Preliminary Investigations of the Possible Relationship Between Passive Behavior by Spotted Dolphins, *Stenella attenuata* and Capture Stress

FINAL REPORT TO THE MARINE MAMMAL COMMISSION
CONTRACT #MMC7AC027

by
Warren E. Stuntz

INTRODUCTION

During the cruise of the tuna purse seiner *Elizabeth C. J.*, behavioral observations were made of porpoise in the purse seine (Norris, Stuntz and Rogers, 1978). One unusual behavior pattern that was observed in the purse seine was labeled "passive behavior." Porpoises showing passive behavior are observed to lie on the bottom of the net and to move awkwardly. In searching for a possible reason for passive behavior, one possibility that suggests itself is a syndrome now being called capture stress or capture myopathy.

"Capture myopathy (CM)" is a syndrome caused by severe exercise or muscular tension brought about by stress. CM was first described in Hunter's antelope (*Damaliscus hunteri*), by Jarrett, et al. (1964) and was called muscular dystrophy. These authors examined and described the pathology of antelope that had died during capture. Since that time, the syndrome has been recognized in a wide range of species including mammals, birds, and fishes (Chalmers and Barrett, 1977; Harthoorn, 1973).

Conditions Causing CM

The conditions under which CM occurs are varied but always involve at least a short period of severe stress. Most common is a chase and subsequent capture such as occur in capturing animals for zoos, research, etc. Transporting animals seems to be especially stressful and CM caused by transport is described by Lewis, et al. (1977) for elk (*Cervus canadensis*) and by Chalmers and Barrett (1977) for pronghorns (*Antilocapra americana*). CM-

like symptoms are also seen in domestic animals after transportation and is often called shipping disease.

No cases of CM have been positively diagnosed in a marine mammal. Colgrove (1978) reported on a suspected case of myopathy in a Tursiops truncatus that had been transported.

Walker (1975) describes the responses of Delphinus delphis in an "advanced state of shock" upon being placed in a tank after capture. Their swimming was "erratic", with "low amplitude tail beats." A behavior pattern where an animal sank to the bottom of the tank was often observed. Mortality was high (75 percent within the first 2 months of captivity). Other species had lower mortality rates, however, the mortality was still high. Lagenorhynchus obliquidens, for example, had 50 percent mortality within 6 months of capture; T. truncatus had only a 33 percent mortality within the first year of captivity.

Implications for Tuna-Porpoise Situation

Similarities between the capture of porpoises in the eastern tropical Pacific (ETP) purse-seine fishery (see Norris, et al., 1978 for description of purse-seining) and the capture of terrestrial mammals leads to the possibility that CM could be a problem for porpoises. If capture myopathy is occurring, the actual mortality due to fishing is probably substantially higher than is presently estimated.

To date there are no data available indicating that CM occurs in the porpoises taken during purse-seining operations. There are, however, some behavioral patterns that could be associated with CM. The most dramatic of these is passive behavior. In passive behavior porpoises are observed lying on the bottom of the purse seine during the backdown period. These animals simply lie against the webbing, often on their backs until they aparently need to breathe, at which time they come to the surface. Their movements are awkward and stilted. Other animals show what may be a related behavior called "rafting" where they simply lie at the surface and move about very little. If rafting and/or passive behavior are symptoms of CM the problem is serious and widespread. Fortunately, there are other possible explanations for passive

behavior and rafting (Norris, et al., 1978) but there are as yet no experimental data available upon which to choose among the various possibilities.

With these considerations in mind, attempts were made to gather some preliminary data on whether or not CM might be a problem in the ETP yellowfin tuna purse seine fishery. This work was done aboard a purse-seiner, the Margaret L. under charter to NMFS for studies related to the gear used in the yellowfin tuna purse seine fishery. (See Methods section below.)

My goals were as follow.

1. Conduct in-water observations and experiments to determine if the observed passive behavior of porpoises in tuna purse seines is a manifestation of physiological or psychological stress;
2. As possible, collect blood samples from animals exhibiting various kinds of in-net behavior and have them analyzed to determine if passive animals have abnormal blood chemistries; and
3. Assist NMFS investigators in the preliminary evaluation of techniques and equipment designed to effect the release of porpoise from a purse seine prior to backdown.

The plan for the in-water observations and experiments was to skin dive in the purse seine and locate passive porpoises during backdown. The plan was to touch the passive animals and gauge their responsiveness to handling relative to animals that were not displaying passive behavior. This effort was abandoned due to the depth and chaotic conditions encountered during backdown. Such a plan might be feasible using SCUBA. The same restraints were involved in selectively capturing animals for blood sampling and we finally decided, after several abortive attempts at selectivity, to simply sample blood from as many porpoises as possible.

