ESCAPE BEHAVIOR OF THE HAWAIIAN SPINNER PORPOISE
(*Stenella* cf. *S. longirostris*)

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ABSTRACT

Incidental mortality of porpoise (Cetacea, Delphinidae) occurs in the tropical tuna seine fishery. Experiments were carried out in a crowding chamber to determine behavioral responses of trained and naive Hawaiian spinner porpoise (*Stenella* cf. *S. longirostris*) to barriers of purse-seine netting, monofilament webbing, polyvinyl sheeting, rows of floats, and openings of various dimensions in a net wall. The object of the experiments was to generate information to be used in development of rescue gear and methods for the fishery. Openings of less than 1.5 m in width and/or 1 m in depth markedly inhibited escape. Negative effect of a line of floats across an opening at the surface was pronounced. Barriers of visually and acoustically relatively transparent monofilament webbing and polyvinyl sheeting were not apparently detected by porpoise prior to physical contact. Recommendations pertaining to potential design of rescue gear are presented.

Incidental mortality of porpoise occurs in the American purse-seine fishery for tropical tunas (Perrin, 1970). In 1970, the National Marine Fisheries Service began a program of research to develop improved gear and methods to reduce the porpoise mortality due to tuna seining. This paper reports the results of experiments on the responses to netting and other barriers by the Hawaiian spinner porpoise (*Stenella* cf. *S. longirostris*), a form closely related to one of the species involved in the tuna fishery.[2] We studied the response of the spinner porpoise to barriers of net, transparent monofilament nylon webbing, transparent polyvinyl sheeting, rows of floats, and to openings of different dimensions in a net wall. The results of these studies will be applied in the design of an escape opening in the tuna purse seine. The experiments were carried out at Oceanic Institute, Oahu, Hawaii, in May, June, and July 1970.

METHODS AND MATERIALS

THE ANIMALS

Three of the five porpoise (Table 1) used in the experiments had been in captivity at Oceanic Institute and Sea Life Park for various lengths of time and are referred to below as the "trained porpoise"; the remaining two, referred to below

Table 1.—Hawaiian spinner porpoise (*Stenella* cf. *S. longirostris*) used in behavioral experiments.

Name	Date of capture	Sex	Weight at time of capture
			kg
Trained porpoise			
Waimea	Mar. 6, 1969	Male	50.0
Nani	Dec. 4, 1969	Female	59.2
Nohea	Dec. 4, 1969	Male	65.9
Naive porpoise			
Westward	June 11, 1970	Female	72.7
Moana	July 9, 1970	Female	51.3

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[2] Taxonomic note: The spinner porpoise of Hawaii has been variously referred to *Stenella longirostris* Gray 1828, by Nishiwaki (1967) and Tomich (1970), and to *S. roseiventris* Wagner 1846, by Fraser (in Morris and Mowbray, 1966) and Rice and Scheffer (1968). The spinner porpoise of the tuna grounds of the far eastern Pacific has been referred to *S. microps* Gray 1846 (Miller and Kellogg, 1955; Handley, in Hester, Hunter, and Whitney, 1963; Nishiwaki, 1967; Pilson and Waller, 1970) and to *S. longirostris* (Rice and Scheffer, 1968; Harrison, Boice, and Brownell, 1969). No critical review of the genus has been accomplished since True's work on the Delphinidae in 1889. The usage here of *S. longirostris* for the Hawaiian spinner is provisional pending the results of taxonomic studies underway at the Southwest Fisheries Center and elsewhere.

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as the "naive porpoise," were freshly captured, were not exposed to any training procedures prior to the experiments, and were tested immediately upon arrival at the Institute.

THE APPARATUS

The crowding chamber (*Figure 1*) was constructed in a large pool at the Oceanic Institute. The pool, known as "Bateson's Bay," is roughly circular, 24.7 m across at its greatest diameter, and approximately 4 m deep at its center. A smaller holding tank communicates with the pool through a wooden gate. Three hemispherical underwater viewing ports allow surveillance of the entire pool.

Net barriers were placed at various points along the pool wall to construct a circular enclosure or crowding chamber about 20 m in diameter in which porpoise were tested. The crowding chamber had two radial walls of netting that extended from the outer edge of the chamber to a central aluminum mast. One of the walls was stationary and was provided with escape openings of various dimensions. The other wall was movable and was used to drive the animals through the opening in the stationary wall. The movable wall pivoted on the central mast and was supported along the leading edge by an aluminum beam and on the distal end by a plastic float. The edge of the pool was marked at 1° intervals.

The walls were made of tuna purse-seine webbing (4¼-inch stretched mesh [10.8 cm] #42 thread knotted nylon). Flotation was provided by purse-seine-type corkline constructed of 6-inch diameter × 3½-inch (15 × 9 cm) sponge-plastic floats.

The basic escape opening was 18 ft (5.5 m) wide and 6 ft (1.8 m) deep. Flaps of purse-seine webbing were laced in, to variously decrease width to 10, 5, or 2½ ft (approximately 3.0, 1.5, or 0.8 m) and/or depth to 3½, 3, 2, 1, or ½ ft (approximately 1.1, 0.9, 0.6, or 0.2 m). For tests of response to a barrier across the opening at the water surface, a corkline constructed of hollow plastic floats (5 × 9 inch [13 × 23 cm], 4 per m) was strung across the top of the opening. In tests of response to barriers of acoustically low-reflective materials, a panel of 3⅜-inch (stretched) mesh (8.6 cm) #12 monofilament webbing, a panel of 0.38-mm-thick polyvinyl sheeting, or a panel of 1.04-mm-thick polyvinyl sheeting, was laced into the opening.

