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RESPONSE OF PACIFIC WALRUSES TO DISTURBANCES FROM CAPTURE AND HANDLING ACTIVITIES AT A HAUL-OUT IN BRISTOL BAY, ALASKA

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ABSTRACT

Observations were made on herds of the Pacific walrus (*Odobenus rosmarus divergens*) to study their response during the capturing and handling of adult males in summer 1995 at a haul-out at Cape Peirce in southwestern Alaska. Three behaviors (alertness, displacement, and dispersal) were quantified from 16 capture sessions. Herd sizes ranged from 622 to 5,289 walruses. Handling of an immobilized walrus consisted of attempts to attach telemetry devices to the tusks and collect various biological samples. Handling activities resulted in an average of about 10-fold or greater levels of behavior in alertness, displacement, and dispersal than during precapture and darting periods. High levels of behavior usually occurred within the first 45 min of handling. In 8 of 10 capture sessions, walruses returned to predisturbance levels of behavior within 40 min of cessation of the handling disturbance. Alertness and displacement were moderately and negatively correlated with herd size during the handling period, which may reflect an effect of a threshold distance from the point of disturbance to responding individuals. Observations of walruses tagged with VHF radio transmitters indicated that the activities from a given capture session did not preclude tagged walruses from using the haul-out over a subsequent 11-wk monitoring period. Moreover, non-tagged walruses continued to extensively use the haul-out during and after the period in which capture sessions were conducted.

Key words: *Odobenus rosmarus*, Pacific walrus, disturbance, haul-out, capture, behavior, darting, VHF telemetry, Bristol Bay.

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One aspect of walrus research involves immobilizing live walruses to collect biological samples and attach telemetry devices (Taggart 1987, Born and Knutsen 1992, Hills 1992, Stewart *et al.* 1993, Wiig *et al.* 1993). Walruses often haul out in dense and large herds and, while immobilizing and handling a walrus, it is desirable to minimize the disturbance to the surrounding herd. Chronic disturbances may cause herds to abandon a haul-out (Salter 1979, Fay *et al.* 1984, Mansfield and St. Aubin 1991), and disturbance to females with calves may cause them to abandon their calves, leading to increased calf mortality (Fay *et al.* 1984). Little information is available on the response of walrus herds to anthropogenic disturbances, and most of the information available pertains to disturbances caused by aircraft and boats (*e.g.*, Salter 1979, Fay *et al.* 1984). The response of walrus herds to disturbances from capture activities has not been documented previously. The purpose of this study was to provide a preliminary assessment of the immediate herd response and near-term individual response of adult male Pacific walruses to disturbances resulting from the immobilization and handling of individual walruses at a summer haul-out in Bristol Bay, Alaska. The behavior and movement of walruses were monitored immediately prior to, during, and immediately after targeted walruses were darted with an immobilizing drug and handled for a variable length of time. The subsequent use of the study haul-out by previously captured walruses was monitored over an 11-wk period using VHF radio telemetry.

Materials and Methods

Capturing and Handling

All capturing and handling were conducted from 29 July to 7 August 1995 at Maggy Beach, a low-grade sandy beach of approximately 1.5 ha at Cape Peirce in Bristol Bay, Alaska. The walrus herds contained primarily adult males and a small number of juveniles. Only adult males were targeted for capture.

Walruses were captured with an immobilizing drug delivered from a Cap-Chur dart gun (Palmer Chemical & Equipment Co., Georgia) powered by a .22 caliber blank cartridge. To dart a walrus, the shooter crawled to within 5–10 m of the target walrus at the edge of the herd, while the remainder of the 5–7-member capture crew waited in an area out of view of the herd. If the darted walrus was sufficiently immobilized for handling (induction period ranged from 11 to 25 min), the rest of the crew walked up to the immobilized animal. If a walrus was not sufficiently immobilized within about 25 min after darting, it was darted with a reversal drug and was not handled. A capture session is defined here as comprising all activities associated with darting and handling. Sources of stimuli to the herd during handling included the approach of the capture crew to the immobilized walrus, attempts to attach at least one tusk-mounted transmitter, and various other handling activities as time permitted. These included the collection of blood and tissue samples, length and girth measurements, ultrasound measurements of blubber thickness, bioimpedance measurements, and administering isoflurane gas anesthesia.