In addition to the passive behavior study, NMFS personnel were to conduct gear and behavioral experiments to reduce incidental porpoise mortality in

commercial tuna seining operations. Specifically, to study the overall dynamics of the backdown channel and the behavior of porpoise and tuna in relation to modifications of the net in the backdown apex. They were also to continue "rollup" prevention experiments initiated aboard the vessel in May 1977.

During the course of this trip, we encountered generally poor fishing conditions and as a result we made only 18 purse seine sets on porpoises. The very small number of sets and the number of experiments to be carried out, greatly limited the amount of work that could be accomplished.

METHODS

The cruise was conducted in the period of 27 October 1977 to 22 December 1977 aboard the NOAA chartered tuna purse seiner M/V Margaret L., Harvey Wells, Master; Richard Williams, Fish Captain. NMFS Cruise #328, NMFS contract number 03-8-M02-18. The vessel is 262 feet long with a 45-foot beam and a draft of 20 feet, 3 inches. She has a fish-carrying capacity of 2,200 tons. Fishing methods employed are described in Norris et al. (1978).

Porpoises were captured by the 3 scientists aboard the Margaret L. by using rubber rafts in the backdown channel. Up to 3 animals could be captured during a single backdown. A large raft and occupant were stationed on the bow side of the backdown channel at the corkline. As porpoises were backed out, the raft was moved closer to the apex for the taking of live porpoise. With the aid of the raftman (or men) in the small inflatable Avon raft (or rafts) the desired number of porpoises were detained at the end of porpoise rescue. Upon capture a porpoise was placed in a rubber raft. When each raft had a porpoise in it, we would tie the 3 rafts together, detach ourselves from the net and drift while taking the blood samples. The animals in the raft(s) were kept wet by one of us. The other two scientists cooperated in restraining the animal in the large raft and in drawing blood.

Blood was drawn from the underside of the flukes in the large visible vein present there. Depending on our qualitative assessment of the animal's condition, 0 ml - 30 ml of blood were taken before the animal was released.

When sampling was complete the samples were returned to the ship and centrifuged to harvest the serum. Hemolysis was a problem and nearly all of the serum samples were affected to some extent. The serum was then frozen and

maintained in the frozen state until it was analyzed. The serum was analyzed by a commercial laboratory using a SMAC (serum multiple analysis computer). The excess serum was refrozen and then analyzed later for creatinine phosphokinase (CPK), Lactate dehydrogenase (LDH), and their enzymes. (See Table 1 for constituents analyzed.)

The technique for sampling blood from dead animals was different only in that the blood was drawn directly from the heart. With that exception, the samples were treated like those taken from living porpoises.

text continued on page 6

RESULTS

During the cruise, 38 sets were made, of which 18 were on porpoises. A total of approximately 7,345 porpoises were captured along with 172 tons of yellowfin tuna. The 20 non-porpoise sets resulted in 1 ton of yellowfin tuna and 64 tons of skipjack. Porpoise mortality occurred during six sets. Sixteen porpoises were killed during these six sets with mortality rates of 0.89 porpoise per set, and 0.093 porpoise per ton of yellowfin tuna.

During the first 6 sets on porpoises a modification to the backdown channel was tested. The results were unsatisfactory and the system was removed. During two porpoise sets we used dry ice to create a bubble "screen" or "curtain." Due to continual poor weather and current conditions we were unable to make any of the planned prolonged sets.

Blood samples were collected from 15 porpoises. One animal (No. WES 006) (see Table 1) died while blood was being collected and was resampled after death using the sampling techniques for dead animals. A total of 16 samples was taken (the container for one sample broke and was discarded; the data from this porpoise are not included).

In those cases where multiple samples were collected (up to 3, 10 ml samples), each sample was analyzed separately by the SMAC. The results showed very little variation in values between samples and the values for each animal were, therefore, averaged (Table 1).

DISCUSSIONS AND RECOMMENDATIONS

Due to the small sample size no conclusions can be drawn. No significant relationships were found between the chase duration (mean 33.8 min, standard deviation 16.45 min, range 12-61 min) and levels of the various serum constituents nor was the duration of a set (mean 97 min, standard deviation 37.45 min, range 70-172 min) found to be significantly related to the serum constituents

The most important result of this work was a clearer understanding of the difficulties to be encountered in attempting to collect data on CM. Since this first step, a research plan has been developed and is now being implemented by the National Marine Fisheries Service.

The first step of that plan was to convene a workshop on the subject of capture stress. The workshop was held in May 1979 (Stuntz and Shay, 1979).

