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VARIABILITY OF HARBOUR SEAL NUMBERS ON HAUL-OUT SITES.

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Introduction

Harbour seals *(Phoca vitulina)* inhabit temperate coastal and estuarine areas in the northern hemisphere. Although they spend much of their time in the water, they must come onto land (or ice) to bear their pups and probably to rest. The seals typically haul out on offshore ledges or bars and on isolated beaches. They may sleep while on land but usually remain alert. They stay close to the water's edge and will readily flee into the water if disturbed (MANSFIELD, 1967; SCHNEIDER, *et al.*, 1980).

Harbour seals may interfere with commercial and sport fisheries by eating fish, frightening fish away from gear, damaging gear and transmitting parasites (especially the cod worm, *Porrocaecum decipiens*). It is difficult to determine the numbers of seals in an area and their impact on fisheries. It is not possible to count seals in the water (EBERHARDT, *et al.*, 1979) and they may move from one area to another (60 km away) on a daily basis (HANSEN, 1979). Seals that have hauled-out can be counted (BONNER, 1976) but for this to lead to an accurate population assessment, the ratio of seals in the water and the location of all haul-out sites are required. The numbers of seals on land (or ice) is influenced by season, reproductive state, tide, time of day, weather, human disturbance, site preferences, etc. (JOENSEN, *et al.*, 1976; LOUGHLIN, 1978; BOULVA and MCLAREN, 1979; HANSEN, 1979; HEIDE-JORGENSEN, 1979; SCHNEIDER, *et al.*, 1980; SULLIVAN, 1980; STEWART, 1981; RENOUF, *et al.*, 1981).

Little is known of the size of harbour seal populations in the Bay of Fundy, Canada. Recent observations indicate that the present distribution of seals is greater than that indicated by a preliminary study conducted in the area in 1973 (BOULVA and MCLAREN, 1979). Removal of a bounty on harbour seals in 1976 may have resulted in a recent increase in the number of seals in this area. An assessment of the importance of the factors which influence haul-out behaviour of seals will be required before various population estimates based on counts can be made. The large tidal amplitudes in the Bay of Fundy would be expected to present the seals with a unique situation. As the tide height changes, the availability of suitable haul-out sites will be constantly changing. If they are to stay near the water's edge, the seals will have to change their location regularly and/or remain in the water until a suitable area becomes exposed. Continual human disturbance has, in some areas of Europe at least, severely reduced the number of suitable haul-out sites to a few, relatively remote areas (e.g. HANSEN, 1979). While levels of human disturbance in the Bay of Fundy may be less that those in Europe, the seals are undoubtedly influenced by human activities. Indeed, the ubiquitous presence of humans and machines probably precludes the studying of "undisturbed" seals *per se* (RENOUF, *et al.*, 1981).

The discovery of a group of seals within the city limits of Saint John, N.B. enabled us to examine some aspects of harbour seal haul-out behaviour. Additional observations in nearby, less frequently "disturbed" areas were occasionally made. Our findings suggest that the tide is the most important natural factor relating to when seals will haul-out. In this area, the variability of haul-out numbers is so great that it may not be possible to census the local seal population by direct counting of the seals on rocks.

