

An acoustic technique for determining diurnal activities in leopard (*Hydrurga leptonyx*) and crabeater (*Lobodon carcinophagus*) seal

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Hourly variations in the rate of underwater vocalizations produced by leopard (*Hydrurga leptonyx*) and crabeater seals (*Lobodon carcinophagus*) were compared with counts of these seals on ice floes. For both species maximum "haulout" corresponded with minimum underwater vocalizations. Consequently, sampling the vocal behaviour of pinnipeds may be used to determine their diurnal haulout pattern. This underwater vocalization rate potentially may be used to calculate a series of hourly correction factors that compensate for submerged seals not seen during a census.

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Les variations horaires du taux des cris sous l'eau de léopards de mer (*Hydrurga leptonyx*) et de phoques crabiers (*Lobodon carcinophagus*) ont été comparés au nombre de phoques sur les glaces flottantes. Chez les deux espèces, les périodes où le plus grand nombre de phoques sont hors de l'eau correspondent aux périodes où les cris sont le moins fréquents. Il est donc possible de déterminer les patterns de sortie de l'eau des pinnipèdes en échantillonnant leur comportement vocal. Il est permis de croire aussi que le taux des cris sous l'eau pourra éventuellement servir à calculer une série de facteurs de correction horaires destinés à compenser l'absence des phoques en plongée au moment d'un recensement.

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Introduction

Ship-based surveys of Antarctic seals during the austral summer have shown that leopard (*Hydrurga leptonyx*), Weddell (*Leptonychotes weddelli*), crabeater (*Lobodon carcinophagus*), and Ross (*Ommatophoca rossi*) seals exhibit predictable hourly variations in "haulout" (Gilbert and Erickson 1977). Many population studies have incorporated a correction factor that compensates for hourly count differences (Siniff et al. 1971; Gilbert and Erickson 1977). Radio telemetry techniques are valuable for determining the diurnal haulout of Weddell seals in fast ice regions (Siniff et al. 1971); however, such techniques are not applicable in pack ice because of the mobility of the haulout platform.

Currently, two techniques are used to determine the haulout pattern of pinnipeds: hourly counts of animals and radio tracking of movements in and out of the water. These techniques require continuous long-term contact with the animals. Hourly counts of animals that are hauled out in inaccessible areas may not be possible. Weather, limited daylight, and cost make 24-h counts unrealistic. Radio telemetry techniques have limited application in unstable habitats, such as pack ice, where

both the animals and the haulout platforms are moving. Transmitter attachment and receiver durability often are problems in the field. To surmount these problems we developed an alternative technique, a passive acoustic recording system that automatically monitors pinniped vocal activities even in remote areas.

Stirling and Siniff (1979) documented four underwater vocalizations from the leopard seal (*Hydrurga leptonyx*) and one from the crabeater seal (*Lobodon carcinophagus*). Both species vocalize frequently during the breeding season. The object of our study was to determine if the diurnal pattern of underwater vocalizations is negatively correlated with the haulout pattern for these two pack-ice species. If so, it is possible theoretically to calculate a series of correction factors that compensate for submerged seals during a given hour of a census.

Materials and methods

Using the RV *Hero* as a survey platform, we counted seals along the Antarctic Peninsula (Martel and Ezcurra Inlets, Bransfield and Gerlache Straits, and Bismarck and Dallmann Bays) from 26 October to 21 November 1978. All leopard and crabeater seals seen on ice floes within 400 m of the ship were

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counted in a continuous census during daylight hours (0400 to 2200). For each sighting the sex, age, and species of seal and the location, time, and amount of ice cover were noted. From these data we calculated the mean number of seals on the ice for each hour.

Underwater vocalizations were recorded automatically with an Interocceans R130 hydrophone (frequency response, 0.03–10.00 kHz \pm 1.0 db) and a Superscope C101A cassette recorder (frequency response, 0.20–5.0 kHz) controlled with a digital timer. This system was placed on an ice floe in an insulated box heated with thermal packs; it sampled underwater vocalizations for 2.5 min every hour. A radio-frequency transmitter on the ice floe and a ship-based receiver were used to relocate the system 24 h later. Crabeater and leopard seal vocalizations were recorded in Martel Inlet on 28–31 October, in Bismarck Bay on 2–5 November, in Dallmann Bay on 7–14 November, and in Ezcurra Inlet on 18 November 1978 ($n = 17$ days sampled).

In the laboratory the number of audible and identifiable underwater vocalizations per sample was tallied for each species. Calls were identified to species by referring to sound spectrograms in Fig. 1 of Stirling and Siniff (1979). The radial distance of sound reception using this system was not measured, but because the automatic gain control in the cassette recorder was used and oceanographic conditions were similar we assume that the same area was sampled during each recording. Seals vocalizing near the hydrophone could saturate the recording and block distant vocalizations; thus, vocalization rates may have been higher. The age and sex composition of the seals producing vocalizations could not be controlled; however, the majority of animals observed during our survey were adults.

