Effect of Bait Availability on Pole and Line Fisheries and The Impact on the Amount of Fish Consumption

C Litay¹, D D Pelasula², S M Horhoruw³, and H Arfah²

¹Research Center for Appropriate Technology-Indonesian Institute of Science, Subang, West Java, 41213, Indonesia
²Research Center for Deep Sea-Indonesian Institute of Science, Ambon, Maluku 97233, Indonesia
³Department of Marine and Fisheries Maluku Province, Ambon, Maluku, 97117, Indonesia

Email: christina_litay@yahoo.com

Abstract. Pole and line fisheries are highly dependent on bait availability. The problem of bait lies in stock availability and improper handling methods cause the bait to become stressed and die. This research aimed to analyse the effect of bait on the pole and line fishing process. This research was a survey through field observations. This research used descriptive analysis. Data were collected including on bait, the fishing process, and catch. The results showed that the pole and line process was one-day fishing. The bait volume used was 25 buckets. The pole and line catching process is quite involved and includes the process of transferring the live bait from the hold into the stocking tank using a large hand net with a 32 cm diameter, the chumming process or the process of spreading live bait using a small scoop net with a diameter of 13.5 cm, and the actual fishing process. The total catch was 500 individuals/trip or 2.5 tons, including Katsuwonus pelamis, Euthynnus affinis, Thunnus albacares and Coryphaena hippurus. Fishing was carried out as a one-day fishing process because it was based on the availability of bait. Fish resource utilization is managed by fishermen optimally because it affects fish consumption.

1. Introduction
Indonesia is the largest marine catch producer in the world, which is second only to China. Fish is a highly nutritious fishery product with protein, essential fatty acids, minerals, rich in essential micronutrients, and is an excellent supplement to nutrient-deficient cereal-based diets [1]. Tuna fisheries have an important role in the economy and food security value for the country. The importance of fish for all food security themes needs to be adequately addressed regarding nutrition, fish supply and sustainability, demand, access to fish distribution, and the role of small-scale workers in the capture fisheries sector [2]. Tuna and skipjack tuna resources are widely distributed in almost all Indonesian territorial waters and have important economic values. The high economic value of tuna and skipjack tuna makes it the main commodity of the fisheries sub-sector.

Tuna and Skipjack tuna are large pelagic fish that always migrate from one water to another whose habitat is suitable in terms of biology, oceanographic conditions, and meteorology [3]. This fish is one of the most productive fisheries products in the world, especially the northwest Pacific and is
also in great demand around the world due to its abundant population and high nutritional value. Fish are the main source of nutrition and healthy food for humans [4].

Tuna fisheries in the world when viewed in terms of commercially important species, are based on the sea and the main fishing gear [5]. The fishing of Tuna in Indonesia is mostly carried out using pole and line fishing gear, as well as fishing in the Banda Sea and around Maluku Province with pole and line fishing as the main fishing gear. In Maluku, the biggest target for pole and line fishing is skipjack. The high production of skipjack tuna shows that this fish is one of the mainstay catches of fisheries from Maluku waters which has potential and important economic value with very high nutritional content. In fact, this type of fish is the belle because, in addition to being a consumption fish that people enjoy doing, it is also an export commodity that is widely used by fishermen in Ambon.

Pole and line fishing gear has the advantage of being the most effective, selective fishing gear for skipjack tuna and environmentally friendly, and has a low bycatch [6]. Bycatch in fisheries is a major environmental and resource management problem. Bycatch is the part of the catch that is not targeted but is perhaps the most significant part of the catch that is dumped dead. Currently, minimizing bycatch is one of the most significant challenges facing fisheries [7]. Therefore, pole and line fishing gear is highly recommended for catching skipjack tuna [8], but on the other hand, pole and line fisheries are highly dependent on the availability of suitable bait. The live bait required consists of small (often pelagic) fish and is released into marine waters in living conditions to elicit a feeding response and order to attract tuna schools within reach of the fishing gear [9].

Current conditions show that the main concern of fishing communities is the productivity of pole and line fisheries, with tuna catching being the main export and main source of income for fishermen. Tuna harvests depend on, among other things, the availability of copious quantities of live bait, which is sourced from the coral reefs within atoll basins, and some fishers suggest that bait fish resources are under stress in many atolls [10].