Table 1. Serum Constituents of Porpoises Sampled.

Sample Number	Position	Sex	Age	LDH* Total V/l	Total Protein g/dl	Globulin g/dl	Albumin g/dl	Inorganic Phosphates mg/dl	Creatinine Phosphokinase(CAK) v/l
Living									
WES 001	30°7'N 110°35'W	Unknown	Two-toned	Off scale	5.8	1.50	4.3	7.2	186
WES 002	31°13'N 110°8'W	Female	Mottled	Off scale	6.6	2.50	4.1	5.0	130
WES 003	"	Female	Mottled	Off scale	6.2	2.45	3.7	5.6	67
WES 006	3°51'N 106°3'W	Female	Speckled	Off scale	6.6	2.50	4.0	5.8	70
WES 007	4°14'N 102°36'W	Male	Adult	Off scale	6.6	2.00	4.6	5.0	28
WES 011	6°8'N 93°42'W	Female	Adult	Off scale	7.8	3.47	4.3	3.8	60
WES 012	"	Female	Adult	Off scale	7.0	2.63	4.3	5.1	18
WES 013	"	Male	Mottled	Off scale	5.3	1.43	3.9	4.4	74
WES 014	7°29'N 85°43'W	Male	Adult	Off scale	6.9	2.43	4.3	6.0	42
WES 015	"	Male	Adult	62.0	7.2	3.10	3.7	4.9	9
Dead									
WAS 006	3°51'N 106°31W	Female	Speckled	Missing	7.4	2.63	4.8	Missing	111
WES 004	3°13'N 111°8'W	Male	Adult	Missing	7.3	3.05	4.2	7.4	149
WES 005	"	Female	Mottled	Missing	8.5	3.20	5.3	9.2	339
WES 008	4°14'N 102°36'W	Female	Speckled	Missing	8.0	3.23	4.7	9.4	74
WES 010	"	Male	Neonate	Missing	4.9	Missing	5.4	Missing	3099

* Lactate dehydrogenase

Table 1. Continued

Sample Number	Sex	Age	Bun/ Creatinine	Cholesterol mg/dl	Total Bilirubin mg/dl	SGPT* U/L	Alkaline phosphatase U/L	SGOT** U/L	Serum Iron mg/dl	Triglycerides mg/dl
Living										
WES 001	Unknown	Two-toned.	39.33	170	.2	64	missing	282	163	71
WES 002	Female	Mottled	51.43	165	.3	84	403	330	145	99
WES 003	Female	Mottled	46.47	172	.2	37	212	224	180	60
WES 006	Female	Speckled	42.00	165	.4	36	436	222	122	51
WES 007	Male	Adult	43.96	248	.4	missing	138	missing	174	78
WES 011	Female	Adult	58.30	158	.4	59	154	259	175	200
WES 012	Female	Adult	54.81	218	.1	33	192	237	126	113
WES 013	Male	Mottled	59.17	166	.2	71	431	254	133	185
WES 014	Male	Adult	50.08	181	.1	76	252	239	158	152
WES 015	Male	Adult	65.56	312	.1	74	100	232	208	230
Dead										
WAS 006	Female	Speckled	36.11	196	0.4	57	488	365	244	54
WES 004	Male	Adult	45.21	181	0.2	75	203	292	180	80
WES 005	Female	Mottled	49.33	[illegible]	[illegible]	[illegible]	23	365	0	178
WES 008	Female	Speckled	48.07	168	0.3	121	500	Missing	182	75
WES 010	Male	Neonate	45.00	260	0.3	Missing	Missing	121	501	438

* Serum Glutamic pyruvate transaminase
** Serum Glutamic oxaloaretic transaminase

Table 1. Continued

Sample Number	Sex	Age	Creatinine Phosphokinase isoenzymes		Lactate dehydrogenase isoenzymes				
			CPK_1 U/L	CPK_2 U/L	LDH_1 %	LDH_2 %	LDH_3 %	LDH_4 %	LDH_5 %
Living									
WES 001	Unknown	Two-toned	115	71	5	17	38	26	14
WES 002	Female	Mottled	90	40	7	18	34	27	14
WES 003	Female	Mottled	40	27	6	18	34	27	15
WES 006	Female	Speckled	50	20	15	15	32	25	13
WES 007	Male	Adult	21	7	4	18	36	30	12
WES 011	Female	Adult	10	50	8	17	35	27	13
WES 012	Female	Adult	10	8	9	11	37	26	17
WES 013	Male	Mottled	30	44	10	15	32	26	17
WES 014	Male	Adult	15	27	8	18	33	26	15
WES 015	Male	Adult	9	0	8	17	33	30	12
Dead									
WAS 006	Female	Speckled	90	21	10	24	32	21	13
WES 004	Male	Adult	100	49	6	17	37	26	14
WES 005	Female	Mottled	150	189	8	17	34	26	12
WES 008	Female	Speckled	60	14	10	22	34	22	12
WES 010	Male	Neonate	1850	1249	24	25	23	17	11