Results and discussion

A one way analysis of variance (ANOVA), using the number of leopard seals on the ice as the random variable and each hour from 0400 to 2200 as a treatment, showed significant heterogeneity ($F_{0.05} = 1.97$, critical value = 1.66). Maximum leopard seal haulout occurred between 0900 and 1800 and minimum haulout between 1900 and 2200, and 0400–0800 (Fig. 1a). Hourly differences in crabeater seal counts showed similar variations ($F_{0.05} = 2.62$, critical value = 1.66). Maximum haulout was from 0900 to 1900 and minimum was from 2000 to 2200 and 0400 to 0800 (Fig. 2a). For both species, the period from 2300 to 0300 could not be sampled because of darkness, but seals are believed to be in the water during this period.

Hourly differences in underwater vocalization rates were compared using a one-way ANOVA with the vocalization rate per minute as the random variable and each of 24 h as a treatment. Significant differences were found for leopard ($F_{0.05} = 3.34$, critical value = 1.59) and crabeater ($F_{0.05} = 2.05$, critical value = 1.59) seals. For both species the peak period for underwater vocalizations was between 1900 and 0600, whereas the

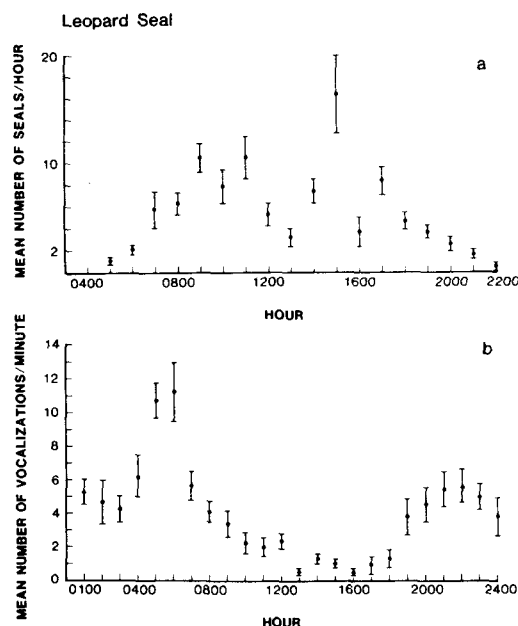


FIG. 1. (a) Mean (and 95% confidence interval) number of leopard seals hauled out per hour for each hour of observation. (b) Mean (and 95% confidence interval) number of underwater vocalizations per minute for each hour.

minimum underwater vocalization rate occurred between 0900 through 1800 (Figs. 1b and 2b).

There is a significant negative correlation ($p < 0.01$) between the mean underwater vocalization rate per minute and the mean number of seals counted per hour (leopard seal, $r = -0.55$ and crabeater seal, $r = -0.66$).

Both crabeater and leopard seals produced pups during our study period. Crabeater seals were seen as male–female pairs on floes, and Siniff et al. (1979) indicated that courtship and mating occur during this period. The mating season of leopard seals is not well known; Harrison et al. (1968) suggested that there is no delayed implantation as in other antarctic seals and that mating occurs around late December or January. However, Sinha and Erickson (1972) suggested that delayed implantation occurs in leopard seals and mating is in November as in other antarctic phocids. The stage of the reproductive cycle affects vocal activity; both crabeater and leopard seals were vociferous during our study and recordings in January and February near the Antarctic Peninsula show a dramatic decrease in vocalizations by these seals (Thomas et al. 1981).

There are technical problems associated with accurately monitoring the haulout pattern of pinnipeds. Remote haulout sites, such as pack ice, offshore rocks,

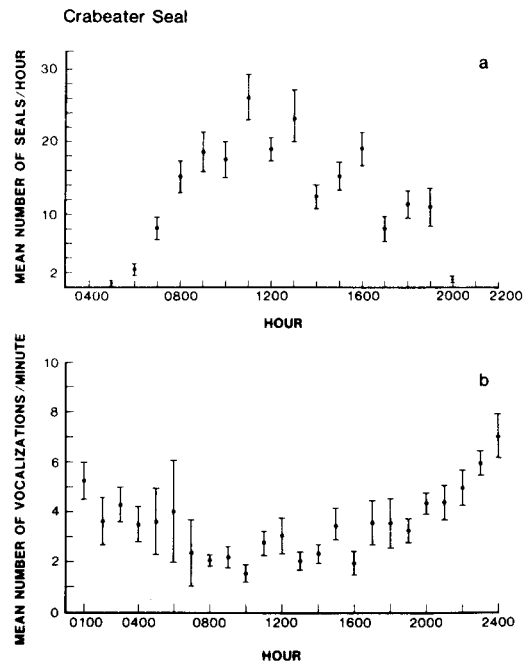


FIG. 2. (a) Mean (and 95% confidence interval) number of crabeater seals hauled out per hour for each hour of observation. (b) Mean (and 95% confidence interval) number of underwater vocalizations per minute for each hour.

