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An application of radio wave telemetry to the study of fur seals' (*Callorhinus ursinus*) behavior on the breeding islands

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Abstract

Fur Seals Resources Section of Far Seas Fisheries Research Laboratory, the Fisheries Agency of Japan, made an investigation of bachelors' activity and the behavior at the hauling ground, using radio wave telemetry system at the St. George Island, Pribilof Islands, the State of Alaska of the U. S. A. which had been designated at the fur seal intensive research area in 1974, 1976 and 1978.

Introduction

Japan, the United Kingdom, the United States and the Soviet Union concluded an agreement on conservation of fur selas in the North Pacific Ocean in 1911. In 1957, Japan, the United States, Canada and the Soviet Union concluded the Interim Convention on Conservation of North Pacific fur seals. A lot of effort has been made in order to attain the maximum sustainable yield of the fur seal resources.

As the result of the effort of keeping strict protection and management of fur seals, both of the amount of the resources and haul had increased from the 1940's toward the first half of the 1950's which showed the success of the management of the resources.

Based on this success on the resources management, the catch of female seals which were excessed in number was reopened in 1956 in order to keep the amount of resources to the level of attaining the maximum sustainable yield. However it was impossible to realize adjusting the resources expected in the beginning. Therefore it was prohibited to kill a female fur seal since 1969, and reassessment of the resources was made together with careful observation in securing fixed number of pups that would lead the maximum sustainable yield. In spite of such effort, again it was proved unsuccessful to attain the expected amount of stock in the beginning. It became necessary to reconsider seriously the theory and actual outcome of the resource management, and to make fundmental investigation on characteristics of the stock.

The characteristics of the stock involves the ratios of mortality, of impregnation, the number of pups born in the certain period, the number of recruit of adult male seals in the stock and the ratio of catch for bachelor which allows to keep a certain number of recruit-

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ment of adult males. It was necessary not to catch fur seals from commercial purpose and to set up the intensive research area in order to have highly accurate values of these parameters as well as keeping the resources in the high level.

In 1973 the North Pacific Fur Seal Commission designated the St. George Island as the intensive research area with the aim of obtaining the Maximum Sustainable Yield for fur seals. At the same time the commission made up the research plan including an investigation of change in the lactation for an adult female, and the activity of each individual in a harem.

Japan insisted on clarifying activity of a bachelor seal in the breeding season which had not been taken up as the subject of investigation. Also Japan proposed newly utilization of biotelemetry together with a visual observation in order to carry out a continuous investigation during long duration. Thereby Japan attended the investigation substantially.

Biotelemetry is a measuring method of obtaining information on ecology and behavior of an animal in a distant place using a telemetric facility. The data can be obtained continuously and in the stable condition utilizing this method. The investigation using biotelemetry system can contribute a great deal the population study by increasing the number of individuals to be observed.

On the other hand, much has been reported on the study of behavior of water living animals using a radio wave telemetry. For example, on California Gray whale by NORRIS and GENTRY (1974), by EVANS (1974), and by SWEENEY and MATTSON (1974) and on whales by SCHEVILL and WATKINS (1966). However only a few reports have ever been presented on loggerhead turtles such as the one by SOMA and ICHIHARA (1977). ICHIHARA and SHIRAHATA (1973) have reported on the development of instruments of biotelemetry in Japan.

The investigations of behavioral ecology using a radio wave telemetry were made by ANAS (1969) in 1967 and 1968, and by GENTRY and JOHNSON (1975, 1976 and 1977) from 1974 to 1976. They have reported the results of their research.

The authors made the ecological investigation with the aim of elucidating the periodicity in feeding of a bachelor male seal which was the object for commercial harvest in the above stated intensive research area from 1974 to 1976 and in 1978. The investigation in 1974 and 1976 had the main object of trial run of the instrument for field work, and the period for the investigation was rather short.

With the result of this trial, the investigation of fur seals in 1978 brought some interesting biological information. The present report mostly presents the information and data obtained in the 1978 investigation, moreover the data of investigation in 1974 and 1976 have been presented for reference.

I. Instruments used for the research

The present research system is devided into the Telemetry control and the Antenna control systems. These systems consist of a transmitter, an antenna, a receiver, a controller and a recoding apparatus.

The telemetry control system is an activity observing system, which can detect movement

of the animals. The antenna control system is a situation observing system, that can find the position of the seal by receiving a signal from the tagged seal into a right and a left antenna.

The observation instruments other than the recorder were developed and made on an experimental basis with an aim of furthering the present study in cooperation with Makita Electronic Institution. One can refer to MAKITA *et al.* (1979) for the details of the instrument system.

A chargeable small battery is used as an electric power for each receiving apparatus so that it is compact enough to bring on a field research trip.

I—a Transmitter

There are two types of transmitters: one is for position detecting; the other for activity observation. Also there are two kinds of activity observation transmitters: one can detect vertical acceleration: the other can detect horizontal acceleration of the sagittal. All the transmitters of 53 MHz with the transmitting system of crystal controlled blocking oscillator. The position detective transmitter can work as long as six months, and the activity observation transmitter for three months (Normal use).

The weight of the transmitter is 200 g for the position detective transmitter and 220 g for the activity observation transmitter, which can be used up to 30 kg/cm^2 of atmospheric pressure.

I—b Antenna

As for antennas, a 4 element short type antenna and a Yagi type 3 element full scale antenna were utilized for the antenna control system. The former is an antenna for detecting direction to observe the range of movement of a tagged fur seal, and the latter is an antenna to observe the activity. These antennas are made compact and easily brought and fabricated for the use of field work.