2. Methods
This research was conducted in Seram waters with a fishing base in Galala, Sirimau Ambon District can be seen in ‘figure 1’.

![Figure 1](image)

Figure 1. The research location is in Galala Sirimau Ambon.

The method used in this research is descriptive method with a quantitative strategy (questionnaire techniques and field observations).

2.1. Tools and Materials
Tools used in this research are hand net, scoop net, bait hatch, cooling hatch, bucket, ice block, stationery, and digital camera. The materials in this study were questionnaires, live bait, block ice, and cooled seawater.
2.1.1. **Data collection.** The method used in this research is descriptive method with a quantitative strategy (questionnaire techniques and field observations). According to [9], the descriptive method is a method that describes the characteristics or characteristics of a situation. This study uses a survey method. The data collected are primary data and secondary data. Primary data is obtained through direct observation by following fishing operations using pole and line fishing gear, namely the type of bait, fishing operation and catch. Secondary data were obtained from published studies. The data analysis used in this research is descriptive. Descriptive analysis was carried out on bait (length/weight), fishing operation (length of operation), and catch (the type of fish).

2.2. **Data analysis**

The analysis of the bait size was carried out descriptively, where the length of the fish bait was measured using a ruler and the weight of the fish using an analytical balance. Analysis of the size of the FL skipjack tuna. Length measurements were carried out using a roll meter, while the weight of the fish was measured using a scale. The analysis applied, namely the length of the fish fork (FL) was analyzed descriptively, that is, a length class was made to determine the size-frequency, then a histogram image was made using the Microsoft Excel 2010 program.

### 3. Results and Discussion

3.1. **Bait**

3.1.1. **Type of baitfish.** Live bait is very important in pole and line fisheries and is a limitation to fishing activity. According to [11] the types of bait that are possible to use in pole and line fishing are anchovies, mackerel, sardines, sprats, scads, red-tailed scad, fusiliers, other species. Pole and line fishermen in Maluku usually use anchovies and sardines as baitfish. In the research location, several types of baitfish used by Galala fishermen in the pole and line fishing process were found, namely anchovy (*Stolephorus* sp), make/sardine (*Sardinela* spp), and catfish / mackerel (*Rastrelliger* sp.) with a percentage of anchovy 85% while 15% sardine and mackerel. The size of the baitfish can be seen in ‘figure 2’. The feed obtained from the chart is 25 buckets (75 liters).

![Figure 2. Size of baitfish at the study site.](image-url)

From the interview results, anchovy is more often used for pole and line fishing gear operations by local fishermen because skipjack tuna as a fishing target has been adapted to eat live anchovy bait. Anchovy is one of the baitfish used in pole-and-line tuna fisheries, apart from Cardinal fishes, Silver sprats, Fusiliers, and Chromis. The fish group consisted of anchovy baitfish (*Stolephorus* spp), and other fish species from the Leiognathidae, Trichiidae, Stomatopoda, and Amphipoda families. The three main components are the main diet of skipjack tuna, namely fish, crustaceans, and mollusks [12].
Anchovy bait in Seram waters used by Galala fishermen has a maximum length of about 9.8 cm. Research conducted by [13] found that the maximum length of white anchovies is 10.8 cm in Bima Bay, Nusa Tenggara, when compared with the research of [14], it was found that the bait anchovy size a length was 8-10 cm.

3.1.2. Baitfish taking. Baitfish are pelagic fish as well as fish that are still in the juvenile stage, measuring 5-7 cm, swimming on the surface when being spread back into the sea during the skipjack/tuna fishing operation. Baitfish used in pole and line fisheries are usually buying bait on the bagan or caught by fishermen en route to the fishing ground using a "bagan", trawl and other fishing gear [11].

Traditionally, baiting was carried out first thing in the morning. A simple, cotton lift net was deployed from one side of the fishing boat using long poles. Starting in the 1970s a number of developments and innovations revolutionized the baitfish fishery, especially the use of nylon nets, much larger pole and line vessels, and night baiting using lights. Currently, most bait is obtained at night using lights [10].