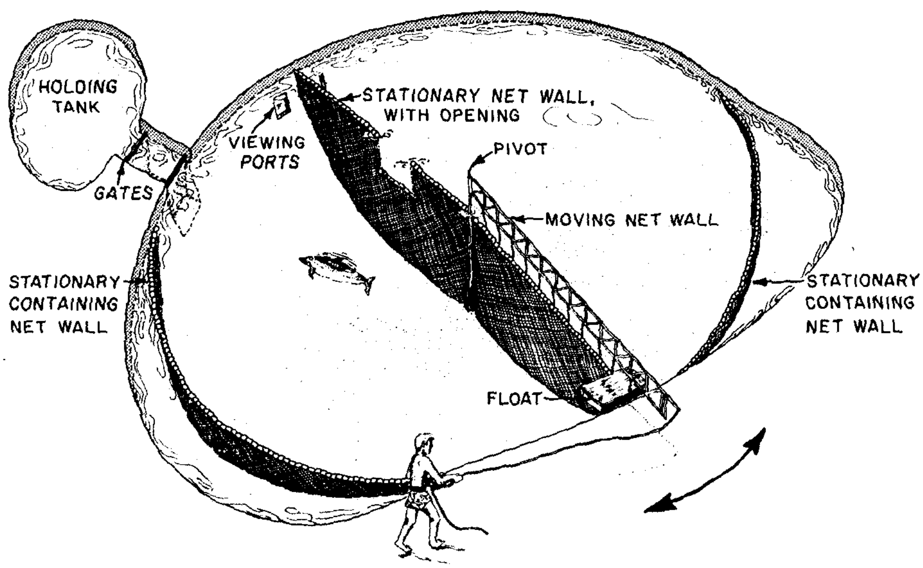

FIGURE 1.—*Crowding chamber.* Largest diameter of pool is 80 feet. Sketch not drawn to scale.

Acoustical tests carried out by the Naval Undersea Research and Development Center, San Diego, Calif., on plastic sheeting of similar thicknesses indicated effective acoustic transparency in the range of porpoise emanations (personal communication from W. E. Evans).

PROCEDURES

The moving wall was rotated around the center mast at a rate sufficient to completely close the chamber in about 4 min. An attempt was made to maintain a constant rate of rotation. Time required for an animal to escape from the chamber was recorded in seconds with a stopwatch, and position of the moving wall at time of escape was recorded in degrees. The reading in degrees was later used to calculate surface area remaining in the crowding chamber at time of escape. The wall was rotated alternately in clockwise and counterclockwise directions. After escape of an animal, the moving net wall was rotated until it was against the stationary wall, and the two radial nets remained together until the beginning of the next trial. Trails were spaced initially at 15-min intervals, to allow time for changing the escape opening. After our proficiency in altering the opening increased, the interval was decreased to 10 min.

Two major types of experimental design were used: (1) a long series of trials alternating two treatments and (2) a series of blocks of consecutive trials of various treatments. In some experiments, the two approaches were combined to yield a factorial design testing simultaneously the effects of variation in two or three of the factors of width, depth, and presence or absence of corkline, monofilament, or polyvinyl barriers. In some tests of the monofilament and polyvinyl panels, the animal was subjected to a single trial with the panel after a series of learning trials without the panel or at the beginning or conclusion of an experiment involving other variables. The design of these experiments is referred to below as "single trial." The results of the first series of experiments (Waimea I, II, and III; see Table 2) using the alternating trials design indicated a probable influence by the direction of rotation of the net wall or by stage of practice effect. The small number of trials in each experiment precluded complete randomization, but the treatments in subsequent experiments were staggered to offset the effect of direction of rotation. A typical sequence of trials was: *a, b, a, b, a, a, b, a, b, b;* where *a* and *b* were different treatments, and rotation in the first trial was clockwise, in the second counterclockwise, and so on in alternating fashion. In this manner, an equal number of clockwise and counterclockwise trials was assured for each treatment.

TABLE 2.—Preliminary experiments with trained porpoise.

Porpoise	Experiment	Variables tested	Design	Number of trials
Waimea	I	Width	Alternating trials	20
	II	Width	Alternating trials	20
	III	Depth, corkline	Factorial	26
	IV	Monofilament panel	Single trial	14
Nani	I	Depth	Alternating trials	20
	II: trials 1-19	Width, depth	Factorial	19
	trial 20	Corkline	Single trial	1
	III: trial 1	Corkline	Single trial	1
	trials 2-16	Depth	Block	16
	trials 17-30	Depth, monofilament panel	Factorial	14
Nohea	I	Depth	Alternating trials	22
	II	Depth	Block	36
	III: trials 1-36	Width	Block	36
	trials 37-44	Depth	Alternating trials	8
	trial 45	Monofilament panel	Single trial	1
	IV	Width, depth, corkline	Factorial	32
	V: trials 1-8	Depth	Alternating trials	8
	trial 9	Thin polyvinyl panel	Single trial	1
	VI: trials 1-8	Depth	Alternating trials	8
	trial 9	Thick polyvinyl panel	Single trial	1

The remaining surface area between the advancing net wall and the stationary wall at the time of escape was used as a criterion of the animals' readiness to escape. This index was the inverse of latency, since the smaller the area that remained when the animal escaped the longer would be the latency. Although we measured latency in seconds, we felt the net position was the preferable measurement because the rate of net movement was imprecise, whereas the actual stimulus for escape, the reduction in the swimming area, could be measured relatively accurately. In presentation of the data, the logarithm (to base 10) of the remaining area at the time of escape is plotted on trial number.