I—c Receiver

A receiver of beat detective system was used for observing a seal's activity, and a receiver of double super heterodyne beat type was utilized for observation of the position. Each receiver can receive up to 11 radio waves and they are used for the both of above purposes.

I—d Controller

There are two kinds of controllers: one is the telemeter controller; the other is the antenna controller. The former controls a receiver and a recorder by connecting the receiver and the recorder, and the latter controls an antenna, a receiver and a recorder by connecting the antenna and the receiver. A researcher can observe an animals at any time by handling a preset knob in the controller and at the same time the information is automatically recorded.

I—e Recorder

For the observation of activity of tagged seals a recorder of EPR-200 A of the TOA K. K. was used, and a recorder of VP-6723 A of Matsushita Electric Company Ltd. was used for observing their situation.

II. Items and methods of investigation

II—a Deciding the place for observation

There are six breeding stations for seals in St. George Island. For the best observation point it is desiable to choose a breeding station from where the best information of a seal in its natural behavior and the ecology can be gathered. Upon discussing this with the U.S. scientists it was decided to used the East Cliff Rookery for the following reasons. The station for observation is shown in Fig. 1.

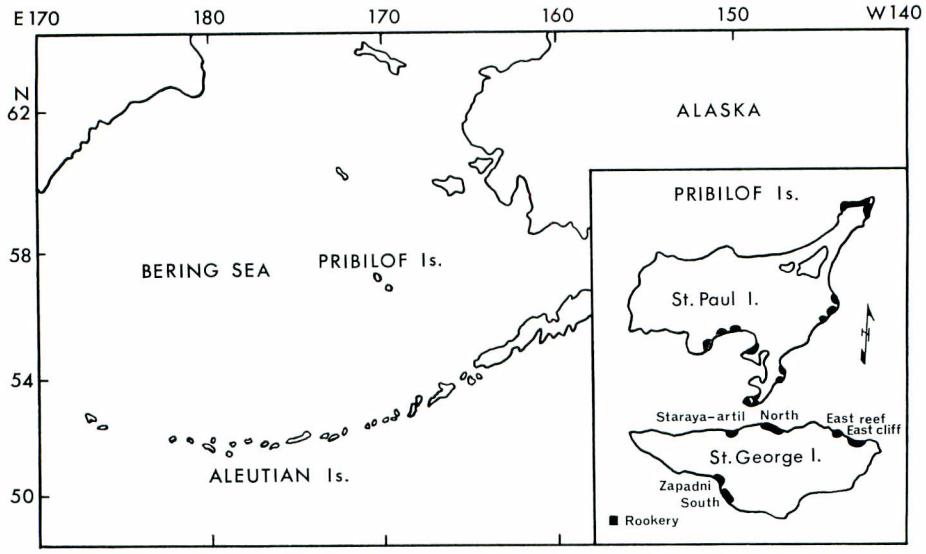


Fig. 1. Research area.

1. The station where the ecosystem of the seals has not been damaged and disturbed by human beings, and which will be kept as it is in the future.
2. The station should have an observation tower which commands the whole view of the hauling ground.
3. A blind (observing hut) must be constructed, from where a researcher can observe the animals without being seen by them.
4. The topography of the Rookery should not disturb a radio wave.
5. The breeding place is not used for other objects of research.

II—b Method of setting transmitter

As a fur seal is susceptible to heat, the resarchers tried to set up a transmitter under low temperature on clowdy weather or early in the morning before the sun rises. The Mcgilvery method was used to herd the seals to the place where the fur seals were bound, and a cloth belt with a transmitter (Harness. Plate I-Fig. 1.) was harnessed to them (Plate I-Figs. 2 and 3). A colored tape was put on the harness to identify the seal with the

aim of carrying on the research even if the transmitter goes wrong. Saddletree style was used to fasten the harness (Fur Seal Resources Section, 1968). (Plate I-Fig. 3).

The transmitter was set up to 13 bachelor seals with a body length of 105 cm to 130 cm during 12 days starting from July 10th in the East Cliff Rookery. Also it was tagged to 10 bachelor seals with a body length of 110 cm to 125 cm in the border area of the East Cliff Rookery and the East Reef Rookery on July 14th, 17th and on July 18th. The reason that the place of tagging was changed was to avoid giving unnecessary excitement to the radio-tagged bachelor seals in the East Cliff Rookery. The second place for setting up the transmitter was not far from the first place, and the bachelors there were usually living at the East Cliff Rookery.

II—c Method of research on the durations spent at sea and land by radio-tagged bachelors

During the investigation period the telemetric observations (Plate II-Figs. 1 and 2) and the visual observations were carried out twice a day, in the morning and in the evening. A part of the record of the observation is shown in Fig. 2. In the figure, ch. 1 to ch. 11 are the channels marked to identify each animal. In the record the ch. mark and its record were drawn in numerical order.