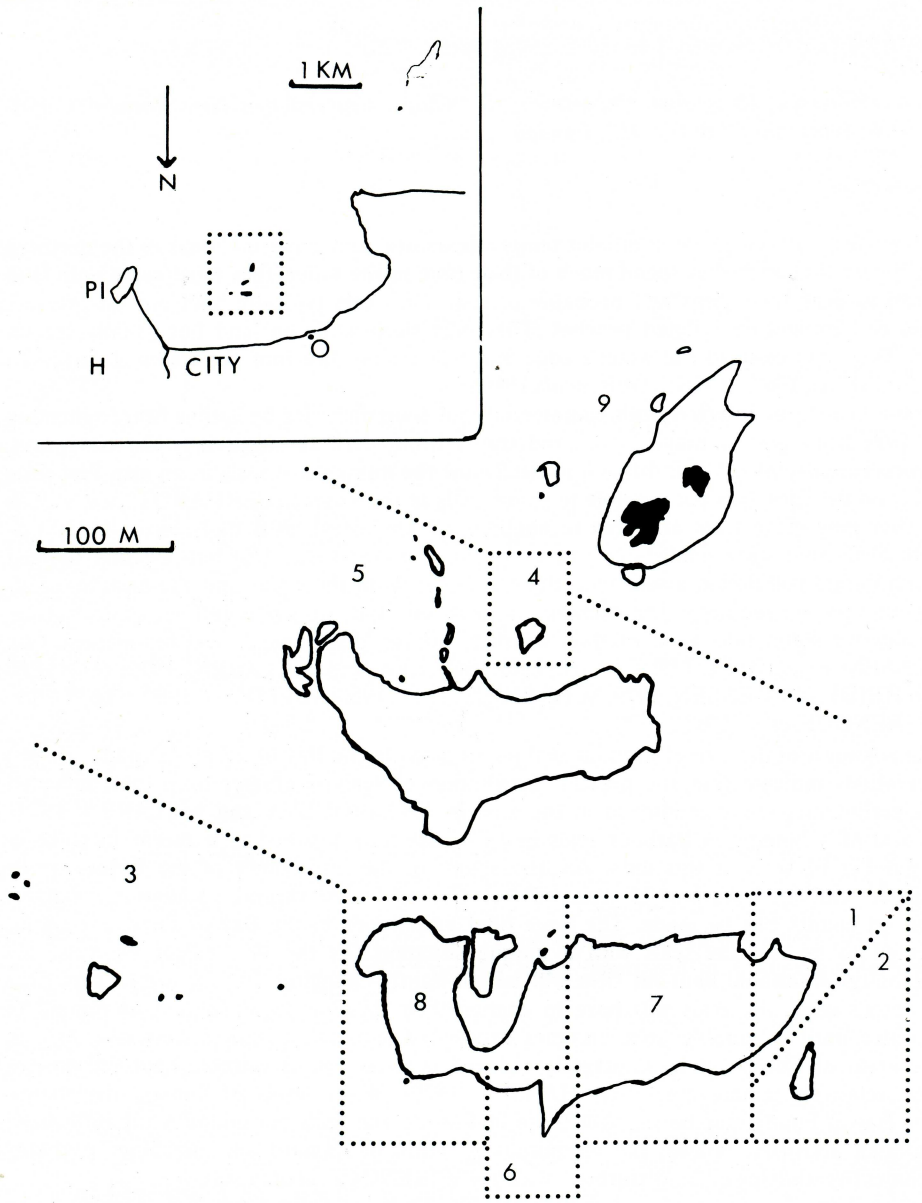

Fig. 1. The Shag Rocks, Saint John, New Brunswick at a tide height of approximately 1 m. The dark area in site 9 is not covered at high tide. 0 = observation site, H = harbour. PI - Partridge Island.

Table 1. Numbers of seals hauled-out on the Shag Rocks within 65 minutes of low tide. All counts were at least one half hour apart.

Month	Between 4:30 and 19:30 AST			Between 9.00 and 15:00 AST		
	$\bar{X} \pm 2$ S.D $_{n-1}$	Range	N	$\bar{X} \pm 2$ S.D.$_{n-1}$	Range	N
June	0 - 52.3	0 - 49	26	0 - 58.7	8 - 49	7
July	0 - 51.9	0 - 41	9	3.1 - 44.9	12 - 31	3
Aug.	0 - 49.4	0 - 42	42	15.3 - 47.8	6 - 42	17
Sept.	15.8 - 60.8	0 - 58	28	10.3 - 62.6	0 - 52	15
Oct.	0 - 94.5	0 - 93	17	0 - 74.0	4 - 93	9

