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Original Paper

STUDY OF SOUND FREQUENCY OF RED SNAPPER (*Lutjanus argentimaculatus*) AS AN ATTRACTOR (LABORATORY SCALE)

Aristi Dian Purnama Fitri[1], Asriyanto[1], Heri Sutanto[2], dan Widatini[3]

Department of Fisheries, Faculty of Fisheries and Marine Science, Diponegoro University, Hayam Wuruk Street 4A Semarang-50241.
Department of Physics, Faculty of Mathematics and Natural Science, Diponegoro University, Prof. Soedarto Street, Tembalang Semarang

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ABSTRACT

Fish have spesific characteristic of sound frequency. This sound frequency can be received by fish to responds. Connectivity between sound frequency and fish respond indicates that source of sound frequency has been to function as an attractor. The objectives of this research were to determine the sound frequency of L. argentimaculatus and to describe fish respond of the sound frequency that records as an attractor for fish to find to signal in a laboratory scale. Source of sound frequency was L. argentimaculatus with total length 17 – 22 cm that doing some activities to find feed. Attractor that used in this research was a to research sound editting frequency recording of L. argentimaculatus that was feeding activity and sound of feed target.Lowest frequency range of L. argentimaculatus was 100,8 Hz while highest frequency range was 3244,1 Hz with the intensity range was 30 dB to 57 dB. The significant response time difference of L. argentimaculatus was between morning and daytime observation and between daytime and evening observation.

Keywords: Sound frequency, *Lutjanus argentimaculatus*, Sound attractor

Correspondence : Phone. (+62) 816602115, Fax: (+62) 24 – 8311525, (+62) 24 – 7474698,
Email: aristi_dian@undip.ac.id ; asrining@yahoo.com

INTRODUCTION

Red snapper (*Lutjanus argentimaculatus*) is consumable coral fish which has a potential local and global fish market. In Indonesia, *L. argentimaculatus* is exported in fillet, fresh and frozen (Asmara, 2006). Distribution of *L. argentimaculatus* for certain species are limited where *L. argentimaculatus* is rarely captured (Pardjoko, 2001).

Untill now, catch of coral fishes has endangering coral reef ecosystem of its ineffectivity, inefficiency, non selective non environmentally friendly fishing. Further more, high diversity of coral reef ecosystem caused to difficulties on defining fish species and fish size as fishing target. Utilization of passive attractor needs a further study because it effects the captured fish quality.

The role of fish physiology and behavior science is significant in supporting the development of fishing technology. The principle of fish behavior on fishing technique is understanding of fish senses (Gunarso, 1985). Those senses are important to natural behavior of fish. One of those senses is hearing sense (Gunarso, 1985). The terms hearing for fish is the response on sound frequency. Hearing sensory organ on fish is *oktavolateralis* (Fujaya 2002).

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Oktavolateralis points to the system of ear sensory and *linea lateralis* which has ben long known as the system of *acoustikolateralis*. Soud frequency utilization as an alternate of fishing technology is a solution of fishing problems.

The aim of this research is to find out the character of sound frequency of *L. argentimaculatus* in feeding activity, understanding the behavior of *L. argentimaculatus* in responding recording frequency of *L. argentimaculatus,* so that this research could explore the sound frequency resulted by *L. argentimaculatus* while feeding to be used as attractor in laboratory scale.

MATERIALS AND METHODS

This research was held in LPWP (Laboratorium Pengembangan Wilayah Pantai – *Laboratory of Coastal Area Development*) Faculty of Fisheries and Marine Science, Diponegoro University in February to August 2009. The method used in this research was experimental in laboratory scale.

The materials used in this research was 7 red snapper (*L. argentimaculatus*) with average length of 170 – 220 mm. The criteria of *L. argentimaculatus* used in this research was: physical condition was flawless and had a high feeding desire. Food used in this research was fishes which size was adjusted to its mouth size of *L. argentimaculatus.*

The media used was a conical fiber treatment tank wich had 1 m diameter length, 1 m height and 588,75 liters volume. This treatment media was equipped with aeration system. The equipment used to record the sound frequency of *L. argentimaculatus* was *Sea Phone SQ03* with the frequency range of 15 to 20.000 Hz +/- 3 dB while the equipment to replay the sound frequency was *underwater loudspeaker, amplifier, notebook* and stopwatch. The program used to analyze sound data was *Wavelab 5.0a* software wich was used to translate sound frequency to numbers in excel.