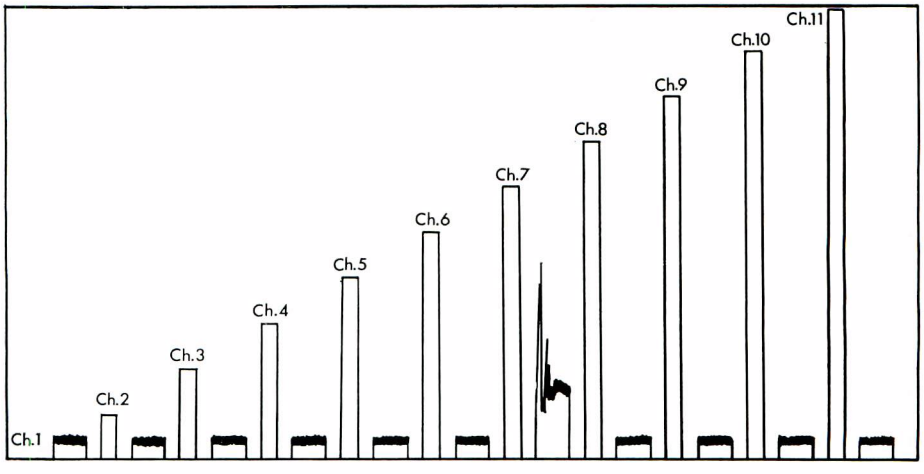


Fig. 2. Record of stay at land of radio-tagged seals. (ch: Channel mark)

When the tagged seal was staying at land the rate of electric signal was recorded as shown in ch. 7. While when the seal was not at land only the noise was recorded. In order to get more a accurate data, the visual observation was done together with the observation using these instruments.

From the island a seal goes out to the sea and lands on an island which was not necessarily the original one. Therefore the researchers visited each of 7 other hauling grounds over the investigating period in order to confirm the number of tagged seals twice a day, in the morning and the afternoon. During this round of visits the sighting observation was done

together with the observation using a handy antenna and a receiver (Plate II–Fig. 3).

II—d Method of investigation for a bachelor's daily and long term movement within the haulling ground area

For getting the knowledge on movement of an animal the most important thing is to know its position at all times. Therefore it is not too much to say that the value of the telemeter is its ability of finding direction. The ordinary way of detecting direction is to find the direction of the strongest radio wave, by revolving an antenna, which is considered to be the identical direction of the tagged animal. This method is good for tracking a small number of seals, but it takes a lot of effort and time to track many seals for a long time and detect their positions. In addition a researcher sometimes have to move on toward the animals, which may stimulate them and fails to obtain good information on their behavior. Therefore in the present investigation, the fixed type of antenna was used. By changing the right and the left side antennas electronically, the ratio of the input signal between them was calculated and the direction of the tagged seal was detected.

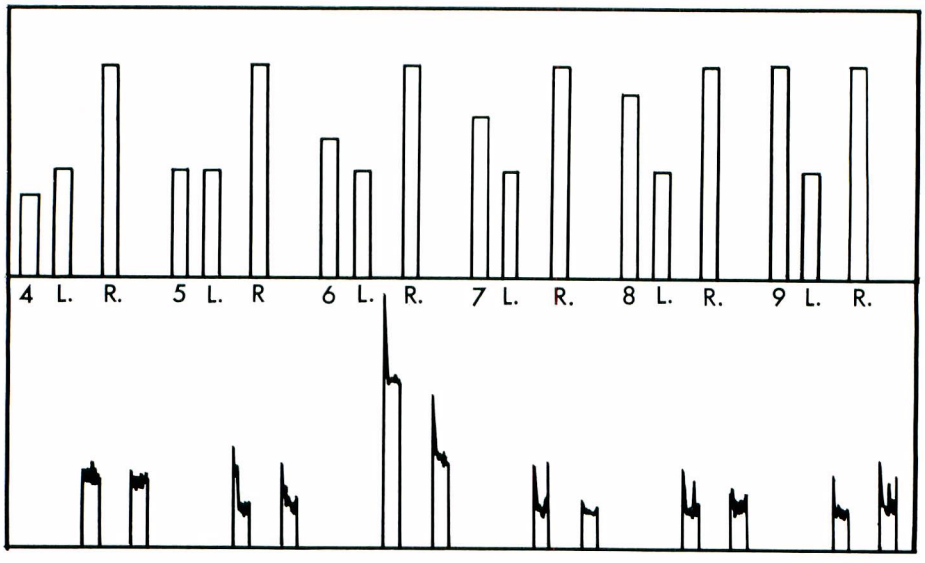


Fig. 3. Record of radio-tagged seal position.
(4~9: Channel mark, L: Left antenna mark, R: Right antenna mark)

A part of the record of the direction detection is shown in Fig. 3. On the upper part of the recording sheet, the channel mark in operation of receiving, the left antenna mark and the right antenna mark are drawn from the left to the right. On the lower part of the sheet the electric intensity of the input signal by the right and the left antenna is recorded. The ratio of electric intensity between both antenna is calculated and the angle of direction each time is found by fitting the value to the special curve for antenna level v. s. angle. Similar to the telemetry control system it is possible to get the record of an animal automatically in any time. A radio wave is easily affected by topography thereby causing errors in measurement.

