longfin grouper, *Ephinephelus quoyanus* (Valenciennes, 1830), convict grouper, *Hyporthodus septemfasciatus* (Thunberg, 1793), and wavy-lined grouper, *Ephinephelus undulosus* (Quoy & Gaimard, 1824) (Tenriware et al., 2013). In contrast, in Southeast Sulawesi the fish caught using the same gear was only common silver-biddy, *Gerres oyena* (Forsskål, 1775) (Ermayana et al., 2018).

The proposed mesh size for the fixed stake trap in the present study was 2.60 cm. Based on the 5 months data of captured fish (Tables 2, 3), the mesh net size was sufficient to allow white-spotted spinefoot of smaller than 8.5 cm in length to escape the newly proposed fixed stake trap, which supports sustainable fisheries.

Table 4. Comparison of fixed stake trap mesh sizes from various locations in South Sulawesi Province, Indonesia.

No.	Location	Mesh size (cm)	Reference
1	Pitumpanua Wajo Regency (South Sulawesi)	0.5	(Tenriware, 2013)
2	Mandar Bay (West Sulawesi)	0.5	(Tenriware et al., 2018)
3	East Tanete Riattang and Barebbo district Bone Regency (South Sulawesi)	0.3	(Surachmat, 2018)
4	Poso Estuary (Central Sulawesi)	0.025	(Ermayana et al., 2018)
5	Tondonggeu waters Abeli District Kendari City (Southeast Sulawesi)	11.2-12.7	(Ermayana et al., 2018)
6	Karang-karangan Luwu Regency	2.60	Present study

The mesh size of 2.60 cm used in the fixed stake trap is larger than those used in other areas. The larger size mesh net supports sustainable white-spotted spinefoot resources since it allows the small white-spotted spinefoot to escape. However, it will be necessary to collaborate with the PVC manufacturers to produce pipes designed explicitly for fixed stake traps. This will enable wider usage of PVC in the commercial fishing sector. From the feedback of the interviews with the fishers, they were happy to accept this technology transfer by considering the efficiency of the fixed stake trap constructed using PVC. The fishers were also aware that white-spotted spinefoot fishery resources are a characteristic of Luwu's fisheries that must be conserved.

Conclusion

This study showed that PVC pipes could be the alternate option to the traditional use of wood to construct the fixed stake trap, which had to be replaced three to four times a year. The PVC poles strengthened with concrete that has lasted for 2.5 years are expected to last at least 5 years. Thus, due to prolonged durability, there will be a saving of around 75 % (USD3150) with the use of PVC over 5 years. In addition, there was no fouling by barnacles on the PVC poles compared to wood. The mesh size used was 2.60 cm, is still within the normal range and can be categorised as environmentally friendly fishing gear that allows small size white-spotted spinefoot *Siganus canaliculatus* to escape from the fixed stake trap. Working closely with the manufacturers of PVC pipes for industrial-scale production of the right dimensions that are specifically designed for fixed stake traps will further enhance sustainable fisheries of white-spotted spinefoot.

Conflict of interest: The authors declare that they have no conflict of interest.

Author contributions: Irman Halid: Conceptualisation, data collection, analysis, review and writing. Harfika Sari Baso: Conceptualisation, analysis, review and writing.