Underwater loundspeaker is made of active speaker wrapped with wide plastic and connected to amplifier by a fully wrapped cable. The speaker was connected with speaker aimed to create an optimal sound

Data Collection

Data collection were including 3 steps. First step was to record sound frequency of *L. argentimaculatus* using the tool *Sea Phone SQ03* on feeding time, but previously *L. argentimaculatus* had been starved for 24 hours. This aimed to achieve sound frequency of *L. argentimaculatus* while they are in hunger, so that the feeding response is observed. Second step was cropping recorded sound frequency using *Wavelab 5.0a* software. Frequency cropping was differentiated into two including the part frequency while food was dropped into conical fiber tank and the part of frequency on feeding of *L. argentimaculatus*. With *Wavelab 5.0a software* it could be observed the sound frequency recorded and the intensity of observed sound.

Sound frequency achieved by the hydrophone was then recorded using *Wavelab 5.0a* software. The sound achieved by the recording tool was then directed to the amplifier and verified using headphone and recorded using *Wavelab 5.0a* software. Calculation of sound frequency data in wave was then transformed into sound intensity in decibel (dB). Fish sound frequency was analyzed using FFT (*Fast Fourier Transform*). Sound intensity produced by fish could be transformed into decibel unit using formula below:

dB = 10 x Log n........................ (1)

(n = average frequency/intensity value of FFT and .txt)

The steps of the analysis of sound recording data for sound data processing so that the character of *L. argentimaculatus* sound frequency and intensity on feeding were observed is shown in **Fig 1**.

The third step was to try out the edited sound frequency of *L. argentimaculatus* to observe the response. The edited sound

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frequency was considered as attractor. Try out was held in morning (06.00-07.00 pm), daytime (13.00-14.00 am) and evening (18.00-19.00 am). This aimed to observe the most effective time of *L. argentimaculatus* response to sound frequency attractor. In this case, *L. argentimaculatus* was starved to observe the positive response to the attractor while they are starved. Before the third steps of the research was held, *L. argentimaculatus* were acclimatized to minimize stress caused by the treatment (Fitri 2008).