Materials and Methods

The main study area (the Shag Rocks) is a set of ledges (Fig. 1) adjacent to Saint John, N.B. (45°14' 00"N and 66° 04' 30" W). Saint John is an industrial city, population 115,000, situated along the north coast of the Bay of Fundy. The observation site was situated on a cliff, 15 m above mean sea level. The hauling sites were 1 to 1.5 km from the observation site. The hauling grounds are adjacent to the harbour entrance. The shore-line is regularly frequented by people and dogs. Houses and a railway track are present along the cliff top. The Shag Rocks consist of rock ledges with a few gravel and sandy areas. An area of 0.1 ha was always exposed (above 8.0 m re. chart datum). At a tide height of 3.2 m (re. chart datum) the exposed area is 1.3 ha. At 1.0 m, the area increases to 5.8 ha. The hauling grounds were arbitrarily divided into 9 regions (Fig. 1). The offshore sides of areas 1, 2, 5, 7, 8 and 9 were not always visible (depending upon tide height).

Additional areas examined consisted of many islands adjacent to Deer, N.B. Haul-out sites associated with these islands were observed, near low tide, from a 13 m vessel on 6 occasions 15 to 58 days apart from Aug. 27, 1982 to Mar. 24, 1983. A single site in the Digdeguas estuary was also observed from land (0.5 km viewing distance).

The study was conducted from Nov. 1981 to April 1983. Seals on the Shag Rocks were viewed with a 20-45x telescope. Two types of counts were made at the Shag Rocks. The first set of counts, which were made at least one half hour apart, recorded the numbers and approximate locations of the seals as well as tide height. Typically, 1-3, well-spaced observations per day were attempted during the summer. On 22 occasions, counts were specifically taken close to low tide. These counts were discarded from the time of day analysis. All other counts were obtained when other duties permitted and thus were essentially random as far as the tide height was concerned. All counts were obtained during daylight hours. From Dec. 4, 1981 to April 19, 1983, 376 observations were made. Of these, 232 were from Juni 1 to Aug. 31 inclusive.

On 15 occasions between June 23 and Oct. 7, the numbers of seals present were counted at 5 minute intervals. On a single day, between 7 and 23 counts were made within an hour of low tide. These counts were made during daylight hours and with no visibility problems. On three days, low tide was within an hour of noon, no apparent disturbances occurred and the maximum number of seals seen each day exceeded 30. These were arbitrarily classified as "best" in Table 2. On three other days when more than 30 seals were present, an obvious disturbance occurred. These counts were classified as "disturbed" in Table 2.

Table 2. Numbers of seals hauled-out on the Shag Rocks within 60 minutes of low tide expressed as a percent of the maximum number seen per day. Counts were taken at 5 minute intervals.

Data Grouping	$\bar{X}$	$S.D_{n-1}$	Range	N
"best 3 days"	92.3	6.4	73-100	67
"3 disturbed days"	73.1	29.8	0-100	46
all 15 days	71.9	30.8	0-100	274

Results

Seals were present on or near Shag Rocks from May to November. No seals were observed between Dec. 4, 1981 and May 18, 1982 or from Nov. 28, 1982 to April 19, 1983. Seals have left the area during the winter for at least the last 15 years (Mrs. R.B. Kelly, Saint John, pers. comm.).

On two occasions, a single grey seal (*Halichoerus grypus*) was hauled-out among the harbour seals. An adult male grey seal was identified (Nov. 11, 1982) by its size. On Sept. 19, 1982, another grey seal was identified, by a streamer tag, as a two-year old which had been tagged as a pup on Sable Island, N.S. (B. Beck, Fisheries and Oceans, pers. comm.). Although other grey seals may have been present, none were identified by size or head profiles.

Fog and rain precluded observing the Shag Rocks for more than 20% of the possible viewing time. All but 23 of the 376 observations were made under satisfactory viewing conditions. Rain and early morning darkness were the major factors related to the 23 times when some difficulties were experienced.