References

- Chen, J.-L., Hsu, K., Chuang, C.-T. 2020. How do fishery resources enhance the development of coastal fishing communities: lessons learned from a community-based sea farming project in Taiwan. *Ocean & Coastal Management* 184:105015. <https://doi.org/10.1016/j.ocecoaman.2019.105015>
- dos Santos, A.P., Seta, J.H.H., Kuhnen, V.V., Sanches, E.G. 2020. Antifouling alternatives for aquaculture in tropical waters of the Atlantic Ocean. *Aquaculture Reports* 18:100477. <https://doi.org/10.1016/j.aqrep.2020.100477>
- Ermayana, Arami, H., Yasidi, F. 2018. Beberapa parameter reproduksi ikan kapas-kapas (*Gerres oyena*) yang tertangkap pada alat tangkap sero di perairan Tondonggeu Kecamatan Abeli Kota Kendari. *Jurnal Manajemen Sumber Daya Perairan* 4:175-182. (in Indonesian).
- Esfandiari, N., Elmi, F., Omidzahir, S. 2020. Study of the structural properties and degradation of coated wood with polydopamine/hydroxyapatite/chitosan hybrid nanocomposite in seawater. *Cellulose* 27:7779-7790. <https://doi.org/10.1007/s10570-020-03324-1>
- Halim, A., Loneragan, N.R., Wiryawan, B., Fujita, R., Adhuri, D.S., Hordyk, A.R., Sondita, M.F.A. 2020. Transforming traditional management into contemporary territorial-based fisheries management rights for small-scale fisheries in Indonesia. *Marine Policy* 116:103923. <https://doi.org/10.1016/j.marpol.2020.103923>
- Karim, M.S., Techera, E., Al Arif, A. 2020. Ecosystem-based fisheries management and the precautionary approach in the Indian Ocean regional fisheries management organisations. *Marine Pollution Bulletin* 159:111438. <https://doi.org/10.1016/j.marpolbul.2020.111438>
- Luoma, E., Nevalainen, L., Altarriba, E., Helle, I., Lehikoinen, A. 2021. Developing a conceptual influence diagram for socio-eco-technical systems analysis of biofouling management in shipping—A Baltic Sea case study. *Marine Pollution Bulletin* 170:112614. <https://doi.org/10.1016/j.marpolbul.2021.112614>
- Retnoringtyas, H., Yulianto, I., Soemodinoto, A., Herdiana, Y., Kartawijaya, T., Natsir, M., Haryanto, J.T. 2021. Stakeholder participation in management planning for grouper and snapper fisheries in West Nusa Tenggara Province, Indonesia. *Marine Policy* 128:104452. <https://doi.org/10.1016/j.marpol.2021.104452>
- Rubal, M., Maldre, K., Sousa-Pinto, I., Veiga, P. 2021. Current distribution and abundance of *Austrominius modestus* (Darwin, 1854) and other non-indigenous barnacles along the northern coast of Portugal. *Regional Studies in Marine Science* 41:101586. <https://doi.org/10.1016/j.rsma.2020.101586>
- Shevalkar, M., Mishra, A., Meenambiga, S. 2020. A review on invasive species in marine biofouling. *Research Journal of Pharmacy and Technology* 13:4517-4521. <https://doi.org/10.5958/0974-360X.2020.00796.9>
- Surachmat, A. 2018. Jenis-jenis benih ikan kerapu (*Ephinephelus* spp.) yang tertangkap alat aero di daerah ekosistem hutan mangrove, padang lamun dan terumbu karang di Kecamatan Tanete Riattang Timur dan Kecamatan Barebbo, Kabupaten Bone Sulawesi Selatan. *Agrominansia* 3:7-17. (in Indonesian).
- Tenriware. 2013. Analisis hasil tangkapan kepiting rajungan (*Portunus pelagicus*) dan udang putih (*Peneaus marguensis*) pada alat tangkap sero di habitat berbeda. *Jurnal Harpodon Borneo* 6: 135-142. (in Indonesian).
- Tenriware, Mandasari, N.A., Rahman, S.R. 2018. Analisis selektivitas dan hasil tangkapan kuniran (*Upeneaus sulphureus*) pada alat tangkap sero dengan ukuran mata jaring berbeda di perairan pantai Teluk Mandar Polewali Mandar Sulawesi Barat. In: *Seminar Hasil Penelitian (SNP2M)*, pp. 159-164. Politeknik Negeri Ujung Pandang, Ujung Pandang, Indonesia. (in Indonesian).
- Treu, A., Zimmer, K., Brischke, C., Larnøy, E., Gobakken, L.R., Aloui, F., Cragg, S.M., Flæte, P.-O., Humar, M., Westin, M. 2019. Durability and protection of timber structures in marine environments in Europe: an overview. *BioResources* 14:10161-10184. <https://doi.org/10.15376/biores.14.4.Treu>
- Zacardi, D.M., Santos, J.A.D, Oliveira, L.S.D, Cajado, R.A., Pompeu, P.S. 2020. Ichthyoplankton studies as referential for the management and monitoring of fishery resources in the Brazilian Amazon basin. *Acta Limnologica Brasiliensia* 32:e203. <https://doi.org/10.1590/s2179-975x6619>
- Zeng, L., Tang, Z., Chen, P., Yu, J., Chen, G. 2021. Optimization of fishery resources assessment methods and ecological effects evaluation of artificial reefs. *Marine Biology Research* 17:72-85. <https://doi.org/10.1080/17451000.2021.1887497>