Because procedures and plans were modified during the course of the experiments, results and interpretation are combined in the presentation of the results.

PRELIMINARY EXPERIMENTS WITH TRAINED PORPOISE

We anticipated that the behavior of the porpoise would change rapidly during the course of the experiments; thus, to avoid wastage of the naiveté of the limited and expensive supply of untrained animals, we conducted a series of preliminary experiments with three trained porpoise (Table 2, Figures 2-4).

WIDTH OF OPENING

The effect of the width of the opening on the escape behavior of the three trained porpoise was first tested by presenting on alternate trials an escape route of standard width, 5.5 m, and one either 3.1 or 3.8 m wide. In Waimea (Figures 2-I and II) and Nohea (Figure 4-IV) there was some evidence that the porpoise escaped sooner when the wider escape route was used but not in Nani (Figure 3-II). We felt this was probably an artifact of experimental design as described above and consequently we considered only the data from the block experiments for evaluating effects of width on the trained porpoise. To determine the width of opening that would influence performance, Nohea was tested over six

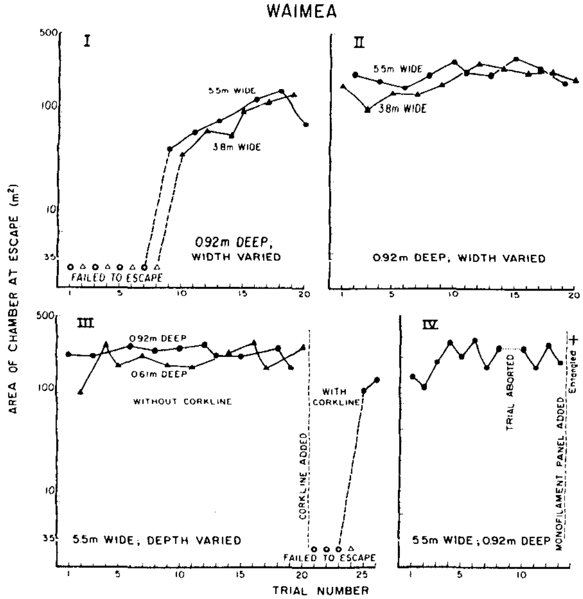

FIGURE 2.—Results of experiments with trained porpoise Waimea. Each plot summarizes one day's continuous experimentation, as follows: I. May 21, II. May 22, III. May 23, IV. May 25, 1970.

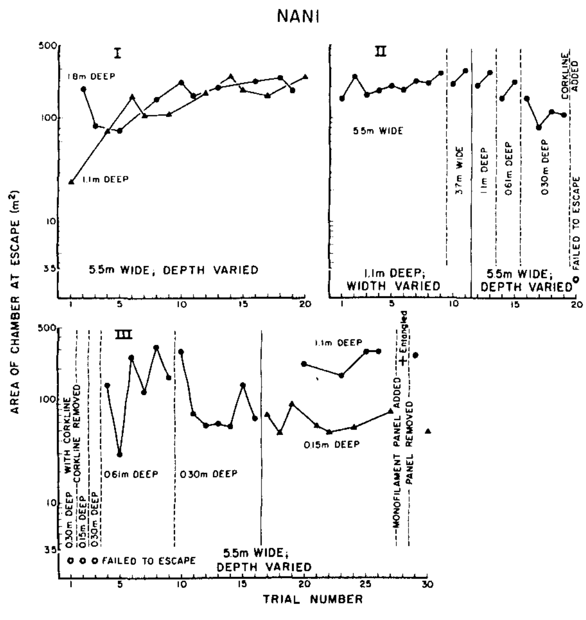

FIGURE 3.—Results of experiments with trained porpoise Nani. I. May 26, II. May 27, III. May 28, 1970.