Immediate Herd Response

All observations were made by the same observer in a blind on a cliff, about 10 m above the haul-out. The sampling area was the beach that was readily visible from the observation blind and extended down to about 7 m below the high-tide line.

Observations were made on the proportion of the herd displaying alertness and displacement behaviors and the number of walruses dispersing from the haul-out. Observations began at least 30 min before darting and continued until all capture activities were completed and the herd appeared to return to precapture levels of activity.

The proportion of the herd displaying alertness and displacement was observed during a single scan of the herd once every 5 min (scan sampling, Altmann 1974). Alertness was indicated when a walrus was in an upright position with its head raised, and displacement was indicated when a walrus was moving toward the water (Salter 1979). The number of walruses dispersing from the haul-out was indicated by the number of walruses that moved toward the water across the tide line within a 1-min period (complete record sampling, Slater 1978) prior to each 5-min behavioral scan. If more than one capture session was conducted in a single day, subsequent capture sessions were initiated only after the herd appeared to calm from disturbances caused by the previous session.

A herd-size estimate was obtained 10–30 min prior to each capture session. Estimates usually consisted of the mean of at least two counts. Counts were often based on an extrapolation of a count from a subset of the herd. In general, herd-size estimates were regarded as coarse estimates because of the difficulty of counting walruses in large herds.

Analysis of variance was used to compare levels of behavior between periods of time which were defined during data analysis. The precapture period had a duration of at least 10 min immediately before darting. The darting period was the time from darting until the immobilized walrus was approached for handling by the capture crew or a second dart was fired to reverse an unanesthetized walrus. The handling period was the time from approach to the immobilized walrus by the capture crew until at least 75% of the crew left the haul-out. If any crew members remained, they stayed a short distance from the herd in a low profile to observe the recovery of the immobilized walrus. Additionally, the data were examined for potential relationships between levels of the three behaviors and herd size and between the duration of the herd's response to handling and the handling period.

Near-Term Individual Response

Six walruses were tagged with a VHF radio transmitter attached to a tusk, which enabled monitoring of their periodic return to the study haul-out. From 6 August to 22 October (78 d) the haul-out was checked twice daily with a hand-held radio receiver for the presence of tagged walruses.

Table 1. Mean level of alertness, displacement, and rate of dispersal over last two scan intervals of precapture period and first two scan intervals of darting and handling periods. Value in parentheses is number of capture sessions that provided data for period-behavior combination (nine capture sessions provided data for all nine period-behavior combinations). All behavior levels within handling period were significantly higher than those in precapture and darting periods.

	Period		
Behavior	Precapture	Darting	Handling
Alertness (% of herd)	<1% (16)	1% (13)	9% (13)
Displacement (% of herd)	<1% (16)	<1% (13)	12% (13)
Dispersal (walruses/min)	0.6 (15)	0.6 (12)	11.0 (12)

Results

Immediate Herd Response

Sixteen capture sessions were analyzed (Table 1); these involved initial herd sizes ranging from 622 to 5,289 walruses ($\bar{x}$ = 2,302). The number of capture sessions that were conducted during each of eight days were 2, 1, 1, 2, 3, 2, 2, and 3. In a few capture sessions behaviors were not quantified for all three periods (precapture, darting, and handling).

Levels of behavior between precapture, darting, and handling periods—Differences in levels of the three behaviors (proportion of herd displaying alertness and displacement, and rate of dispersal) between the precapture, darting, and handling periods were tested using analysis of variance. The analysis used mean level of behavior from the last two scan intervals of the precapture period and the first two scan intervals of the darting and handling periods. Tests of significance were performed separately for each behavior following an unbalanced randomized-block design where the precapture, darting, and handling periods were the treatments and capture sessions were the blocks. An assumption was violated by this procedure: herds (experimental units) were not assigned randomly among periods (treatments) within each capture session (block). However, blocks were not significantly different for any of the three behaviors ($P \geq 0.46$) and contributed very little to precision for treatment comparisons.

Within each behavior, the level of behavior was significantly different among the precapture, darting, and handling periods ($P \leq 0.02$). Multiple comparisons of mean level of behavior among the three periods (Fisher's least significant difference) indicated that levels of all three behaviors during the darting period were not significantly different from those during the precapture period ($P > 0.05$). An average of ≤1% of the herd displayed alertness and displacement, and an average of 0.6 walruses/min dispersed from the haul-out during these periods (Table 1). In contrast, all three behavior levels during

the handling period were significantly higher ($P < 0.05$) than during the precapture and darting periods (Table 1).