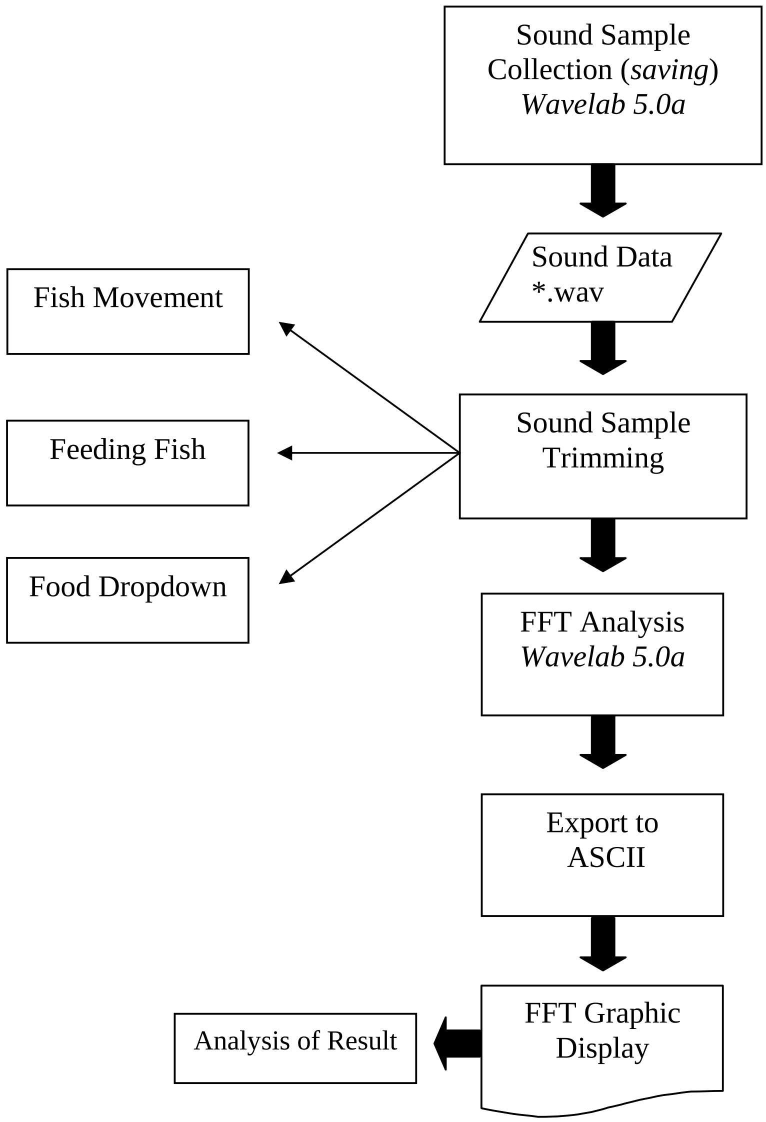

Fig 1. Process of Sound Frequency Data Analysis

Observations were including the response of *L. argentimaculatus* in frequency of fish approach to the attractor and analysis of the behavior of *L. argentimaculatus* to the attractor. Analysis of *L. argentimaculatus* response was done using Analysis of Variance to indicate the difference of response time (morning, daytime and

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evening), then Tukey test was held to compare the paired difference of three groups. *L. argentimaculatus* behavior was analyzed descriptively. Treatment unit were including: Water condition in treatment tank suitable to real condition in the nature.Physical condition of fish in the laboratory represent the physical condition of fish in open waters.Fish condition was considered similar for each treatment.

RESULTS AND DISCUSSION

Character of *L. argentimaculatus* Sound Frequency

Measurement of *Sea Phone SQ03* which had been transformed into numbers in Excel showed that the lowest frequency range was 100,8 Hz and highest frequency range was 3244,1 Hz. While sound intensity range of *L. argentimaculatus* was between 30 dB to 57 dB. Excel data concerning frequency range and intensity is presented in **Table 1.**

Table 1. Sound Frequency and Sound Intensity Range of Red Snapper (*Lutjanus argentimaculatus)*

No	Frequency (Hz)	Intensity (dB)
1	100,8	5,63E+01
2	151,9	5,33E+01
3	192,4	5,08E+01
4	192,4	5,02E+01
5	194,8	4,88E+01
6	234,8	5,42E+01
7	237,8	5,00E+01
8	237,8	4,94E+01
9	237,8	5,78E+01
10	240,7	5,54E+01
11	243,7	5,78E+01
12	256,2	5,06E+01
13	257,7	5,00E+01
14	259,4	5,74E+01
15	262,6	4,90E+01
16	265,9	4,36E+01
17	286,5	5,07E+01
18	293,8	5,21E+01
19	301,2	5,09E+01
20	308,8	5,06E+01
21	312,6	4,73E+01
22	324,5	4,98E+01
23	345,4	4,99E+01
24	367,5	4,79E+01
25	381,5	4,27E+01
26	411,1	4,76E+01
27	416,2	4,73E+01
28	426,7	5,33E+01
29	432,1	5,42E+01
30	471,4	4,67E+01
31	501,6	5,56E+01

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No	Frequency (Hz)	Intensity (dB)
32	527,3	5,26E+01
33	527,3	5,48E+01
34	533,9	5,46E+01
35	547,3	5,65E+01
36	589,7	4,28E+01
37	627,6	3,03E+01
38	635,5	4,32E+01
39	684,7	5,66E+01
40	728,7	5,50E+01
41	737,8	5,53E+01
42	747	5,59E+01
43	756,4	5,57E+01
44	775,5	5,49E+01
45	815	4,41E+01
46	825,3	5,09E+01
47	835,6	4,16E+01
48	1085,1	4,52E+01
49	1228,9	3,44E+01
50	1291,7	3,88E+01
51	1307,8	3,81E+01
52	1391,8	3,47E+01
53	1444,8	3,87E+01
54	1876,3	3,15E+01
55	1923,5	4,66E+01
56	1923,5	4,42E+01
57	1923,5	4,56E+01
58	1947,6	5,09E+01
59	1950,5	4,77E+01
60	1972	4,87E+01
61	1992,6	4,58E+01
62	1995,1	4,38E+01
63	2001,5	3,98E+01
64	2006,5	4,46E+01
65	2021,7	4,45E+01
66	2261,3	4,93E+01
67	2289,6	4,55E+01
68	2292,2	5,06E+01
69	2294,1	4,08E+01
70	2318,3	4,17E+01
71	2529,3	3,71E+01
72	2625,5	3,92E+01
73	2829,1	3,92E+01
74	3244,1	4,47E+01
	Avarage	4,77E+01

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Response of *L. argentimaculatus* to recorded sound frequency

Laboratory observation showed that the frequency of *L. argentimaculatus* approach to the sound frequency attractor on different time resulted a different response pattern (**Fig 2**). Observation in the morning showed the effective period to attract *L. argentimaculatus* was while the attractor was activated for 15 minutes. It indicate that *L. argentimaculatus* had an optimum time to response the sound frequency attractant is 15 minutes. And so did on the daytime observation. Observation on 30 minutes and 60 minutes period decreased the *L. argentimaculatus* approach frequency, showed the exceeding time to the attractant.