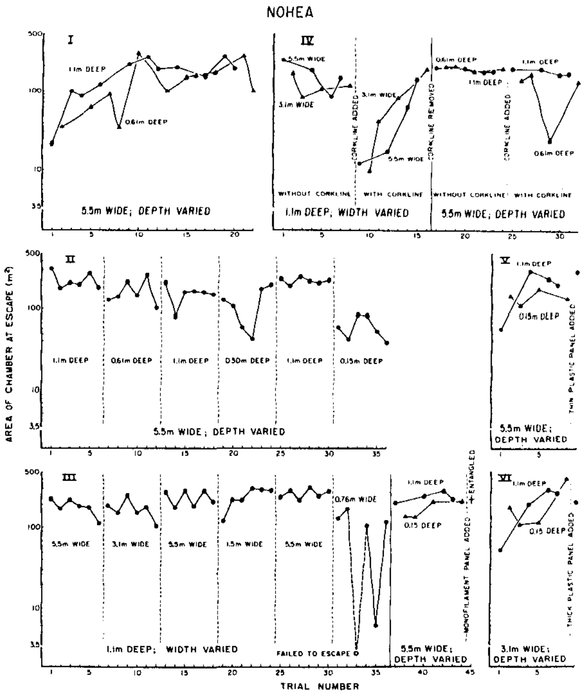

FIGURE 4.—Results of experiments with trained porpoise Nohea. I. May 30, II. May 31, III. June 1, IV. June 21, V. June 28, VI. June 29, 1970.

blocks of six trials each (Figure 4-III). The width of the escape route was 3.1 m in the second, 1.5 m in the fourth, and 0.76 m in the sixth block of experimental trials, with interspersed blocks of trials at 5.5 m. A significant decrease in performance occurred only when the escape opening was narrowed to 0.76 m. In one trial at 0.76 m the animal refused to leave the crowding chamber and had to be extricated from the webbing. In others, the porpoise exhaled air and sank passively to the bottom of the pool and did not move even when the chamber was completely closed. Exhalation of air and sinking to the bottom was a pattern that appeared in other porpoise in other experiments and was accompanied by failure to escape.

Our tentative conclusion was that the width of the opening was not a significant variable in the block experiments if it exceeded about 1.5 m.

DEPTH OF OPENING

We determined the effect of the depth of the escape route by varying depth of the hole from 1.8 m to 0.15 m while maintaining the standard hole width of 5.5 m. We will describe the results for each porpoise separately since the experiments were different for each animal.

Waimea failed in the first eight trials to escape through an opening 0.92 m deep (Figure 2-I). Performance improved thereafter to a plateau that was maintained throughout a subsequent identical experiment the next day, throughout a series of alternating trials with 0.92-m- and 0.61-m-deep openings on the third day of the experiments, and in a fourth experiment (Waimea IV) 2 days later with a 0.92-m-deep opening.

Nani showed no difference in response after the first two trials with openings 1.8 m and 1.1 m deep (Figure 3-I). High performance continued through a series of trials with a 1.1-m-deep opening, but dropped in blocks of trials of 0.61-m- and 0.30-m-deep openings (II). In subsequent experiments Nani failed to escape twice when openings 0.15 m and 0.30 m deep were used and performed erratically in blocks of trials with openings 0.61 m and 0.30 m deep (III). After seven trials with the 0.30-m opening, no failures was experienced in seven trials with a 0.15-m opening, but the animal escaped consistently earlier (larger remaining area) when the 1.1-m-deep opening was used.

Nohea escaped earlier when the hole was 1.1 m than when it was 0.61 m deep in 14 of the first 16 trials of an alternating series (Figure 4-I). In a subsequent series of blocks of trials at decreasing depths (II), a pronounced drop in performance occurred at depths of 1 ft and 5 ft. The following day's performance remained at a high level except when a corkline was strung across the opening (IV).

Our tentative interpretation of the above results was that a critical depth of opening lay near 1 m: 11 failures to escape occurred at 0.92 m or shallower; none occurred with openings 1.1 m deep or deeper; and performance was even more adversely affected by further decreasing the depth of the opening. We also concluded that the results of the first few trials for each animal were of most importance in predicting the probable response of naive wild porpoise, as the animals were able quickly to achieve high levels of performance even at very shallow depths.

CORKLINE

A corkline across the top of the opening caused Waimea (III) and Nani (II) to fail on initial trials, and greatly affected the performance of Nohea (IV). Waimea, after four failures, overcame reluctance to pass through an opening with a corkline at the surface and reachieved a high level of performance. An interaction between the corkline and depth of opening was apparent in the factorial experiment with Nohea. Initial trials with the corkline (second block) produced a temporary drop in performance with a 1.1-m-deep opening. In the fourth block, the corkline was again inserted, and performance dropped at 0.61 m depth but not at 1.1 m.

MONOFILAMENT PANEL

When the panel of nylon monofilament webbing was inserted into the opening (1.1 m deep) after a series of trials in which performance was consistently high, Waimea (IV), Nani (III), and Nohea (III) swam into the webbing as if it did not exist. Performance in subsequent trials without the panel was not affected (Nani III). Upon hitting the webbing, the porpoise became entangled and had to be extricated by a diver.

POLYVINYL PANEL

In the two single trials with a panel of clear polyvinyl sheeting inserted in the opening, Nohea (V and VI) hit the panel and slid over the top as it buckled. No difference was noted in behavior in these trials from that in trials in which the panel was absent.

During these experiments Nohea in several trials passed back and forth through the opening two or three times after the initial escape, while the net wall was being closed. The values for the surface area index shown in the figure are for the first passage. The incidence of such behavior throughout the course of all the experiments occurred only after considerable experience with a particular net configuration. In most cases, only one or two double "escapes" occurred during an experiment.