Handling-response period—The start of the handling-response period, the interval over which the herd responded directly to handling activities, was equivalent to the start of the handling period, the time when the immobilized walrus was approached by the capture crew. The end of the response period was the time when, in two consecutive scan intervals, dispersal decreased to its average level recorded for the last two scan intervals of the precapture period and alertness and displacement decreased to within two percentage points of their average level recorded for the same intervals. The handling-response period ended before the start of subsequent capture sessions on all days with multiple capture sessions.

During the handling-response period, high levels of behavior usually occurred within the first nine scan intervals (45 min) (Fig. 1). Correlations between average alertness, displacement, and dispersal over these nine intervals and average herd size over the last two scan intervals of the precapture period indicated a strong positive correlation between alertness and displacement, and moderate negative correlations between herd size and alertness and between herd size and displacement (Table 2). Dispersal was not correlated with either of the other two behaviors or herd size.

Concurrent measurements of the duration of the handling and handling-response periods were obtained for 10 capture sessions. For these, the duration of the handling-response period ranged from 45 to 110 min. Handling-response duration was not significantly correlated with the duration of the handling period ($r = 0.08$, $P = 0.82$). Herds returned to their precapture level of behaviors within 70 min of the end of the handling periods and, in 8 of the 10 sessions, precapture levels were reached within 40 min (Fig. 1).

Near-Term Individual Response

Each of the six tagged walruses returned to the study haul-out at least five times over the 11-wk monitoring period, indicating that capture activities did not cause them to discontinue their use of the haul-out. Furthermore, daily estimates of herd size at the haul-out indicated the extensive use of the haul-out by other walruses during and subsequent to the period over which the capture sessions were conducted (Fig. 2).

Discussion

Results from this study should be viewed cautiously. Sample sizes were small, and estimating the size of herds and levels of behavior was difficult. Distinguishing between alertness and displacement was sometimes difficult, particularly during handling, because of the large numbers of active individuals. Lastly, some individuals were probably exposed to more than one capture session, and effects from potential habituation to multiple disturbances were

