音波発生器の効果試験

Test of sound generator

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1985年に試作した4台の音波発生器に新たに製作した2台の音波発生器を加えて合計6台とし、2隻の独航船の流網に各々3台の音波発生器を取付けた。混獲されたイシイルカの水平・垂直分布を調べ、音波発生器の有効性を検討した。

1. 実験期間

1987年6月7日～7月11日　操業30回

2. 実験船

明洋丸船団　　第58幸進丸

喜山丸船団　　第68弁天丸

3. 実験機器及び方法

3.1 音波発生器

音波発生器の詳しい仕様は、1985年のINPFCドキュメント[1]に述べられている。音波発生器は20～50 kHzの周波数範囲でパルス波とFM波をランダムに発生するもので、その最大音圧は1 *m*の距離で186 dBである。

電池と電子回路はブイの中に収納し、送波器はブイの下部に取り付けられ、水平方向には無指向性で超音波が発射される。機器の作動時間は12時間に設定され、揚網後翌日の使用にそなえ充電される。

3.2 音波発生器の取付け位置

音波発生器は中空糸3本を中央部に水平に編込んだ中空糸網に取付けた。

表1の水平区分の欄に記入してあるように、網端から55, 110, 165反目の3カ所に55反間隔で音波発生器を取付けた。従って音波発生器は水平区分2の中間、水平区分3と4の境目、水平区分5の中間に位置した。

3.3　データの採取

各実験船の通信長に混獲イルカの種別、生死、頭数、混獲位置などを所定の用紙に記入して貰った。

4. 結果及び考察

4.1　機器の使用状況

6台の音波発生器は全て実験期間中正常に作動し、流網に絡まることもなかった。

4.2　混獲イルカの分布

両実験船とも30回操業し、音波発生器は全操業にわたって使用された。流網全体を水平9区分、垂直3区分に分割し、混獲イルカの位置を表1，2に示した。水平分布については混獲イルカの相対的位置を正確に示すため、水平方向の長さを一定の縮尺で記入した。

混獲イルカは両実験船ともイシイルカ6頭で、CPUEは0.200頭/回（以下、同じ）であった。1987年は全ての網に何らかの混獲回避技術が施されていて、従来比較対象であった一般網が無くなった。中空糸又はマルチ糸を中央部に水平に3本編み込んだ流網を各々中空糸網（AT）、マルチ網（MT）とし、実験網（ET）と比較した。中空糸網の船が100隻、マルチ網の船が27隻である。

実験網と一般網のCPUE及び前者の後者に対する比率は、1985年で各々0.325, 0.445, 73%、1986年で各々0.250, 0.331, 76%であった。CPUEの年変動があるにしても、過去2カ年の一般網のCPUEに比べ今回の実験網のCPUEは大きく減少している。

表3に示したように1987年の操業について実験網と同じ船団の中空糸網のCPUEを比べると、前者の方がほぼ一割減少しているが、音波と中空糸の相乗効果は期待した程大きくない。

今までの音波発生器の効果試験[1,2]では音波発生器と混獲イルカの間の最短距離は750～1,050 mであり、音波の到達範囲は大きめに見積って水平区分1～6と考えられる。音波が到達する水平区分1～6と音波が弱まる水平区分7～9のCPUEを計算し表4に示した。中空糸網とマルチ網では両者に大きな差がないが、実験網では前者が後者の½となっている。このことは音波によりイルカが遊泳コースを変えさせられ、7～9区分に多く羅網する可能性があることを示している。水平区分1～6における実験網のCPUEは、中空糸網やマルチ網のそれらに比べ約27%減少していて、音波の効果が認められる。

各区分の混獲数を総混獲数で割って混獲分布を計算し、表5, 6に示した。

垂直分布に関しては、実験網の合計の混獲分布がその他の網の場合と似ているが、個別に詳しく調べると第58幸進丸では上部の混獲が多く、第68弁天丸では中間部の混獲が多くなっている。

表7に混獲イシイルカの絡まり状況の分布を示した。その他の網に比べると第68弁天丸では尾びれによる単純絡まりが多く、第58幸進丸では複雑絡まりが多いが、その理由は分らないので今後の検討が必要である。

今回の試験では音波発生器と混獲イルカの間の最短距離は670 mで、今までのデータに比べや

や小さくなっている。音波発生器の有効距離の試算[2)]では440～740 mであり、今回の最短距離はこの範囲に含まれる。音波発生器の有効範囲を広げるには、音圧が低くても威嚇効果が期待できる音、例えば生物学的に意味のある断末魔の悲鳴などを利用することを考えねばならない。

参 考 文 献

1) Y. Hatakeyama, 1986 : Test of new-type sound generator, Document submitted to the meeting of the Scientific Subcommittee of the Ad Hoc Committee on Marine Mammals, INPFC, Tokyo, Japan.

2) Y. Hatakeyama, 1987 : Test of sound generator, ibid.