EXPERIMENTS WITH NAIVE PORPOISE

Eleven experiments were conducted with the naive porpoise (Table 3, Figures 5 and 6). The first naive animal, Westward, was captured on June 12, 1970, and after a relatively short handling period was placed in Bateson's Bay. Her swimming behavior during the first 5 days of captivity was unlike that of the trained porpoise. The trained porpoise continually swam about the tank during and between experiments, diving and "porpoising," and spinning. Westward, on

TABLE 3.—Experiments with naive porpoise.

Porpoise	Experiment		Variables tested	Design	Number of trials
Westward	I		Depth	Alternating trials	20
	II		Depth	Alternating trials	20
	III		Depth	Block	36
	IV:	trials 1-40	Depth, width, corkline	Factorial	40
		trial 41	Monofilament panel	Single trial	41
	V		Width	Block	36
	VI:	trials 1-10	Depth, thin polyvinyl panel	Factorial	10
		trials 11-15	Thick polyvinyl panel	Block	5
Moana	I		Depth	Alternating trials	11
	II		Depth	Alternating trials	20
	III		Width	Block	36
	IV		Depth	Block	24
	V:	trials 1-12	Depth	Block	12
		trials 13-25	Width, corkline	Factorial	13

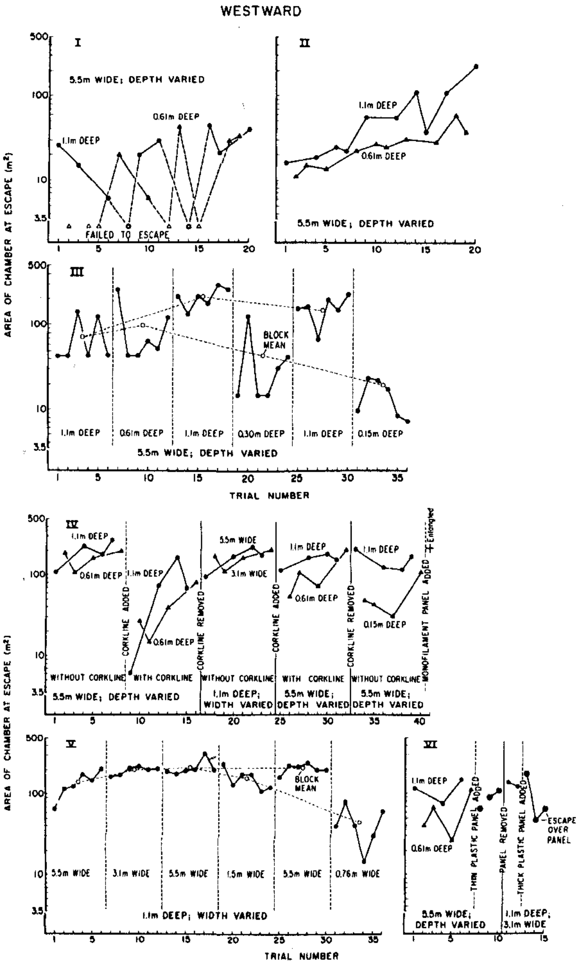

FIGURE 5.—Results of experiments with naive porpoise Westward. I. June 12, II. June 22, III. June 24, IV. June 25, V. June 26, VI. June 29, 1970.

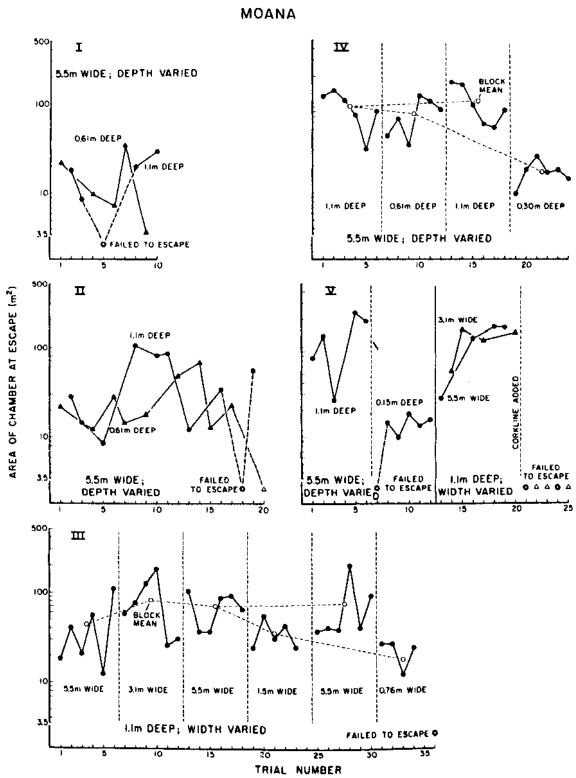

FIGURE 6.—Results of experiments with naive porpoise Moana. I. July 10, II. July 11, III. July 12, IV. July 13, V. July 15, 1970.

the other hand, remained at the surface in a near-upright position with blowhole exposed and rostrum submerged, swimming very slowly with slow, low-amplitude beats of the posterior half of the body. Her head bobbed up and down slightly as she swam. Opinion among the animal-training staff of the Oceanic Institute as to the cause of this behavior was divided; some believed the animal to be in shock, perhaps even moribund, others believed the behavior to indicate extreme fright. The first experiment was carried out the day after capture. Subsequently Westward's behavior slowly changed, until 5 days later on June 17 it was indistinguishable from that of the trained porpoise. The remainder of the Westward experiments were carried out after June 17.