Generally, as the water level dropped, the offshore sides of the rocks became hidden. On many occasions, seals in area 5 (Fig. 1) were observed only when they raised their heads or hind flippers above nearby rocks. The dark colour of wet seals often made them difficult to distinguish from the dark rocks. Seals which were dry often became a light yellow colour and were easily identified. When large groups of seals were present, some of them would be hidden behind others. Some of the "hidden" seals were seen if they raised their heads or flippers. One "set" of hind flippers glimpsed behind a seal would be counted as one seal, when in fact, there could have been more than one seal hidden from view. In these cases the size of the hidden seal could not be determined. Thus our counts did not distinguish between pups and adults. It is believed that counting accuracy increased at higher water levels and with fewer seals present.

Between June 27 and Oct. 29, 22 instances of human related disturbance were observed. On other occasions, the seals were seen to rush into the water as a group but no source of disturbance was identified. Sources of disturbance include large and small fixed-wing aircraft, helicopters, motorboats, canoes, people and dogs walking on the beach, fishing boats, fishing activities and traffic and industrial noises. In all "categories" the reactions of the seals varied from no apparent movement, to raising the head and looking around, to moving to the water's edge, to rushing into the water. Typically most of the members of a group would react similarly. When more than one group of seals was present however, not all groups would necessarily react in a similar way.

Nearby aircraft usually resulted in the seals entering the water. Distant aircraft did not appear to disturb the seals at Shag Rocks. A low flying, 4 engine aircraft which passed at least 2 km south of a site in the Digdeguash River resulted in all 28 seals present entering the water as the noise became loud.

The seals would readily enter the water if a canoe or small motorboat came into view. Except in one instance, in which the seals were being hunted from a fishing boat, the presence of fishing boats did not result in the seals vacating haul-out sites. On one occasion a boat (engaged in picking up lobster traps) passed between areas 3 and 8 (Fig. 1). None of the 20 seals hauled-out on area 3 left the site (no seals were present on area 8). When nets were set between the shore and the Shag Rocks (Sept. 29, 30 and Oct. 7-14) the seals hauled-out on the offshore side of the rocks (areas 3, 4 and 5).

In addition to known cases of human disturbance, there were occasions when a group of seals would suddenly rush into the water, for no apparent reason. On two occasions between 2 and 3 hours before low tide, the seals were some distance from the water. As the water continued to drop, a few seals began moving to the water's edge. Other seals in the group, possibly startled by the movement of the few, rushed into the water. Over half of the seals entered the water on each occasion. Within 10 minutes they had hauled-out again but not all went back to the same rock.

Seals began to arrive at the Shag Rocks late in May. The maximum numbers of seals present per month from May to November were 5, 49, 41, 42, 58, 93 and 49 respectively. On a day-to-day basis, the numbers of seals hauled-out was variable. Even close to low tide, there was a large variability in seal numbers (Table 1). Zero counts were common. Variability in numbers was present on a minute-to-minute as well as a daily basis. Fifteen sets of counts taken at 5 minute intervals near low tide (Table 2) revealed that the numbers of seals were not static even for a short time period. An example of a typical count, when low tide was early in the day (8:45 AST) and no obvious disturbances were noted, is given in Fig. 2.

The presence of one or more seals on the Shag Rocks was examined with respect to time of day and time of tide (Fig. 2). No significant relation was found between the presence of one or more seals and time of day (chi square test, $p=.5$). The seals did haul out close to low tide (chi square test p .001). The presence of seals before low tide was significantly greater than after (chi square test p .01). The seals utilized areas 1 to 5 during the summer and 3 to 5 during the fall. A chi square test for site preferences indicated that site selection was non-random (p .001).