Table 1. Distribution of Dall's porpoises entangled (Kōshin-maru №58)

▲ Sound generator

● Porpoise entangled

Date of retrieval	Vertical section	Horizontal section								
		1	2 ▲	3 ▲	4	5 ▲	6	7	8	9
June 8	Upper								●	
	Middle									
	Lower									
	Upper					●				
	Middle									
	Lower									
June 18	Upper								●	
	Middle									●
	Lower									
June 28	Upper									
	Middle									
	Lower			●						
July 5	Upper	●								
	Middle									
	Lower									

Table 2. Distribution of Dall's porpoises entangled (Benten-maru No. 68)

▲ Sound generator
● Porpoise entangled

Dete of retrieval	Vertical section	Horizontal section								
		1	2 ▲	3	4 ▲	5 ▲	6	7	8	9
June 20	Upper									
	Middle							●		
	Lower									
July 6	Upper		●							
	Middle									
	Lower									
July 8										
	Middle									
	Lower									●
July 9	Upper									
	Middle					●	●			●
	Lower									

Teble 3. Comparison of Dall's porpoises' CPUE between EN and AT in the same fleet.

Fleet	E N			A T		
	Set	Number of porpoises entangled	CPUE	Set	Number of porpoises entangled	CPUE
Kizan maru	30	6	0.200	869	187	0215
Meiyo maru	30	6	0.200	870	197	0226
Total	60	12	0.200	1,739	384	0221

EN : Experimental net AT : Air-tube thread net

Table 4. Comparison of Dall's porpoises' CPUE between horizontal section 1～6 and 7～9

Type of net	Set	Horizontal section 1～6		Horizontal section 7～9		Total	
		Number of porpoises entangled	CPUE	Number of porpoises entangled	CPUE	Number of porpoises entangled	CPUE
E N	60	6	0.150	6	0.300	12	0.200
A T	2,634	356	0.203	205	0.234	561	0.213
M T	628	87	0.208	35	0.167	122	0.194

EN : Experimental net AT : Air-tube thread net

MT : Multifilament thread net

Teble 5. Horizontal distribution (%) of Dall's porpoises entangled

Type of net		Horizontal section								
		1	2	3	4	5	6	7	8	9
EN	Koshin-maru No. 58	16.7	0	16.7	0	16.7	0	0	33.3	16.7
	Benten-maru No. 68	0	16.7	0	0	16.7	16.7	16.7	0	33.3
	Total	8.3	8.3	8.3	0	16.7	8.3	8.3	16.7	25.0
AT		8.7	10.2	12.2	11.4	10.9	10.0	11.6	10.2	14.8
MT		12.3	12.3	9.8	16.4	9.8	10.7	7.4	8.2	13.1

Table 6. Vertical distribution (%) of Dall's porpoises entangled

Type of net		Vertical section			
		Upper	Middle	Lower	Unclear
EN	Kōshin-maru No. 58	66.7	16.7	16.7	0
	Benten-maru No. 68	16.7	66.7	16.7	0
	Total	41.7	41.7	16.7	0
AT		47.6	36.5	11.4	4.5
MT		39.4	43.4	13.9	3.3

Table 7. Distribution (%) of state of Dall's porpoises entangled

Type of net		Simple entanglement			Complex entanglement	Unclear
		Caudal fin	Pectoral fin	Mouth		
EN	Kōshin-maru No. 58	20.0	20.0	0	60.0	0
	Benten-maru No. 68	66.7	0	33.3	0	0
	Total	45.5	9.1	18.2	27.3	0
AT		26.4	13.4	14.6	25.7	20.0
MT		18.9	12.3	13.1	31.2	24.6

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TRANSLATION

TEST OF SOUND GENERATOR

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Abstract

Three each of sound generators emitting random waves of 20 kHz to 50 kHz frequency were attached to experimental gillnets used by two vessels, and the effectiveness of using sound generation was examined by comparing the vertical and horizontal distribution of Dall's porpoise incidentally taken. CPUE for the experimental gillnets decreased by only 10%, compared with CPUE for the air-tube thread gillnets of the same fleet. However, since CPUE for the experimental gillnets in horizontal areas 1 to 6 of the net where sound pressure was high decreased by about 27%, compared with CPUE for the other gillnets, the effectiveness of sound generation was recognized. CPUE for the experimental gillnets in the horizontal areas 1 to 6 was one half that of CPUE in horizontal areas 7 to 9 in which sound pressure was low, and was also largely different from the distributions of incidental take for the other gillnets. This was considered to be due to the influence by sound generation. As the effective range of the sound generator is considered to be about 700 m, it is necessary to use a biologically significant sound generator, in order to extend this range.

Three each of a total of six sound generators (4 machines manufactured on an experimental basis in 1985 and 2 machines newly built) were attached to two catcher boats. The effectiveness of sound generator was examined by comparing the horizontal and vertical distribution of Dall's porpoise incidentally taken.

1. Period of experiment

From 1987 June 7 to July 11. 30 operations.

2. Fishing vessel used

Koshin maru No. 58, one of the catcher boats attached to the mothership Meiyo maru. Benten maru No. 68, one of the catcher boats attached to the mothership Kizan maru.