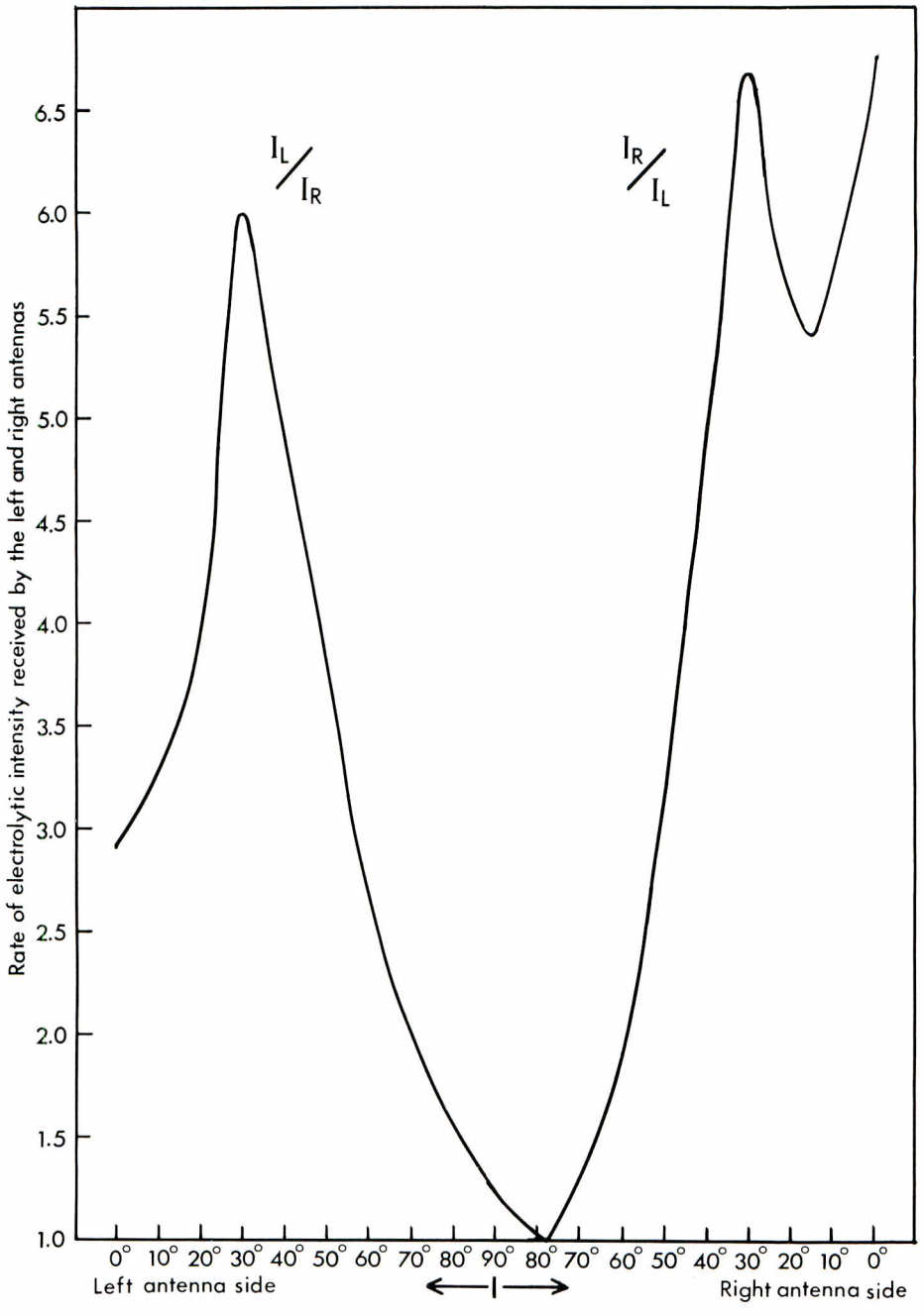


Fig. 4. Special curve for antenna level v. s. angle.
(IL/IR: Electric intensity of left antenna per it of right antenna)
(IR/IL: Electric intensity of right antenna per it of left antenna)