The pole and line boat arrived at the baiting point for the first time at 21.00 WIT, waiting for the fishing gear to carry out hauling. The bait bought at the first lifting of the net was not sufficient, so the ship went to another chart to buy live bait which was 02.00 WIT. The process of taking and finding the bait to the chart takes a long time because of the long-distance and also the existence of the bait which is sometimes not always there. Based on the results of the interview, the low stock of live bait was due to the fishing being carried out in February, which was very limited or insufficient for fishing activities. Bait collection was completed at 02.30 WIT and then the live bait handling process was carried out. The process of taking live feeds from the charts must be carried out with care can be seen in ‘figure 3’.

![Figure 3. The process of baitfish taking.](image)

According to [15], the most effective small fish as bait have criteria of bright or silvery color; behavior that has fast, erratic movements in water, returning to the ship after being deployed; able to survive handling and storage onboard for a long time; size is generally considered to be important, although a suitable limit is between 3 cm to 15 cm depending on fishing conditions. The live bait that is often used by local fishermen is anchovies, the main obstacle for this live bait is that its availability at a certain time cannot be sufficient. Pole and line operating activities, so it is necessary to find a solution for alternative types of live bait when anchovies are difficult to obtain or the stock is not sufficient for pole and line fishing gear activities [16].

3.1.3. Baitfish handling. It is necessary to handle live bait so that the bait can survive for a long time and reach the fishing ground. Bait handling begins once it has been removed from the chart and is in the bait hold onboard the vessel. Bait-fish that usually caught in nets placed on the chart and then stored onboard. The handling of bait in the hold should be carried out with great care can be seen in
‘figure 4’. Regulation of the water circulation is very important so that the bait remains alive in the hold.

![Figure 4. Baitfish handling in hold.](image)

To keep the bait alive, several treatments were carried out, including:

a. The bait hatch is washed and cleaned of scales or other debris adhering to the walls of the hatch.

b. The transfer of the bait from the bagang to the bait hold with buckets filled with seawater is carried out quickly and with great care to avoid the risk of fish death due to wounds, loss of scales, and stress.

c. Water circulation regulation, so that the water quality in the feed hold is relatively the same as outside. The circulation of seawater in the hold is maintained, where the circulation of seawater above the ship is removed by using a pump or by making filter holes at the bottom of the ship.

d. Providing lighting at night. Position the lamp hanging in the middle of the hold with a distance of ± 30 cm from the water surface in the hold. The lamp used as a lighting lamp is a 5 Watt incandescent lamp.

e. Removing the dead bait from the hold using scoop net. This is so that the dead bait does not go down to the bottom of the hold and interfere with water circulation.

Based on the observation on the boat, the handling of live bait by Galala pole and line fishermen are not optimal, so that many live baits is stressed and dead. This condition affects the fishing of skipjack tuna with pole and line, because the success of the fishing process using pole and line fishing gear is highly dependent on the availability of bait. If live bait does not reach the required stock, the fishing process is automatically stopped. These results indicate that fishermen's knowledge and skills in handling live bait are needed.

According to [17], bait wastage can be thought of as having three components:

- Poor baitfish handling: for many of the bait species commonly used in Indonesia (e.g. the anchovies Encrasicolina devisi, E. heteroloba), any contact that the fish have with a hard surface (e.g. side of bucket, net, other fish) during the transfer operation will tend to result in scale loss, contributing to mortality.

- The manner in which baitfish are stored aboard a pole-and-line vessel also has a large impact on mortality. This includes the kind of circulation in the bait tanks, lighting of the tanks, and density of baitfish in the tanks.

- The third form of bait wastage is more subtle: using more bait than necessary to chum a tuna school. This involves the fishing skill of the pole-and-line vessel captain and the crew doing the chumming. Much can be done to decrease this wastage, especially for bait handling. Improvements would tend to mitigate baitfish shortages.

The bait problem lies not only in the availability of stock and improper handling methods that cause the bait to stress and die, but there is competition. The reality in the field shows that the bait problem lies not only in the availability of stock, but also due to competition between boat owners who buy bait for pole and line fishing operations and fishermen who prefer to sell baitfish directly to
the market. This condition is due to the higher price of baitfish being sold to the market for public consumption, compared to being sold as pole and line bait. Based on SOP VI regarding bait data in the I-Fish document, it is clear that live bait used in pole and line tuna fisheries is usually caught by fishermen on their way to or in the fishing area. Live bait is caught en route using a bagan, trawl, and other fishing gear. The bait fishery should be viewed as a separate fishery from the Primary target fishery and undertake a separate evaluation [11].