or inaccessible beaches, often preclude observations of haulout. Observer or survey vessel disturbances often disrupt haulout behavior. The proposed technique offers an alternative method to investigate hauling activity in pinnipeds. Underwater vocalizations are negatively correlated with the diurnal haulout of leopard and crabeater seals and our acoustic sampling system may have practical application for a wide variety of pinnipeds and haulout sites. Several pinnipeds are vocal under water: *Odobenus rosmarus* (Schevill et al. 1966); *Phoca hispida* (Stirling 1973); *Pagophilus groenlandicus* (Møhl et al. 1975); *Erignathus barbatus* (Ray et al. 1969); and *Leptonychotes weddelli* (Thomas 1979). Some pinnipeds are more vocal while hauled out, e.g., *Zalophus californianus* (Bartholomew and Peterson 1967), *Mirounga angustirostris* (Bartholomew and Collias 1962), and some species of fur seals, *Arctocephalus* (Stirling and Warneke 1971). This acoustic system can be modified for either underwater or airborne sampling. Diurnal haulout may change seasonally or between haulout sites and monitoring vocalization rates may provide a technique for documenting these changes.

In summary, using the hourly rate of underwater or airborne vocalizations may be a practical technique to document the diurnal haulout pattern of pinnipeds. Its

application in remote haulout sites and its noninterfering mode of operation are advantages. This technique can be used for determining the diurnal haulout pattern of many pinnipeds. A series of census correction factors can be calculated using hourly vocalization rates; however, we recommend sampling in the same area and season as the census because the density of seals may vary between areas, vocalizations may decrease outside the breeding season, and high densities may induce contagious vocalizing.

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- BARTHOLOMEW, G. A., and N. E. COLLIAS. 1962. The role of vocalization in the social behavior of the northern elephant seal. *Anim. Behav.* **10**: 7-14.
- BARTHOLOMEW, G. A., and R. S. PETERSON. 1967. The natural history and behavior of the California sea lion. *Spec. Publ. Am. Soc. Mammal.* No. 1.
- GILBERT, J. R., and A. W. ERICKSON. 1977. Distribution and abundance of seals in the pack-ice of the Pacific sector of the Southern Oceans. In *Adaptations within Antarctic ecosystems: Proceedings of the 3rd SCAR symposium on Antarctic biology*. Edited by G. Llano. Smithsonian Institution, Washington, DC. pp. 703-740.
- HARRISON, J. R., R. C. HUBBARD, R. S. PETERSON, C. E. RICE, and R. J. SCHUSTERMAN. 1968. The behavior and physiology of pinnipeds. Appleton-Century-Crofts, New York.
- MØHL, B., J. M. TERHUNE, and K. RONALD. 1975. Underwater calls of the harp seal, *Pagophilus groenlandicus*. In *Biology of the seal*. Edited by K. Ronald and A. Mansfield. *Rapp. P. V. Reun. Cons. Int. Explor. Mer.*, **164**: 533-543.
- RAY, G. C., W. A. WATKINS, and J. J. BURNS. 1969. The underwater song of *Erignathus* (bearded seal). *Zoologica (N.Y.)*, **52**: 79-82.
- SCHEVILL, W. E., W. A. WATKINS, and R. RAY. 1966. Analysis of underwater *Odobenus* calls with remarks on the development and function of the pharyngeal pouches. *Zoologica (N.Y.)*, **51**: 103-105.
- SINHA, N. A., and A. W. ERICKSON. 1972. Ultrastructure of the corpus luteum of Antarctic seals during pregnancy. *Z. Zellforsch. Mikrosk. Anat.* **133**: 13-20.
- SINIFF, D. B., I. STIRLING, J. L. BENGTON, and R. A. REICHEL. 1979. Social and reproductive behavior of crabeater seals (*Lobodon carcinophagus*) during the austral spring. *Can. J. Zool.* **57**: 2243-2255.
- SINIFF, D. B., J. R. TESTER, and V. B. KUECHLE. 1971. Some

- observations on the activity patterns of Weddell seals as recorded by telemetry. In *Antarctic Pinnipedia*. Edited by H. Burt. *Antarct. Res. Ser.* **18**: 173–180.
- STIRLING, I. 1973. Vocalizations in the ringed seal, *Phoca hispida*. *J. Fish. Res. Board Can.* **30**: 1592–1594.
- STIRLING, I., and D. B. SINIFF. 1979. Underwater vocalization of leopard seals (*Hydrurga leptonyx*) and crabeater seals (*Lobodon carcinophagus*) near the South Shetland Islands, Antarctica. *Can. J. Zool.* **57**: 1244–1248.
- STIRLING, I., and R. M. WARNEKE. 1971. Implications of a comparison of the airborne vocalizations and some aspects of the behavior of the two Australian fur seals, *Arctocephalus* spp., on the evolution and present taxonomy of the genus. *Aust. J. Zool.* **19**: 227–241.
- THOMAS, J. A. 1979. Quantitative analysis of the vocal repertoire of Weddell seals (*Leptonychotes weddelli*) in McMurdo Sound, Antarctica. Ph.D. thesis, University of Minnesota, Minneapolis, Minnesota.
- THOMAS, J. A., F. T. AWBREY, S. LEATHERWOOD, W. E. EVANS, and J. R. JEHL, JR. 1982. Ross Sea killer whale (*Orcinus orca*) distribution, behavior, color pattern, and vocalizations. *Antarct. J. U.S.* **16**. In press.
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