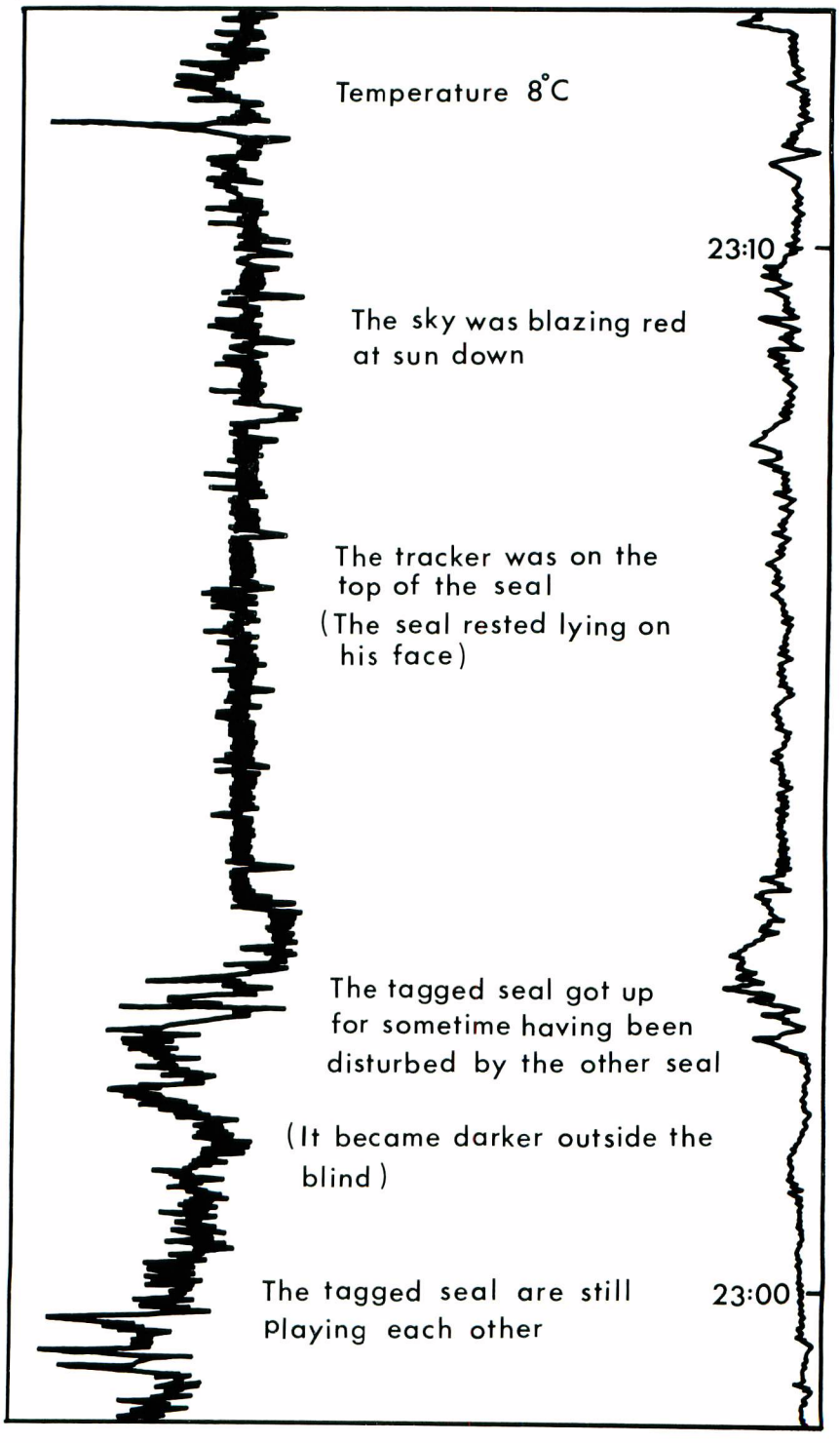


Fig. 5. Record of a radio-tagged seal's activity.

Hence it is desirable to make the special curve for the place of investigation. The curve at the investigating station is shown in Fig. 4.

In the present investigation, the researchers had only one set of this system. Therefore they measured a line of direction, and at the same time they measured the strength of a radio wave from all directions of the investigation area at the same place. Then a table of correlation between receiving radio wave and the distance thereby the distance of the tagged seal from the antenna was estimated. A visual record was also used to make the record better.

As for the daily movement of bachelor males in the hauling ground, successive observation of position of the five tagged seals was carried out over a long time. To study the long term home range of bachelor seals in the hauling ground, the position of the 17 tagged seals was observed twice a day, in the morning and in the evening.

II—e Method for observation of daily activity of a bachelor male in the hauling ground

The daily activity of bachelor male was investigated using the radio transmitter for activity observation and the telemetry control system in the observation station. The part of the record of a tagged seal's activity is shown in Fig. 5. In the figure, the left side record is the information of the activity, the explanation is the individual seal's activity by visual observation and the right side record is electric intensity of the receiving wave. The record of the visual information was used as much as possible in order to compare it with the receiving wave pattern. As shown in the figure, the record of activity corresponds with the electric intensity. Therefore it is possible to get an information if the seal is moving or resting even if the seal has only a radio transmitter (simple transmitter) without an activity detective sensor. Hence in the present investigation the behavior of the bechelor male having the signal transmitter was also recorded and it was used to supplement the record of behavior with a transmitter for activity observation.

III. Result of investigation and some considerations

III—a Duration spent at the land and sea by a bachelor male

The number of days spent at the sea by a radio tagged bachelor was illustrated in Fig. 6.

According to the 22 examples, the number of days spent at the sea was between 1 day and 34 days. The Progress Report of St. George Island Research by Japan (Fur Seal Resources Section 1975) points out that it was about three weeks. GENTRY and JOHNSON (1976) stated that the days spent at sea were from 1 day to 39 days based in the irresearch of 49 subadult males (age 2-4) using a radio telemetry in the Zapadni Rookery and this result shows that it almost all corresponds with the result of the present report.

As for the period of stay at sea, it is shown that there are two patterns from Fig. 6: one is the short period of 1 to 2 days; the other is long period of 11 to 34 days of stay. The ratio of the short stay at sea was 31.8% in the total number of observation. This ratio was 20% according to the investigation by GENTRY and JOHNSON (1976) and it was 65% by GENTRY *et al.*, 1979). The difference between these two ratios is substantiably large.

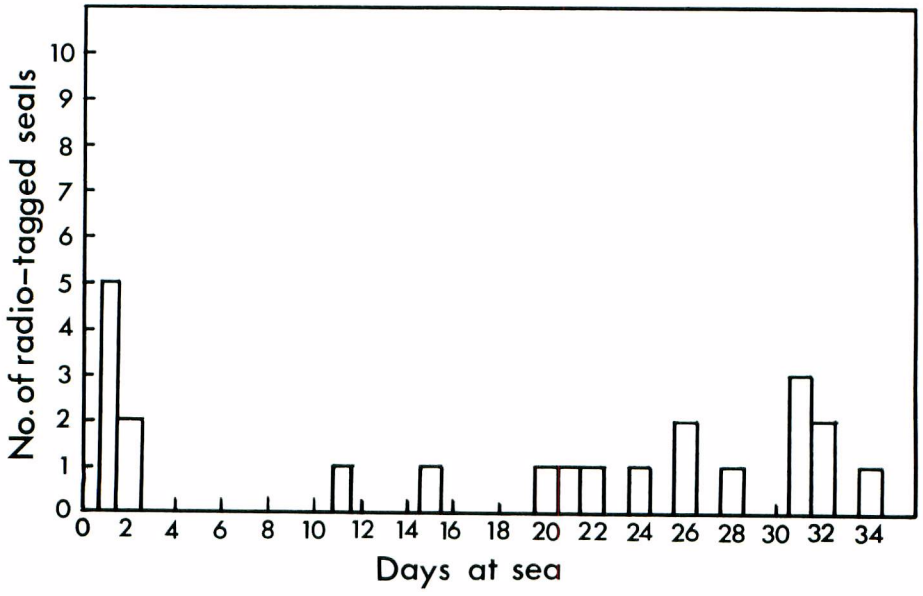


Fig. 6. Distribution of number of a radio-tagged bachelor by days spent at sea.