Frequency of *L. argentimaculatus* on feeding in the evening showed the different response time compared to morning and daytime observation. *L. argentimaculatus* still positively response the attractant to 30 minutes period. After 30 minutes, the frequency of *L. argentimaculatus* approach decrease until 60 minutes observation period was observed with no response to the attractor. Observation result on response time of *L. argentimaculatus* is showed in **Table 2.** In generally, evening observation showed that the response of *L. argentimaculatus* to the attractor was earlier than morning and daytime observation. Average early response time of fish were less than 80 seconds measured since the hydrospeaker dropdown. Because of its activity was more often in the evening, the response of fish to the sound attractant around it was relatively earlier. This was proven by its approach to the attractant, gather around it, try to touch and move around the attractant. While on daytime observation of fish response was quiet long about 300 seconds (5 minutes).

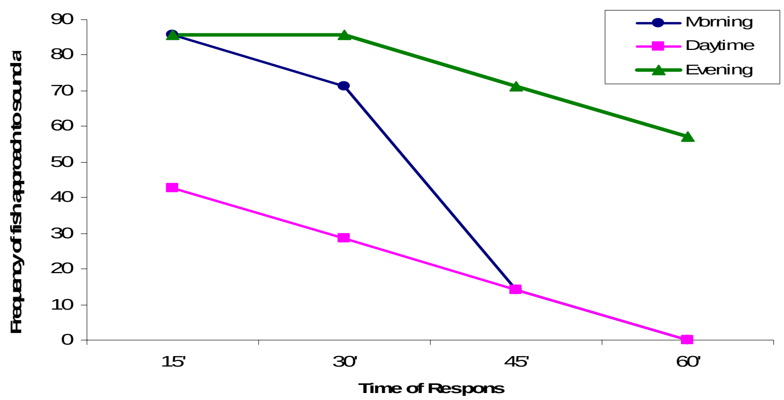

Fig 2. Frequency of *L. argentimaculatus* approach to sound attractor on different observation time

Tukey test showed the significant value of less than 0,05 on treatment period between morning and daytime observation, and between daytime and evening observation ($p < 0.05$) (**Table 3**). This result proved that there is a significant difference of response time of *L. argentimaculatus* between morning and daytime and daytime and evening observation.

Table 2. Response Time of *Lutjanus argentimaculatus* (seconds) on each observation time

Repetition	Observation Time		
	Morning	**Daytime**	**Evening**
1	181	492	46
2	105	697	54
3	57	774	64
4	30	561	58
5	61	849	49
6	63	793	51
7	72	450	61
8	65	467	57
9	59	609	62
Average	**77**	**544**	**56**

.

Table 3. Tukey Test Statistical Analysis

Multiple comparisons

Dependent Variable : Time response (seconds)

Time periods			Mean difference	Std. error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	MORNING	DAY	-466.556*	81.965	.000	-671.25	-261.86
		NIGHT	21.222	81.965	.964	-183.47	225.91
	DAY	MORNING	466.556*	81.965	.000	261.86	671.25
		NIGHT	487.778*	81.965	.000	283.09	692.47
	NIGHT	MORNING	-21.222	81.965	.964	-225.91	183.47
		DAY	-487.778*	81.965	.000	-692.47	-283.09
Bonferroni	MORNING	DAY	-466.556*	81.965	.000	-677.50	-255.61
		NIGHT	21.222	81.965	1.000	-189.73	232.17
	DAY	MORNING	466.556*	81.965	.000	255.61	677.50
		NIGHT	487.778*	81.965	.000	276.83	698.73
	NIGHT	MORNING	-21.222	81.965	1.000	-232.17	189.73
		DAY	487.778*	81.965	.000	-698.73	-276.83

*The mean difference is significant at the .05 level

Time periods		N	Subset for alpha = .05	
			1	2
Tukey HSD[a]	NIGHT	9	55.78	
	MORNING	9	77.0	
	DAY	9		543.56
	Sig.		.964	1.000

Means for groups in homogeneous us subsets are displayed
a. uses harmonic mean sample size = 9.000.