3. Experimental machines and methods

3.1 Sound generator

Specifications of the sound generator were described in an INPFC document[1)] submitted in 1985. The sound generators used for this experiment emit random supersonic pulses and FM waves of 20 kHz to 50 kHz with a maximum sound pressure of 186 dB at 1 m distance.

Batteries and electronic circuits were placed in a buoy and the transmitter that was installed in the lower part of a buoy. Horizontal dispersion of the emitted sound waves was omnidirectional. The times for operation of the sound generators were set at 12 hours and batteries were re-charged after each retrieval in preparation for the next operation.

3.2 Locations in the net of sound generators

The sound generators were attached to the gillnets that contained three air-tube threads knitted horizontally at the central part, as shown in the column of horizontal division in Table 1. The sound

generators were attached to the net at the three positions that were 55, 110, and 165 tans from the end of a set of 330 tans. Therefore, the sound generators were placed in the center of horizontal area 2, the boundary between horizontal areas 3 and 4, and in the center of horizontal area 5.

3.3 Collection of data

The chief wireless operator of each experimental boat recorded on the prescribed form data on incidentally taken porpoise such as numbers, species, whether alive or dead during the retrieval, location in the net where the entanglement occurred, etc.

4. Results and discussion

4.1 Operating condition of the sound generators

All six sound generators operated normally during the experiment and never entangled in the gillnets.

4.2 Distribution of porpoise incidentally taken

A total of 30 salmon gillnet operations were made by two experimental boats. The sound generators were used in all 30 operations. Locations in the set of nets where the entanglement of the Dall's porpoise occurred are shown in Tables 1 and 2. For analysis the set of gillnets was divided into nine areas horizontally and into three areas vertically. The horizontal location of each circle in the body of Tables 1 and 2 reflects the actual horizontal location on the net where the entanglement occurred. A total of six Dall's porpoise were incidentally taken by each experimental boat and CPUE was 0.200. As

measures to avoid the incidental catch were taken in all gillnets in 1987, there were no standard gillnets for comparison as in the past. The results from gillnets knitted with three air-tube or multifilament threads at the center, were compared with those from experimental gillnets. There were one hundred boats with the air-tube thread nets (AT) and 27 boats with the multifilament thread nets (MT).

CPUE values for the experimental nets and the standard nets and their ratio were 0.325, 0.445 and 73% respectively, in 1985, and 0.250, 0.331 and 76% respectively, in 1986. Although there were some annual fluctuations in the CPUE value, CPUEs for the experimental nets in the most recent operations were greatly decreased, compared with CPUEs for the standard nets in the previous two years.

As shown in Table 3, comparison of CPUEs for the experimental gillnets (EN) and air-tube thread gillnets (AT) in the same fleet, shows a decrease of about 10% for the former, but the effectiveness of sound generation plus air-tube threads was not as great as expected. Previous tests of sound generator[1),2)] indicate that the minimum distance between the locations of the sound generator and entanglement of the porpoise ranged from 750 to 1,500 m. Therefore, the attainable range of the sound generation is estimated to cover horizontal areas 1 to 6 at most. The CPUEs for horizontal areas 1 to 6 which appeared to be the attainable range of sound generation and for horizontal areas 7 to 9 at which sound was weakened were calculated as shown in Table 4. There are no large differences between the air-tube thread gillnet and multifilament thread gillnet, but for the experimental gillnet, CPUE in areas 1 to 6 was half that in areas 7 to 9. This indicates that the swimming courses of porpoise were changed by the sound generations, and there are many possibilities that porpoise are entangled in horizontal areas 7 to 9. The CPUE value for the experimental gillnet in horizontal areas 1 to 6 decreased by about 27% compared with CPUEs for the air-tube thread gillnet and multifilament thread gillnet and the effectiveness of sound generation was recognized.

Distributions of incidental catch were examined by dividing the number caught in each area by the total numbers caught as shown in Tables 5 and 6.

Regarding the vertical distribution of incidental catch, although the distribution for the total experimental gillnets was similar to that for the other gillnets, closer investigation showed many incidental catches in the upper part of the net for the Koshin maru No. 58 and the central part for the Benten maru No. 68. (Table 6).

The conditions of entanglement for Dall's porpoise incidentally taken are shown in Table 7. In comparison with conditions of entanglement for other gillnets, there were many simple entanglements by the caudal fin for the Benten maru No. 68 and complicated entanglements for the Koshin maru No. 58, but the reasons for this are not known, and further studies are required.

The shortest distance observed between the sound generator and entangled Dall's porpoise was 670 m in 1987. This was somewhat shorter than the 750 m in 1985[1)] and 1,050 m in 1986[2)]. According to calculations[2)] conducted in the previous year the effective range of the sound generator ranged from 440 m to 740 m. The shortest distance obtained in 1987 is within this range. In order to expand the effective range of sound generators we should consider using biologically significant sounds such as death shrieks, which should have threatening effects even if the sound pressure is low.

REFERENCES AND TABLES 1 TO 7 ARE IN ENGLISH
IN THE JAPANESE DOCUMENT