GENTRY and JOHSON (1976) described that their short stay at sea is the result of escape from the higher atmospheric temperature, rain and threat by a man. It was observed that many seals moved to the sea when the temperature was high, it rained and they got the threat by a man such as tagging during the present investigation.

GENTRY and JOHNSON (1975) also conducted an experiment regarding the bachelor of fur sealswhen disturbed by a man, both for the grown up males in June, and for the grown up female in September in 1974 in the East Reef Rookery. All the 17 adult male seals returned to the island in 12 hours and all the seals were continuously away from the rookery 1.9 hours in average according to their reports.

The behavior of adult male seals when disturbed by a man would be different from that of adult females and bachelors. In any case it can be estimated that their short stay at sea is not the purpose of feeding.

Based on the present research the long term stay at sea was between 11 days and 34 days and averaged 25.6 days. Of all the seals, the 10 seals returned to the St. George Island stayed at sea for 25.1 days and the 5 seals that left the St. George Island went to the St. Paul Island staying 26.6 days in average respectively. The seals landed the neighboring St. Paul Island stayed at sea 1 to 2 days longer than those returned to the St. George Island. At any rate, it is estimated that the average period of a bachelor male's staying at sea is from 25 to 27 days.

On the other hand, GENTRY and JOHNSON(1976) reported that the period of long term stay at sea for subadult male was between 10 to 20 days. GENTRY *et al.* (1979) reported that the average period of juvenile males' away from the land was 19.9 days. These reported

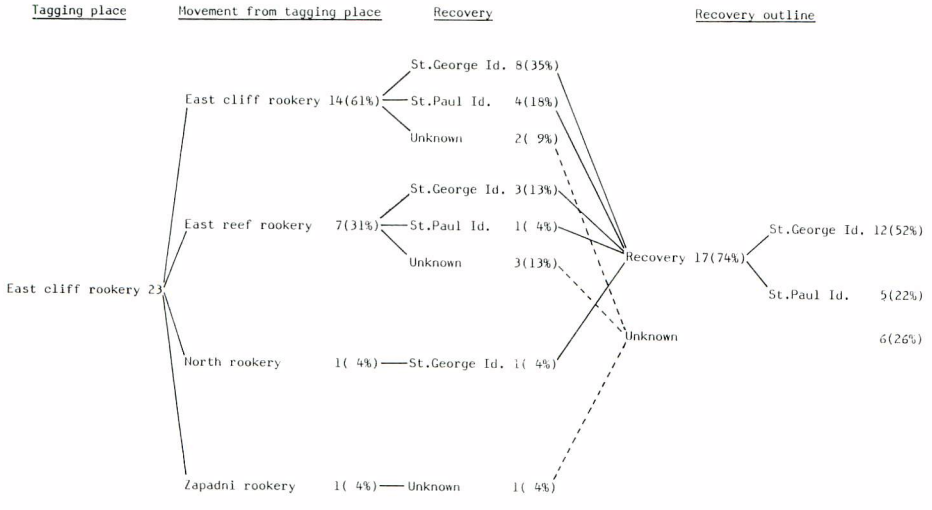
figures are very different from the result of the present report. This difference might have been occurred due to different number of samples and the different surroundings of the Rookery. Relating to this problem, GENTRY *et al.* (1977) stated that as for the frequency of feeding there was a little difference between the Zapadni Rookery and the East Reef Rookery.

If feeding is their main purpose of staying at sea, there would also be a relationship between the period of stay at sea and situation of the feeding sea area and the each hauling ground. In other words, the period of stay at sea for the seals in a hauling ground near the feeding sea area is short, and that for the seals far from the feeding area is relatively long. According to the report of the fur seal sighting in the breeding season in the vicinity of the Pribilof Island by YOSHIDA *et al.* (1978), seals were observed most frequently in the Southwest sea area of the St. George Island (sharing 41.2% of the total number of seal observed), where is corresponding to the same area in the main feeding sea area during breeding season. On the other hand, the East Cliff Rookery is situated in the back side of the feeding ground and far from there.

The relationship between the number of days of staying at sea for a bachelor seal and the distance between a rookery and the feeding sea must be clarified. Because this study will bring necessary information for the investigation of the number of seals existing in the breeding island. Therefore for the future investigation it would be important to have the enough number of tagged seals as well as making biotelemetry research not only from the land but also from the sea. At the same time, information of sea condition around the rookery and the feeding area must continuously collect for the betterment of the investigation.

It was formerly expected to investigate the number of days spent by tagged seals on the land. However due to the short of days for the investigation period, the data of duration on

Table 1. A radio-tagged seals' tranportation.



land could not be obtained.