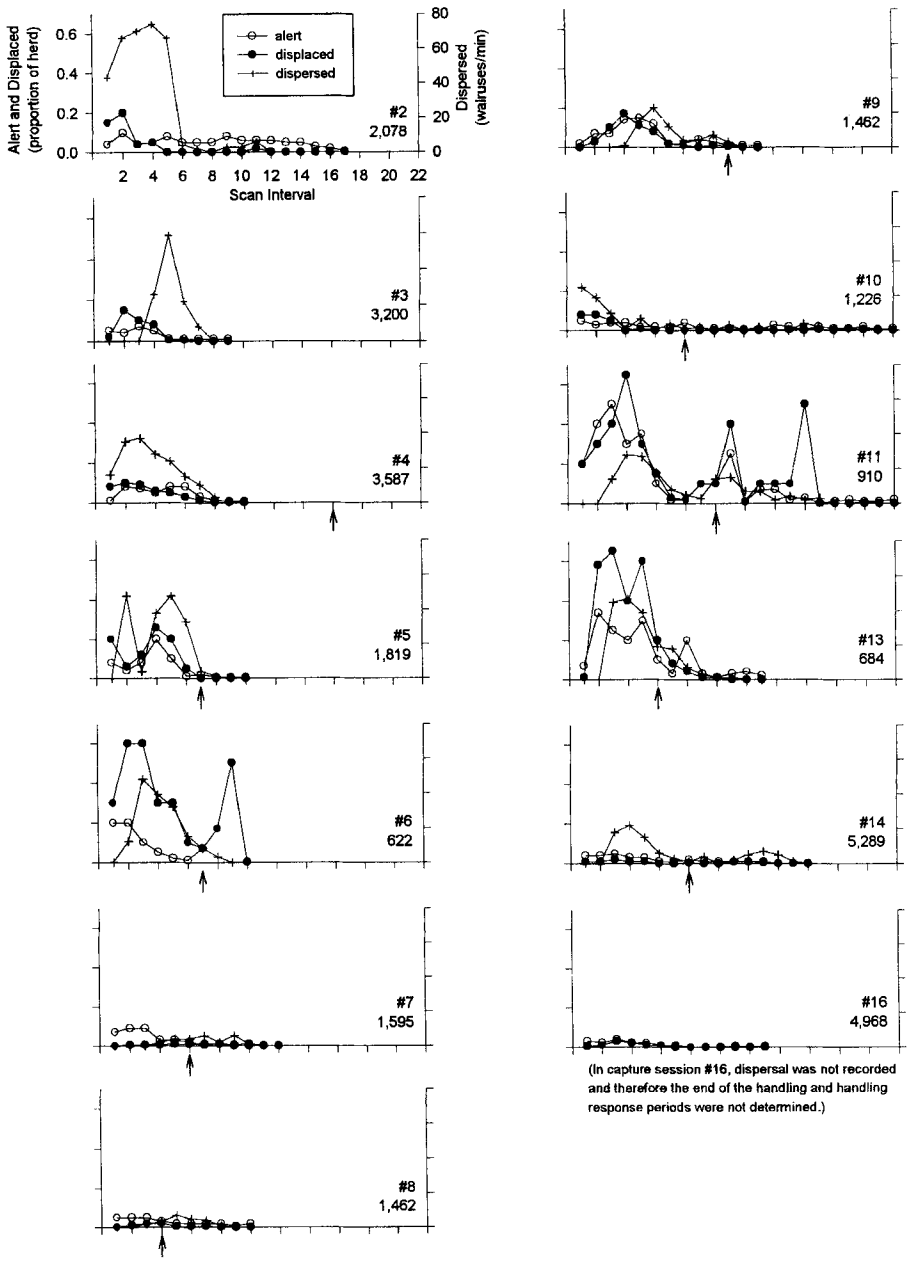

Figure 1. Proportion of herd alert and displaced and rate of dispersal from haul-out during handling-response period. These behaviors not measured in three capture sessions (#1, #12, and #15), and therefore those capture sessions not included. Arrow at x-axis indicates end of handling period as defined in text (not determined for three sessions). Numbers in lower right-hand corner of each graph identify capture session followed by precapture herd size.

Table 2. Correlations between average alertness, displacement, and dispersal over first nine scan intervals of handling period and average herd size over last two scan intervals of precapture period. Values in parentheses are *P, n.* Significant correlations in bold.

	Alertness	Displacement	Dispersal	Herd size
Alertness	—			
Displacement	**0.91**			
	(0.000, 13)	—		
Dispersal	0.21	0.29	—	
	(0.518, 12)	(0.366, 12)		
Herd Size	**−0.59**	**−0.59**	−0.00	—
	(0.032, 13)	**(0.036, 13)**	(0.995, 12)	

unknown. We attempted to temper our interpretations with these points in mind.

Disturbance to herds during the capture sessions were caused primarily by handling; darting usually had little to no effect. Levels of all three behaviors were about 10-fold or more higher during the handling period than during the darting and precapture periods. To dart a walrus, the shooter crawled slowly to the herd and kept movements slow and a profile low to the herd. The capture crew was unable to make the same approach, because the immobilized walrus required immediate attention. Also, it was impossible for the capture crew to handle an immobilized walrus without disturbing neighboring individuals, because the walrus herds were tightly packed.