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Discussion

Sound frequency and intensity of *L. argentimaculatus* on feeding is stridulation signal value of *L. argentimaculatus* while feeding. Stridulation is sound resulted by bones activity such as *pharynx* utilization on other hard bodyparts (Popper and Platt, 1993). Stridulation resulted by feeding activity as a result of teeth movement (pharyngeal teeth) is high frequency sound with a wide sound pulse and band (Popper and Schilt, 2008). Low frequency stridulation is unfortunately produced because of swim bladder factor which has function as sound frequency resonance resulted by stridulation factor (Hastings and Popper, 2005). *L. argentimaculatus* is predator fish which used to produce sound frequency on feeding (Tavolga, 1971 *in* Popper and Schilt, 2008). Fish species on the same group would produce difference sound frequency depend on the activity (feeding, communication, spawning, fin movement while swimming, hiding and orientating) and its body size (Popp and Schilt, 2008; Bass and Ladich, 2008; and Komal *et al.*, 2005).

Optimum period to stimulate *L. argentimaculatus* response to the attractor was 15 minutes to 30 minutes. Average *L. argentimaculatus* approach frequency in the evening which is higher than in the morning and daytime indicate that *L. argentimaculatus* is a nocturnal fish. Activity in the evening is moreover compared to morning and daytime activity. Yushinta (2004) mentioned that several fish species had the low sight capability as in nocturnal fishes. As substitute, those fishes has *linea lateralis* and other senses which are more sensitive to sense its surrounding.

Sound harmonization achieved by *L. argentimaculatus* on sound attractant stimulation in the evening was relatively longer than in the morning and in the daytime showed the higher frequency of approach on sound stimulation showed that *L. argentimaculatus* is nocturnal fish (**Fig. 3**). Sound frequency achieved by fish and capable to give response in longer period could figure the feeding activity time (Santiago and Castr,o 1997).

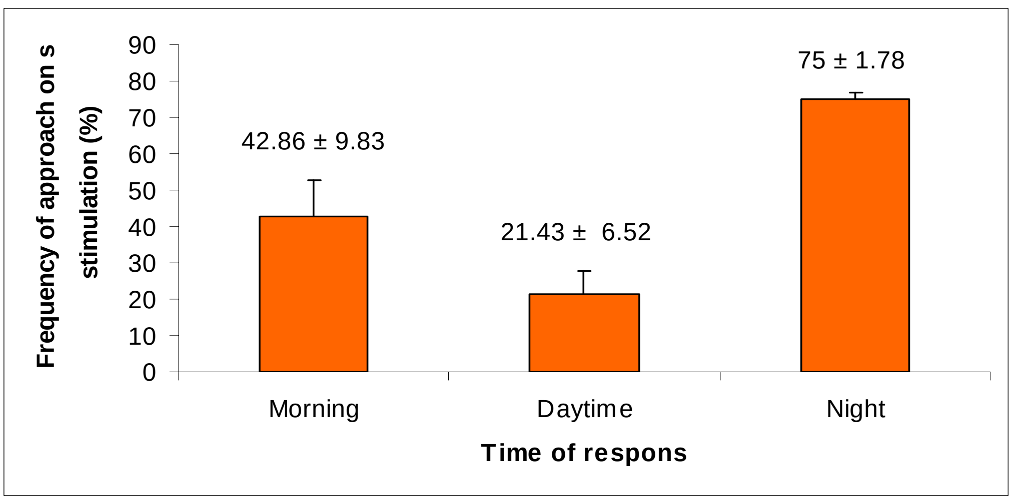

Fig 3. Frequency of *L. argentimaculatus* approach to sound stimulation on different observation time

Response of *L. argentimaculatus* by sound frequency attractor indicate that sound frequency attractor which source is *L. argentimaculatus* sound frequency while feeding is auditory signal to detect food availability (Scholz and Ladich, 2006; Amorim *et al.*, 2008). Gunarso (1985) and Fujaya (2004) treatment on fish has function

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as stimulator of natural senses, has optimum period to response. Fay and Walton (2008) mentioned that fish organ which has a role in detecting sound frequency are inner ear, swim bladder and linea lateralis. Those three sensory organs are available in *L. argentimaculatus*.

CONCLUSION

Lowest sound frequency range of *L. argentimaculatus* is 100,8 Hz and highest sound frequency range was 3244,1 Hz with the intensity range between 30 dB and 57 dB. The difference of *L. argentimaculatus* response time was significant between morning and daytime observation and between daytime and evening observation.

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