The movement of the tagged seals from the rookery to the other hauling ground was shown in the table 1. Out of 23 bachelor seals harnessed a radio transmitter in the East Cliff Rookery of the St. George Island, 7 seals (31%) moved to the East Reef Rookery, 1 seal (4%) to the Zapadni Rookery and the other 1 (4%) to the North Rookery before they left for a long term stay at the sea.

Fourteen seals (61%) stayed at the East Cliff Rookery where they had been put a transmitter. The East Cliff Rookery situates in the neighborhood of the East Reef Rookery. Therefore if we consider these two rookery as the large one rookery, we can say that 21 out of 23 seals (91%) stayed in the same rookery after they had the transmitter. This result suggests that their activity was not critically hampered by harnessing of a transmitter and driving by a man. Also this result corresponds with the report by GENTRY *et al.* (1979) that they could not confirm any apparent escape of the seals from the place where they had been disturbed.

As for the tagged seals' return to the islands after staying at sea long period, 12 seals (52.2%) returned to the St. George Island, and 5 seals landed the St. Paul Island. Of 12 seals returned to the St. George Island, 2 seals were caught at the St. George Island after the investigation, and their transmitters were mailed to Japan. It is not clear which rookery they had landed in. Six seals (26%) did not return to the island, and 17 seals (74%) returned to either St. George Island or St. Paul Island. This ratio of return almost coinside with the ratio of 18.0% obtained by GENTRY *et al.* (1979) who has investigated 180 juvenile males in the Zapadni Rookery and the North Rookery in 1977.

III—b Daily and long term home range of bachelors at the hauling ground

In order to investigate bachelor seals' daily home range, five radio-tagged seals were observed continuously.

Among those five, the one that we were able to observe for the longest time was chosen for completion of data. The result is shown in Fig. 7. Observation period was approximately 71 hours in the total, that is, from 1323 of July 14 to 2305 of July 15 and from 0926 of July 16 to 2259 of July 17. Then the radio-tagged seals went to the sea, and observation turned out impossible. The mark Ⓢ in the drawing shows the position of the fur seal at the time of starting record and Ⓔ at the time of ending record. The marks from A to H show the positions where the bachelor seals grouped with high density.

The radio-tagged seals moved from G to F from 1323 of July 14 to 2305 of July 15. During this period, the daily moving distance was approximately 450 m, and the major axis of the home range was approximately 170 m. They were moving around from E–F–G from 0926 of July 16 to 2259 of July 17. During this period, the daily moving distance was approximately 400 m and the major axis of the home range was approximately 140 m.

From the above results, it is presumed that the daily moving distance of bachelors is approximately 400 m and the major axis of the home range is approximately 150 m at the hauling ground. Their movement had no uniformity in direction.

The position of the radio-tagged seals estimated by the record of instrument almost coin-