Seals were observed on all 6 trips to the Deer Island area. Of the 7 haul-out sites located, one was frequented on all 6 trips, the others between 1 and 5 times. The total number of harbour seals observed per trip varied from 142 (Oct. 26, 1982) to 65 (March 24, 1983). (At the Shag Rocks site, 82 seals were observed on Oct. 26, 1982). On Jan. 25, 1983, we counted 136 seals on 6 sites. A single, adult male gray seal was seen on Sept. 23, 1982.

Discussion

The harbour seal is typically described as non-migratory (MANSFIELD, 1967; BIGG, 1981). The regular absence of seals during the winter months suggests that this small group of seals may migrate (short distances at least). The presence of seals, in the winter, near Deer Island suggests that not all seals leave the haul-out sites of the Bay of Fundy over the winter. The seals may be forced to leave the Saint John area during the winter because of lack of food or other features which may not apply in the Deer Island area. It is also possible that the Shag Rocks are only serving as a temporary, stop-over site when seals are moving between

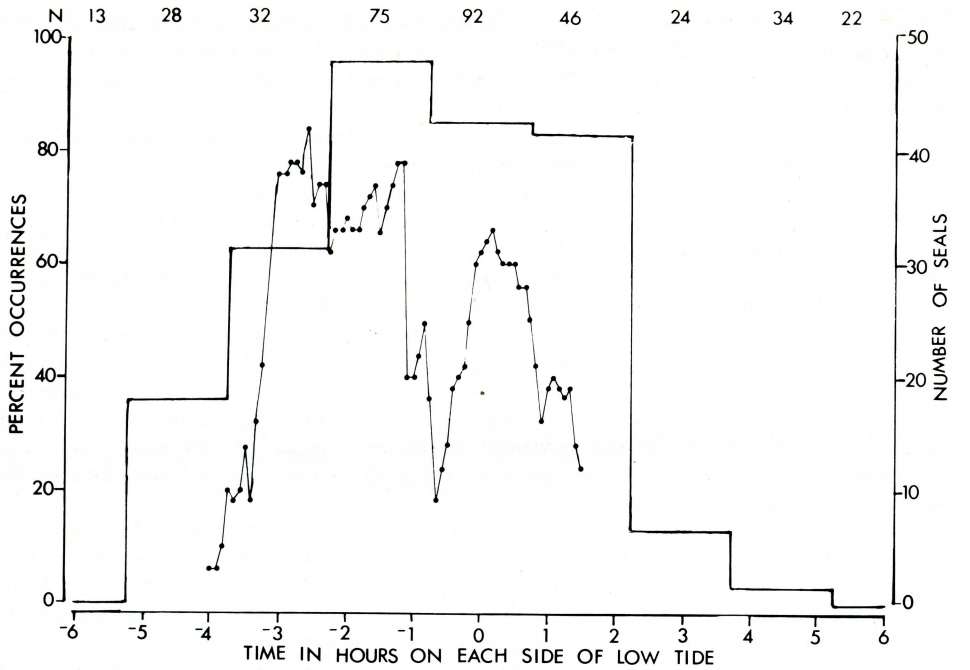

Fig. 2 Harbour seal haul-out patterns. Thick line: the presence of one or more seals relative to low tide. Thin line: number of seals hau=ed-out over one tidal cycle, counts every 5 minutes.

other, "permanent" sites. The high variability of seal numbers (especially the absence of seals for 2-3 day periods over the summer), indicate that the local population is mobile. Regular seal movements of up to 60 km are thought to occur in the Kattegat off Denmark (HANSEN, 1979). The haul-out site at Saint John could be one, of many, located within the range of a local population of seals. Thus, we may have been observing only a segment of a discrete population of harbour seals.

The grey seals were only seen on single days and, in each area, no re-sightings occurred. We do not have any other evidence of grey seals (adults or pups). While it is possible that other grey seals were present (e.g. adult females or sub-adults) in the study area, it is not likely that their numbers were significant.