Moana, the second naive porpoise, was captured on July 9, 1970. When placed in Bateson's Bay, she exhibited the same behavior as Westward, but to a lesser extent. Periods of surface swimming in a semiupright position, but without head-bobbing, were interspersed with periods of normal porpoising and diving. During the first experiment she swam slowly at the surface in the diagonal posture but during the second and subsequent experiments, her behavior was similar to that of the trained animals.

DEPTH OF OPENING

In the first few trials (Figure 5-I) a marked difference existed in the response of Westward to an opening 1.1 m deep and one 0.61 m deep. The animal swam slowly at the surface, circling or moving back and forth in the chamber. When the opening was 1.1 m deep, she moved slowly through the opening just as the moving wall closed. When the opening was 0.61 m deep, she moved past or circled slowly in front of the opening and then dove and entangled herself in the webbing of the moving wall. In the sixth trial, her behavior became more varied; she swam in tight circles beneath the surface and attempted to pass between the end of the moving wall and the periphery of the chamber before passing through the opening, after which she slapped her tail against the water surface. Behavior in subsequent trials became increasingly erratic. In trial 13 she darted through the opening rather than moving through slowly as in the previous trials. In trial 14, she tried again to squeeze past the moving wall and became lodged in the narrow opening. In trial 15, she assumed a position across the corkline of the moving wall, half in and half out of the chamber, and remained there until removed. In the remaining trials, she moved rapidly through the opening, and in the last two, she assumed a horizontal attitude similar to that usually taken by the trained porpoise and stopped bobbing her head but still kept her blowhole above the surface.

An identical experiment (II) of alternating trials was carried out 5 days later, after all traces of the slow surface-swimming and head-bobbing behavior had disappeared. Performance was consistently higher with the 1.1-m opening. The effect of depth is clearly seen in the results of a block-design experiment for Westward (III).

The second naive porpoise, Moana, a smaller and presumably younger animal than Westward, achieved a higher rate of successful passage in the first depth experiment (Figure 6-I). She failed only once, with the 1.1-m-deep opening. In the second depth experiment (II) her performance was extremely variable compared to that of Westward, and no relation between depth and success rate existed. In two trials (18 and 20) while swimming in tight circles near the apex of the chamber, she snagged her flipper in the webbing and had to be extricated. In later block-design experiments (V and IV) the effect of depth was evident as it was for Westward.

WIDTH OF OPENING

Results of block-design experiments testing the effect of width of opening for Westward (Figure 5-V) and for Moana (III) were similar to those for the trained porpoise (Nohea), but an effect was discernible at widths of 1.5 m.

As with the other experiments, performance of Westward was higher and more stable than that of Moana. Westward began to pass through the opening two or three times during a single trial. The frequency of multiple "escapes" was higher for the 5.5-m-wide opening than for the narrower openings (Table 4).

CORKLINE

Insertion of a corkline at the surface across the top of the opening sharply affected the performance of Westward (IV) and Moana (V). The performance of Moana showed the greatest effect. After a series of preparatory trials, Moana failed to pass through the opening in five straight trials with the corkline. In each trial she laid the anterior part of her body across the corkline and remained there until removed. In the block-design experiments with Westward (IV), the second block of trials with a corkline produced a smaller drop in performance than did the first, with the 0.61-m-deep opening only, demonstrating as for the trained porpoise (Nohea IV, Figure 4) an interaction between depth and presence or absence of a barrier at the surface.

TABLE 4.—Multiple escapes of Westward.

Width of opening in block of six trials	Number of double escapes	Number of triple escapes
m		
5.5	0	0
3.1	1	0
5.5	2	2
1.5	1	0
5.5	2	0
0.76	0	0

MONOFILAMENT AND POLYVINYL PANELS

When the monofilament panel was inserted into the 1.1-m-deep opening at the end of a series of depth trials, Westward (IV) "got up a full head of steam and plowed into the monofilament" (extracted from field notes of W. Wasden) and became entangled. Insertion of polyvinyl panels produced similar results in multiple trials; Westward (VI) in each trial hit the panel and slid over it and out of the chamber. There was nothing in the behavior of the porpoise to indicate that they recognized the presence of the panels.

DISCUSSION AND CONCLUSIONS

The swimming behavior of the naive porpoise Westward and, to a lesser extent, of Moana, the first few days after capture was very similar to that of porpoise (*Stenella* spp.) in tuna purse seines as observed by one of us (Perrin) off Central America. A typical "failure to escape" episode is illustrated for Moana in Figure 7. Immediately after a purse-seine net has been set, when the diameter of the encircled area is greatest (approximately 250 m), the porpoise swim about quite rapidly in small tight groups of a dozen or so individuals, the members of a group diving and surfacing together (Figure 8). As the net is hauled and the area enclosed becomes smaller, especially after the backing down operation (see Perrin, 1969), the porpoise congregate and raft near the center of the enclosure and mill very slowly, holding their bodies in a semiupright position with blowhole exposed and rostrum at or slightly below the surface (Figure 9). At this point, individual animals can be seen to leave the group and dive. When the net has been completely hauled, animals are often found with their snouts entangled in the webbing several meters below the corkline.