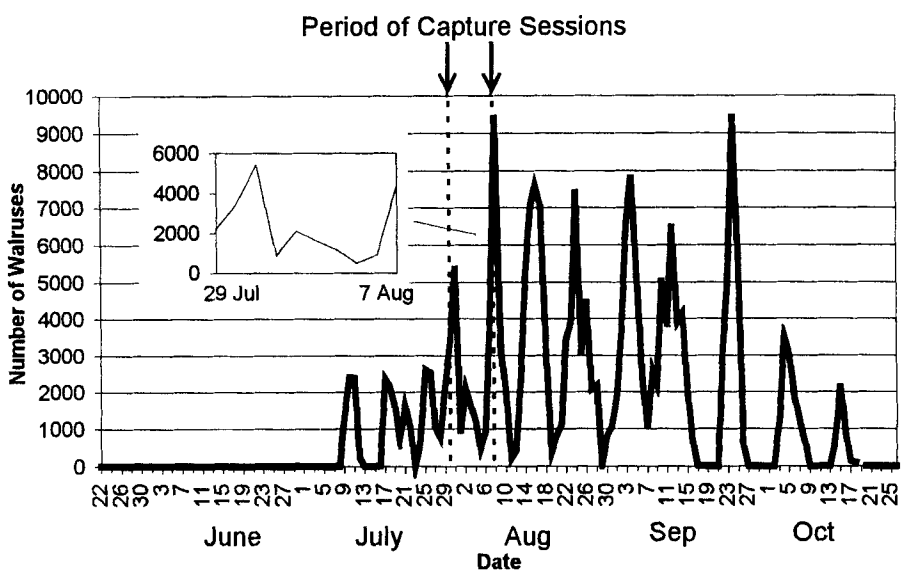

Figure 2. Daily estimates of number of walruses at study haul-out (data provided by USFWS Togiak National Wildlife Refuge). Inset shows period over which capture sessions conducted.

Neighboring walruses usually moved toward the water as the capture crew approached, then either entered the water or lay down about 10–20 m away from the capture crew. Departing walruses often invoked alertness and displacement in neighboring walruses as they passed through the herd toward the water. This seemed particularly evident when departing walruses were at the interior and landward side of the herd and was intensified by the propensity of walruses to pack tightly together when hauled out.

The high correlation between alertness and displacement during the handling response period may be due in part to difficulty in distinguishing between the two behaviors, but it is also consistent with what would be expected from an escape response. The sequence of escape is alertness followed by movement toward the water (displacement). Levels of all three behaviors were low during the precapture and darting periods. During undisturbed periods, walruses often raised their head in response to stimuli from neighboring walruses and repositioned themselves within the herd, so that levels of alertness, displacement, and dispersal did not appear to be as strongly related as they were during disturbance periods.

The negative correlations between precapture herd size and levels of alertness and displacement during the handling period may reflect the increased distance between the point of disturbance and peripheral walruses with increasing herd size. Walruses that were opposite the point of disturbance during the handling period were closer to the disturbance in small herds and seemed more likely to respond to the disturbance than those in large herds. Many research studies may involve herd sizes comparable to the smaller herds reported here.

The lack of correlation between herd size and dispersal suggests that dispersal from capture disturbances may be independent of herd size; however, the small sample size (12 pairs of observations) limits the power to detect such a relationship if one exists. Sufficient power (0.80) to detect a significant ($\alpha = 0.05$) moderate correlation ($r = 0.50$) would require a sample size of at least 28 pairs of observations (Cohen 1988).

Although the herd usually returned to precapture levels of behavior within 40 min after cessation of the handling disturbance, return time was quite variable. Some variation may be due to differences among capture sessions in the type and magnitude of stimuli that were created during the handling period. We did not quantify the differing stimuli that were produced during the capture sessions; however, we attempted to approach the herds from downwind and to keep noise to a minimum. Scent may be a strong stimulus in invoking a response in walruses but has not been studied adequately. The magnitude of a response to a visual stimulus is apparently dependent on the object's size, speed, and direction of movement. Both the frequency and intensity of a sound stimulus are determinants in invoking a response (Salter 1979, Fay *et al.* 1984). There is evidence that walruses respond to sound levels similar to those to which humans respond (Kastelein *et al.* 1993).

The response of walrus herds to disturbances will probably vary among locations, seasons, and with the age and sex composition of the herd. For

example, females with calves are apparently more apprehensive and therefore more responsive to disturbances than adult males (Salter 1979, Fay *et al.* 1984). Moreover, the magnitude of the response of a herd to a disturbance may depend on the length of time individuals have been hauled out. If the herd has only recently hauled out prior to a disturbance, it may be less responsive to disturbances and more likely to recolonize the haul-out immediately after the disturbance than a herd that has been hauled out for a longer time (Fay *et al.* 1984, Mansfield and St. Aubin 1991).

Salter (1979) noted that when Atlantic walruses (*O. r. rosmarus*) dispersed from a disturbance, the number of walruses at the haul-out eventually returned to predisturbance levels, although it was unknown whether or not the same individuals returned. In the present study observations of walruses tagged with VHF radio transmitters indicated that the activities from a given capture session did not preclude tagged walruses from using the haul-out over the subsequent 11 wk. This is consistent with observations of Atlantic walruses by other investigators (Born and Knutsen 1992). Moreover, non-tagged walruses continued to use the haul-out extensively during and after the period over which capture sessions were conducted.

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