Table 1. Continued

Sample Number	Sex	Age	Glucose mg/dl	Creatinine mg/dl	Urea Nitrogen mg/dl	Uric Acid mg/dl	Sodium mg/dl	Chloride mg/dl	Potassium mg/dl	Calcium mg/dl
Living										
WES 001	Unk	Two-toned	178	1.5	59	1.1	157	119	6.6	6.1
WES 002	Female	Mottled	164	1.4	72	1.2	152	116	5.2	7.9
WES 003	Female	Mottled	154	1.7	79	.8	150	119	4.1	8.7
WES 006	Female	Speckled	122	1.5	63	1.2	156	118	4.9	9.3
WES 007	Male	Adult	100	1.6	68	.7	141	111	6.3	8.3
WES 011	Female	Adult	134	1.2	68	.7	153	118	4.6	8.6
WES 012	Female	Adult	120	1.3	73	1.7	missing	114	5.0	10.1
WES 013	Male	Mottled	122	1.2	71	.8	154	123	5.2	8.0
WES 014	Male	Adult	111	1.3	62	1.5	150	118	5.6	8.3
WES 015	Male	Adult	87	1.0	64	1.5	136	116	6.0	7.1
Dead										
WAS 006	Female	Speckled	117	1.8	65	2.2	157	113	Missing	11.3
WES 004	Male	Adult	213	1.6	74	1.5	158	120	10	10.8
WES 005	Female	Mottled	234	1.5	74	2.8	Missing	119	Missing	0.0
WES 008	Female	Speckled	Missing	1.7	79	3.0	158	117	Missing	12.9
WES 010	Male	Neonate	145	1.6	72	1.1	152	112	Missing	14.5

The workshop concluded that capture stress was probably causing some mortality in porpoises involved in the ETP tuna fishery. The workshop also addressed the problem of how to collect data on the level of stress in dolphins. The major conclusion was that an experiment should be done on Delphinus delphis, the common dolphin, in waters near San Diego, CA. The study would be designed to determine (1) if capture stress occurs in dolphins, and (2) if so, what the best techniques are for measuring the stress levels.

ACKNOWLEDGEMENTS

I thank Mr. James M. Coe and Mr. David A. Bratten of the U.S. National Marine Fisheries Service, Southwest Fisheries Center in La Jolla, California for their enthusiasm and help while at-sea. I thank the crew and skipper of the M/V Margaret L. for all of their assistance. I appreciate the opportunity provided by the Southwest Fisheries Center, to participate in the cruise under their contract.

REFERENCES

Chalmers, G.A., M.W. Barrett. 1977. Capture Myopathy in Pronghorns in Alberta. JAVMA, 171: 918-923.

Colgrove, G.S. 1978. Suspected transportation-associated myopthy in a dolphin. J. Amer. Vet. Med. Ass. 173:1121-1123.

Harthoorn, A.M. 1973. Physiology and Therapy of Capture Myopathy. 2nd Annual Report. In Proceedings. Transvaal Nature Conservation Division. Pretoria, S. Africa. 191 pp.

Jarrett, W.F.H., F.W. Jenning, and A.M. Harthoorn. 1964. Muscular Dystrophy in a Wild Hunters Antelope, E. Afr. Wildl. J. 2:158-159.

Lewis, R.J., G.A. Chalmers, and R. Bhatnagar. 1977. Capture Myopathy in Elk in Alberta, Canada. A Report of Three Cases. JAVMA 171: 927-932.

Norris, K.S., W.E. Stuntz and W. Rogers. 1978. The Behavior of Porpoises and Tuna in the Eastern Tropical Pacific Yellowfin Tuna Fishery - Preliminary Studies. National Technical Information Service AB-283970, 85 pp.

Stuntz, W.E. and T.B. Shay. 1979. Report on Capture Stress Workshop. Admin. Rep. LJ-79-28, Southwest Fisheries Center, NMFS, La Jolla, CA.

Walker, W.A. 1975. Review of the Live-Capture Fishery for Smaller Cetaceans taken in California Waters for Public Display, 1966-73. J. Fish. Res. Bd, Can. 32(7):1197-1211.