Occasional viewing difficulties, the possibility of hidden animals, the variability of numbers present and the questionable status of the population being sampled, precluded a rigorous statistical analysis of the data. No significant relationship was found between the presence of one or more seals and the time of day. A significant relationship was found between the presence of seals and the height of tide (Fig. 2). While haul-out centered around low tide, seals were present before low tide more often than after. No seals hauled-out at high tide even though it was physically possible to do so (Fig. 1, area 9). BOULVA and MCLAREN (1979) and SCHNEIDER, *et al.* (1980) report a similar pattern of haul-out behaviour in "tidal" areas. In regions where tidal amplitudes are low, most seals haul-out in mid-afternoon (BOULVA and MCLAREN, 1979; STEWART, 1981).

The variability of seal numbers near low tide was very high (Table 1). In most months, the mean plus or minus 2 standard deviations exceeded the range of numbers seen. Counts obtained between 9:00 and 15:00 hours Atlantic Standard Time (when the light would be more suitable for an aerial census) indicate a slightly reduced variability relative to counts obtained throughout the day. The variability however was still very high. In July and September, the highest counts occurred outside of this time period.

Counts made at 5 minute intervals indicate that the variability in seal numbers is high over short time periods (Fig. 2). Table 2 relates the numbers of seals observed within an hour of low tide to the maximum number of seals observed that day (not necessarily near low tide). While it is possible to select days on which counts with low variability occurred ("best" 3 days) this procedure could not be preplanned and could still result in obtaining a number 27 percent below the maximum seen that day. Variability in the numbers of seals hauled-out resulting from natural causes may be quite high. The variability in the numbers obtained on all 15 days (Table 2) is similar to that observed on the 3 days when the human disturbance was obvious.

Counts of harbour seal numbers are obtained using a variety of methods. Single, yearly counts are common (e.g. FREY and ALPIN, 1970) and the most frequent are half-hourly counts taken over a day (e.g. HEIDE-JORGENSEN, 1979). Of necessity, many studies are restricted to a few days per year. LING, *et al.* (1974) for example collected data at a study area on Miquelon on 41 days during the summer of 1970. They recorded maximum daily counts which varied by over 50 per cent from day to day. Their counts were taken at 2 hour intervals during daylight. They were able to exclude data obtained on the few days when human disturbance was observed. They felt that their study site was "relatively undisturbed". Recently RENOUF, *et al.* (1981) reported 41 cases of human disturbance over a 14 day period at the same site. During our study we identified 22 instances of human disturbance which we could readily identify. Most of our counts were obtained over a very short period of time (that is, it only took a few minutes to arrive at the observation site, set up the telescope etc., make the count and leave). Thus if a disturbance had occurred prior to our arrival, it would not have been noted. On days when the 5 minute counts were taken, an observer was at the site for up to 6 hours and thus was in a position to record sources of disturbance.

The variability of seal haul-out numbers at the Shag Rocks site could be due to a number of factors. Natural and human disturbance factors are influencing the number of seals hauled-out at a specific time. The home range of the population under study cannot be properly determined. If a census of the seals in the Bay of Fundy were to occur, a method utilizing an aerial count would not likely be worthwhile. The minute-to-minute variability and the inability to identify disturbed populations (from the air) would introduce a severe bias. If haul-out sites are examined from the ground, it would be necessary to view all haul-out sites simultaneously for a number of days in order to obtain realistic estimates of the numbers of seals hauled-out. The number of seals remaining in the water would still be unknown. Reliance on haul-out counts will in most instances produce an underestimate of the number of seals in the region. Radio-tagged, Alaskan harbour seals hauled-out on 16 to 80% of the days during a recent study (PITCHER and MCALLISTER, 1981). Haul-out counts may also lead to an over-estimation of seal numbers. If seals are regularly moving from site to site and are being observed at each site (though on different days) it may appear that there are more seals present in an area than actually exist. We will have to learn much more about the daily and seasonal activities and movements of harbour seals before a valid population estimate can be made.

Acknowledgments

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