3.2. Fishing operation

Pole and line is a simple method of catching tuna with hook and line attached to a long pole. The fishing method is comprised of two interlinked fisheries; one for live bait and one for tuna. The target species of pole and line fisheries are skipjack, albacore or yellowfin tuna [18]. There are five key stages of a pole-and-line fishing operation: baitfish fishing; school locating; chumming of baitfish, catching fish; and catch storage. The use of bait in a fishing gear operation serves to invite or stimulate fish so the system the operations performed will be more effective [19].

Fishing operations from pole and line fishing units carried out in Maluku waters is a one-day-fishing system, which means that in the early morning fishermen after getting baitfish, then they go to the fishing area which is the place for fishing operations after getting catch and at that time the fishermen also return to the fishing base. one-day-fishing system is effect due to limited baitfish. The process of catching tuna in Seram waters in one trip is presented in ‘figure 5’. The catch is generally sold to small traders, stored in cold storage, or sold to fishery company. Generally, the average fishing operation time starting from the voyage from the landing base, fishing group fishing, fishing groups to returning to the landing base from pole and line units at the study location is 28 hours.

![Figure 5. Skipjack catching process with pole and line.](image)

Preparations that must be made before fishing operations are preparations before the ship departs, including refueling, freshwater, ice, food supplies, and ship documents. Pole and line fishing operations in Seram Waters are carried out one-day fishing. This is related to the problem of live bait availability. If all preparations have been completed, the ship departs at 15.00 WIT. It relates to the calculation of travel time to chart to obtain live bait. The pole and line ships arrived at the baiting point for the first time at 21.00 WIT and the second at 02.00 WIT.

The process of taking and finding the bait to the chart takes a long time. It’s because of the long-distance and also the existence of the bait, which is sometimes not always there. The bait collection was completed at 02.30 WIT. After that the ship headed to the fishing ground. Fishing is carried out around the FADs. At 03.00 WIT the anglers began to prepare the pole and line fishing rods, where the artificial bait was attached to the hook and then used on the fishing rod. The pole and line boat arrived at the fishing ground at around 05.00 WIT. Arrangement of catching is carried out only in the morning at 05.30 - 09.00 WIT and adjusted to the availability of bait.

In pole and line operation, Galala fishermen perform 2 (two) fishing techniques, namely the fishing process by looking for fish schools and the catching process on FADs. The most common process is
fishing on FADs. Tuna are caught from free-swimming schools or around FADs and seamounts. Schools of skipjack prefer to swim close to the ocean surface seeking prey; when they find it they enter a “feeding frenzy”, during which they will bite anything that moves in the water, including the hook of a pole and line. When live bait is released into a school of skipjack, the hungry tuna display this same feeding frenzy behavior, and the tuna are easily caught one after the other [18].

3.2.1. Catching fish by looking for schools of fish
While on the fishing ground, the kerer or buoy-buoy performs surveillance and is also tasked with finding FADs and determining the fishing ground, using binoculars from the bridge of the boat. Natural signs of fish schools such as ripples of water, visible birds flying close to the surface of the water, swooping and grabbing onto the surface of the water, dolphins are seen jumping onto the surface of the water or the surface of the water becomes dark due to the hordes of fish who swim near the surface of the water, then the captain (skipper) directs the ship towards the natural signs with maximum speed.

3.2.2. Catching fish in FADs
When carrying out the fishing operation around the FADs, the ship makes a circular motion around the FADs, a buoy-buoy (ABK who is in charge of throwing live bait around the FADs) has the role of paying attention to where the hordes of skipjack tuna come from, then the ship slowly heads upwards current from FADs. Seram Island waters is a fishing ground in the Maluku region which has potential pelagic fish resources. In the pole and line fishing area, fishermen are assisted by the presence of Fish Aggregating Devices (FADs) or FADs, dolphins, and seabirds which are used to locate tuna. FADs, or ‘FADs’, are floating platforms that are anchored, which work on the basis that tuna and other species gather around the floating object. FADs are focused on fisheries, with benefits such as lower operating costs for fuel for fishing.