Although the head bobbing exhibited by Westward was not observed in the purse-seine situation, the similarities in behavior between freshly captured animals and those captured in a purse seine were striking. In both cases the animals did not display normal motor patterns; they rested or swam at abnormally slow speeds, and this behavior was often ended by a rapid dive beneath the surface with no noticeable change in behavior preceding the act. The principal characteristics of this behavior, the inhibition of activity in a fear-inducing environment, resembled fear responses described for many other vertebrates and frequently classified as an immobility or freezing response (Ratner and Thompson, 1960; Hinde, 1970). Hogan (1965, 1966) suggested that withdrawal and immobility are separate, mutually inhibitory systems. If this view is correct, then driving porpoise through an escape route in the purse seine would not be successful once the animals began to show the immobility response, because withdrawal would be inhibited. Under these circumstances the additional fear stimulus associated with driving might be the catalyst for the rapid dive to escape, which results in entanglement. Driving may have to be carried out before immobility begins. Once the animals became immobile the only strategy may be to pull the net out from beneath them as is currently done during the "backing down operation" (Perrin, 1969).

That the behavior of Westward and Moana evolved into more typical behavior during the course of a single experiment also supports the notion that their unusual behavior was caused by the circumstance of captivity rather than ill health.

Our conclusions with respect to projected design of a rescue gate for removing porpoise from a purse seine during fishing operations were:

1. The gate should be sufficiently wide so that when the perimeter of the net circle buckles after pursing, the width does not become less than 1.5 m. Considering the equivocal results of the experiments for openings wider than 1.5 m, the opening should be as wide as practically possible.
2. Depth of the opening should be not less than 1 m and as deep as it is possible to make it without causing loss of the fish in the net.
3. There should be no line, corkline, or other barrier across the opening at the surface.
4. A self-actuating release port that will open when struck by a porpoise swimming into it

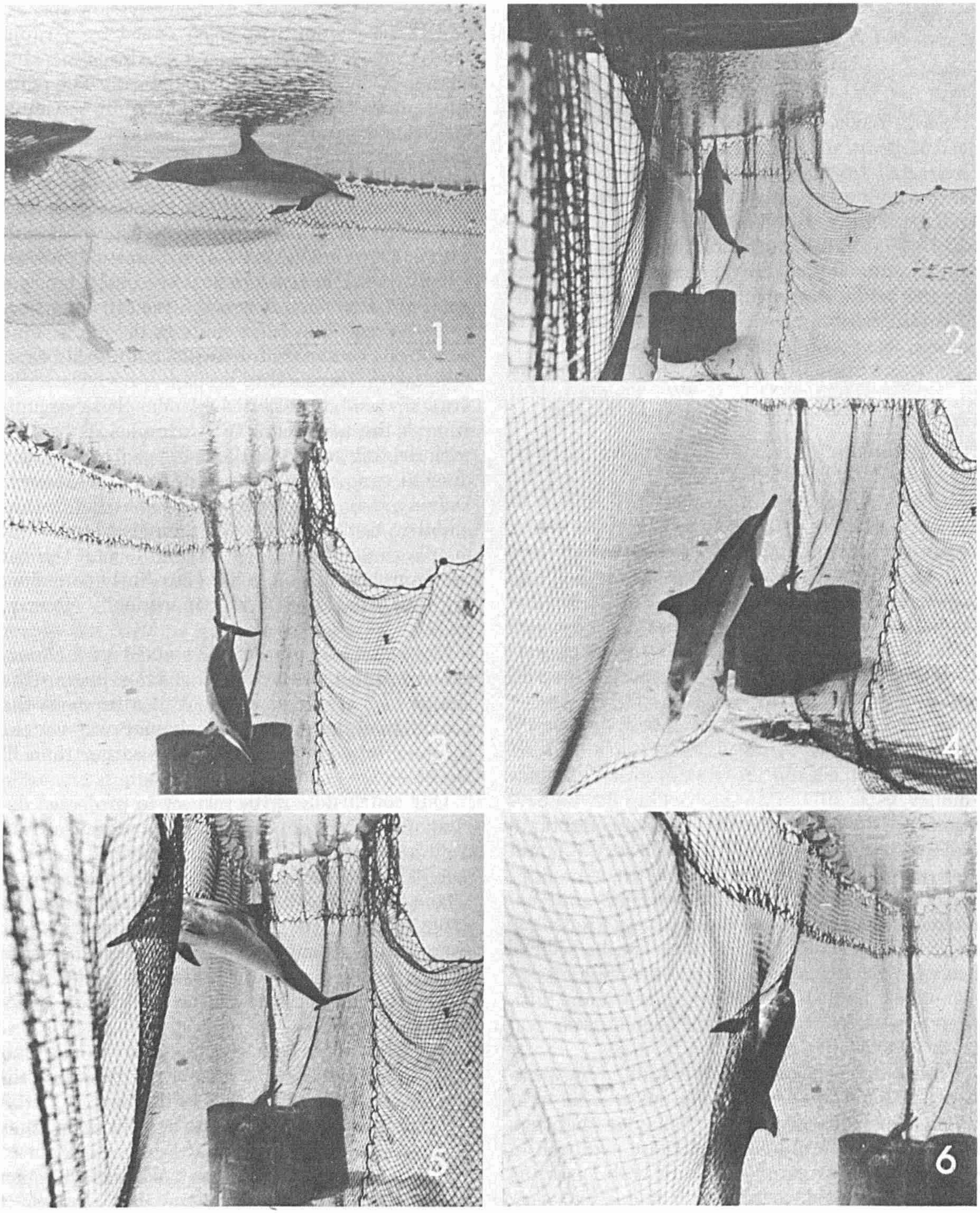
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FIGURE 7.—Typical "failure to escape" episode. Moana (1) patrols moving wall at beginning of trial, then (2) takes up position at apex of chamber and remains there for most of trial, in vertical attitude. As chamber nears closure Moana dives (3), orients toward opening (4), and turns and swims into moving wall (5), becoming entangled (6).