Spraying water is intended to obscure the view of the fish, so that they cannot distinguish between baitfish as food or fishing rods, besides that the water spray machine functions to affect the visibility of the fish so that they remain in the bow of the ship. The buoys quickly and actively cast bait towards the schools of fish, after it was estimated that the fish were in the area where the fish were being thrown, were then led to the bow of the boat. When the fish crowd is attracted to approach the ship, the boat engine is turned off and the anglers are ready at the bow of the boat for the fishing process. The fishing process is carried out simultaneously by all anglers. The spread of bait and fishing for skipjack tuna can be seen in ‘figure 6’.

Figure 6. Catching fish in FADs.

The fishing operation is carried out on a one-day fishing basis because it is based on the availability of bait. In the pole and line catching process, three important things must be considered, namely the process of transferring live bait from the hold to the stocking tank using a large 32 cm diameter hand net, the chumming process or the process of spreading live bait using a small scoop net with a
diameter of 13.5 cm, and the fishing process which is carried out quickly jerking and lifting the rod after the fish grabbed the hook onto the deck of the ship. The process of spraying water during the fishing process aims to obscure the view of the fish, so that they cannot distinguish between baitfish as food or fishing rods, besides that the water spray machine functions to influence the visibility of the fish so that they remain in the bow of the ship.

3.3. Catch
In 2014 the skipjack tuna landed at the Ambon fish landing center was 11,730.7 tons. The catch of Galala pole and line fishermen is skipjack tuna with a total catch of 500 individuals/trip or 2.5 tons. The catch of pole and line vessels is more than 80% skipjack tuna with a maximum catch of 10-12 tons per trip. The level of skipjack tuna production depends on baitfish production, so the problem of baitfish availability is a limiting factor for skipjack fisheries in Maluku [20].

In pole and line fishing, other types of fish are caught (bycatch). According to [7], bycatch is defined as the portion of the catch that is not targeted. Minimizing bycatch is one of the most significant challenges facing fisheries today. Other types of fish caught (bycatch) apart from skipjack tuna (*Katsuwonus pelamis*) are tuna (*Euthynnus affinis*), young yellowfin tuna, and lemadang fish (*Coryphaena hippurus*) with a percentage of 75% skipjack fish and 25% other fish can be seen in ‘figure 7’.

![Figure 7](image_url)

*Figure 7.* Catch types a) *Katsuwonus pelamis*; b) *Euthynnus affinis*; c) yellowfin tuna; d) *Coryphaena hippurus*.

In pole and line fishing, the catch obtained is 75% skipjack fish, while bycatch is 25%. argu that the main target of pole and line fisheries is skipjack tuna, ~ 70-85% of the catch, with yellowfin, bigeye tuna, and albacore accounting for ~ 15-20% of the catch. The fish catch size 29.5-32.8 cm FL with a proportion of 47% indicates that the fish are not yet fit to be caught. Research by [21] showed that the juvenile size of skipjack tuna was between 1.4-30 cm. This condition is because the fishing process is not during the fishing season. According to [4], from October to February the Seram Sea area is dominated by skipjack tuna at maturity stage I, and also October to November is the peak of skipjack spawning.

3.4. Fish Consumption
Baitfish is an important factor in small-scale pole and line fisheries, so the availability and sustainability of baitfish must be considered. If the baitfish is scarce or the stock decreases, then the fishery production will experience a decline which causes problems in fish consumption. Lack of fish consumption will affect health and food security. Small-scale fisheries generally make broader direct and indirect contributions to food security than large-scale fisheries [22].

Fish play a particularly important role in improving the nutrition of millions of people in the world [23]. Fishery resources are an important source of proteins, vitamins, and micronutrients, particularly for many low-income populations in rural areas, and their sustainable use for future global food
security [1]. Small-scale fisheries in developing countries play a vital role in contributing directly to food and livelihood security, as well as foreign exchange earnings [24]. Fish consumed by humans generally come from small-scale fisheries and this sub-sector is important for the world's fish supply. Small-scale fisheries in several countries greatly contribute to national food security, both as daily consumption food and traded food products, and can generate foreign exchange income [25].

4. Conclusion
Fishing was carried out as a one-day fishing process because it was based on the availability of bait. If the fish feedstock decreases, fishing operations will be stopped and this will affect the production of the catch. Fish resource utilization is managed by fishermen optimally because it affects fish consumption. Low fish consumption will have an impact on health and food security.

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