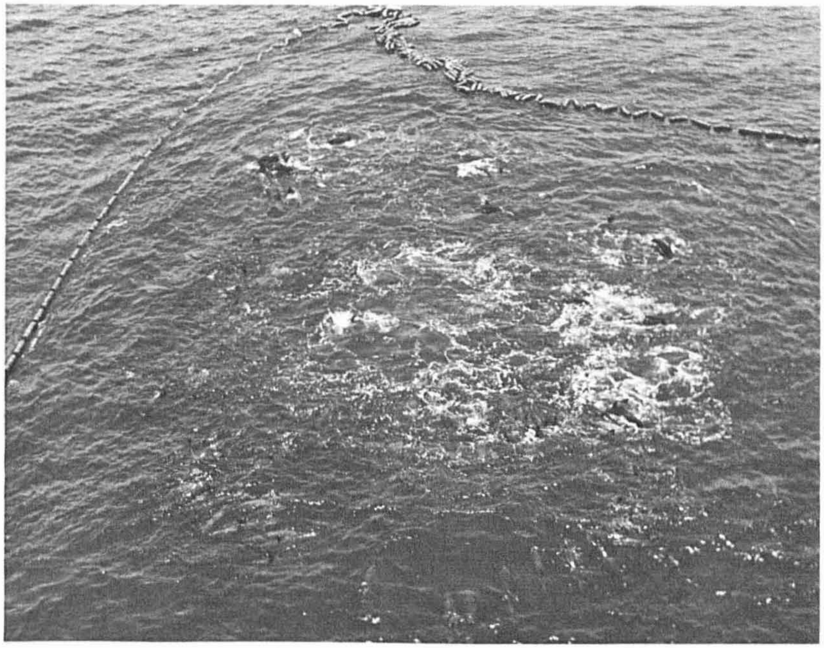

FIGURE 8.—Porpoise (*Stenella graffmani*) in tuna purse seine at beginning of set, when net is at near-maximum diameter. Animals are circling and diving in groups of a dozen or so individuals.

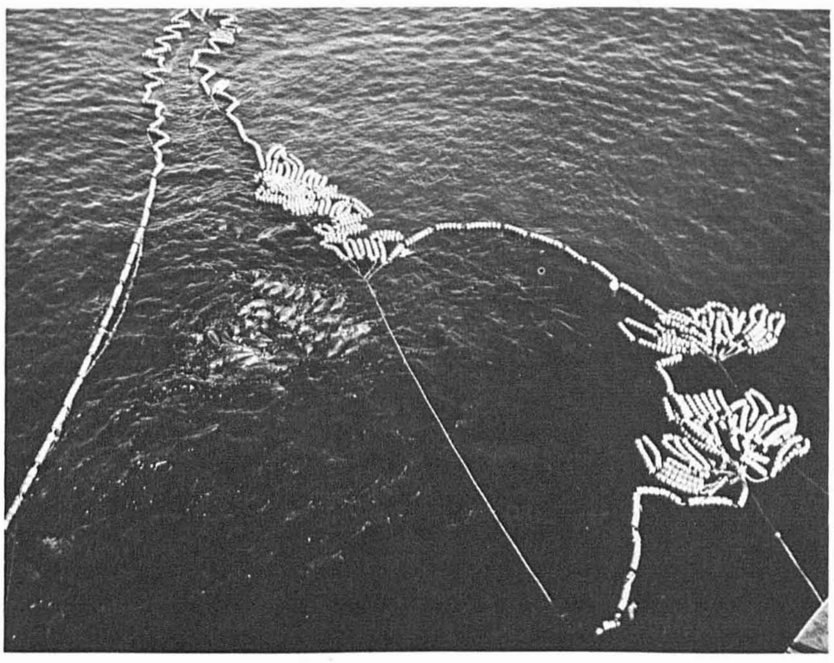

FIGURE 9.—Porpoise in purse seine, after most of net has been taken aboard. Animals are "rafting" in compact group, each maintaining approximately vertical attitude, with blowhole exposed and dorsal fin submerged. Large fish underwater in foreground are yellowfin tuna.

might be feasible if constructed of acoustically transparent materials, providing that it were so constructed that the fish in the net would not also use it.

5. It is to be expected that great difficulty will be encountered in inducing wild porpoise to pass through an opening in the perimeter of a purse-seine enclosure.

ACKNOWLEDGMENTS

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