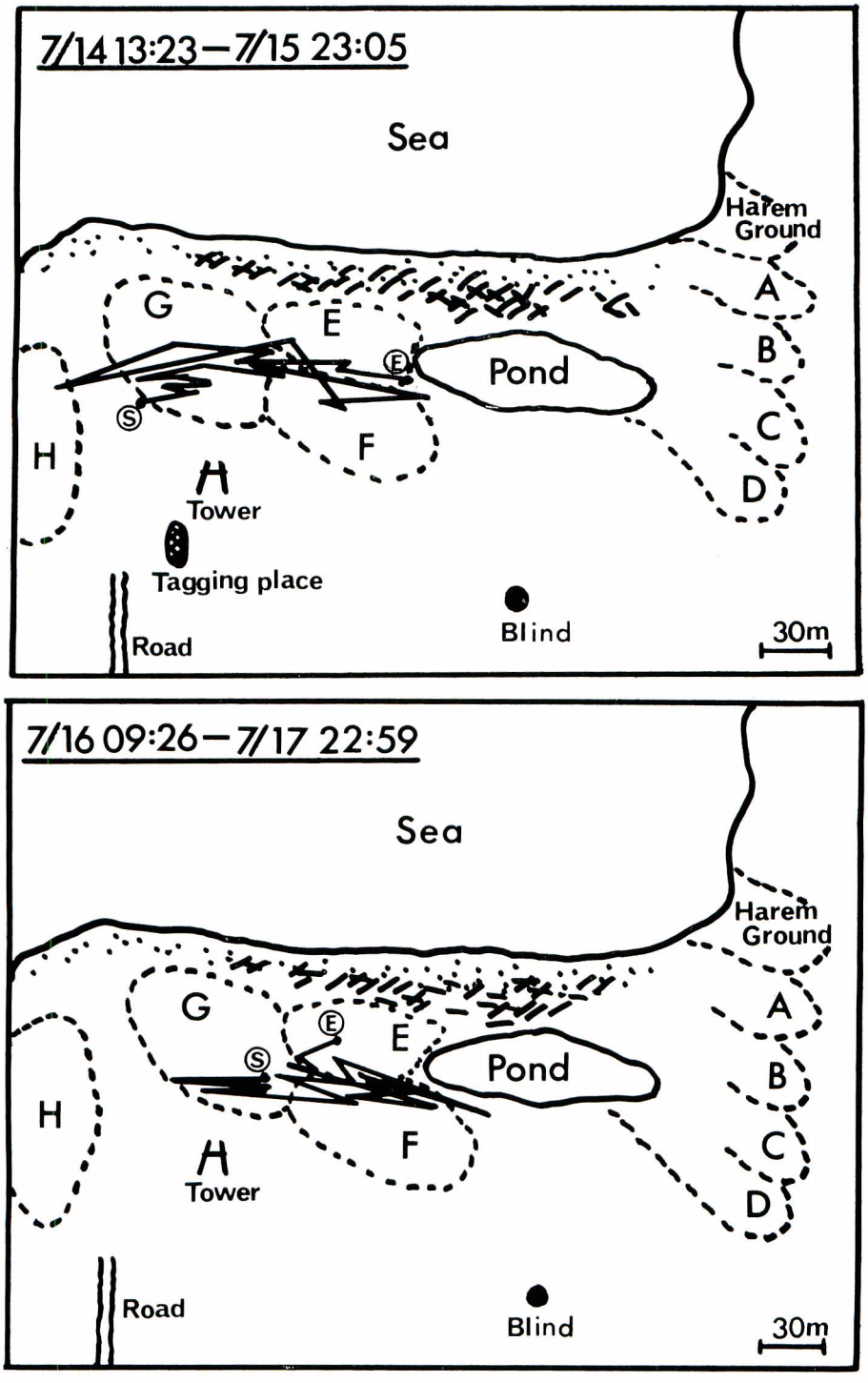


Fig. 7. Daily home range of the radio-tagged bachelor. (No. 14)

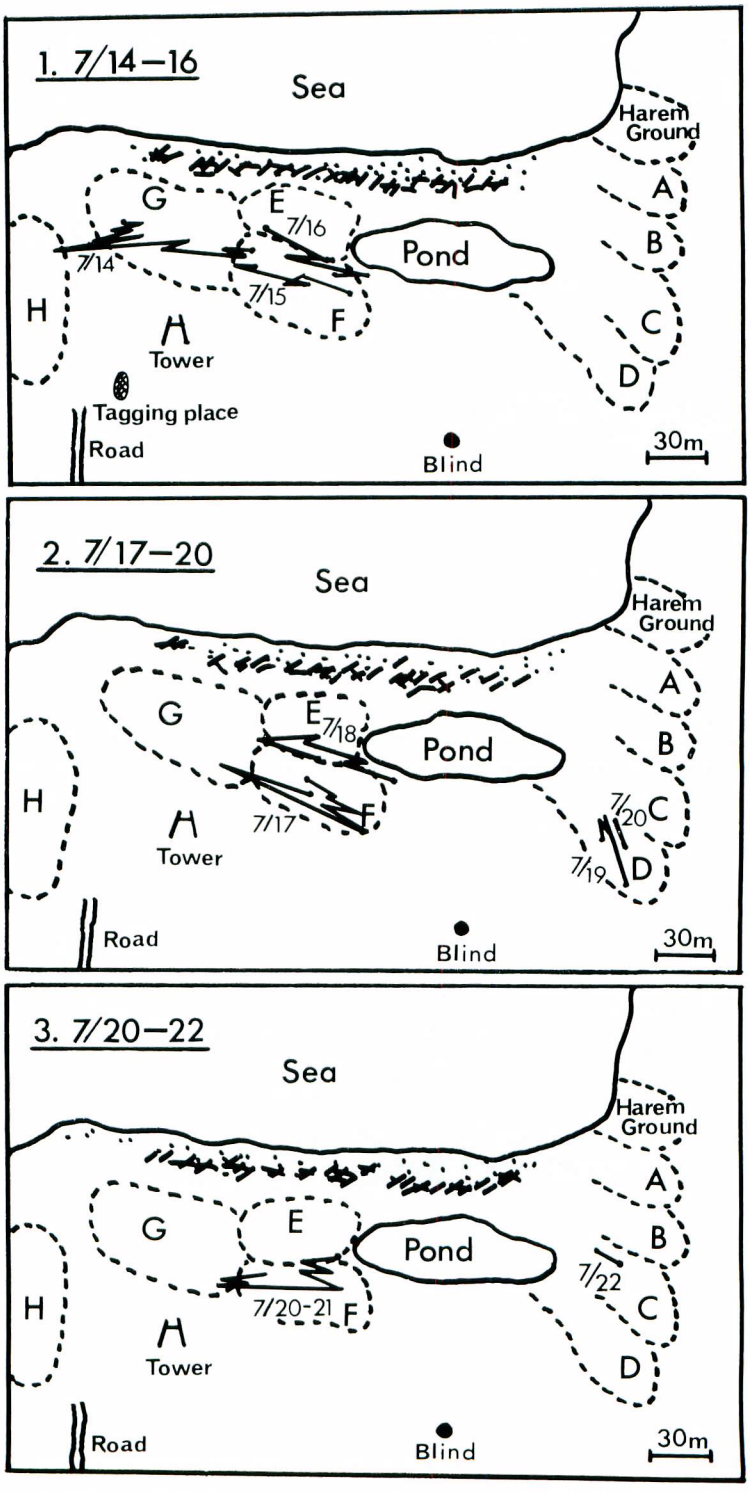


Fig. 8. Trace of staying place of the bachelor seal with the transmitter.

cided with those by visual observation. However, visual observation alone was not enough to make clear the daily moving area as the observation was impossible during night time.

The investigation of long term movement of bachelors was performed from July 14 to July 22, observing 17 seals.

The result of the investigation of the seal that stayed in the hauling ground for the longest period is shown in Fig. 8. As for the record for the other 16 seals, almost the same results were obtained. They were moving around the area E–F–G from July 14 to July 18. A radio signal was impossible to be accepted from noon of July 18 and the radio wave became good in condition in the morning of July 19. During this day, they were in the sea. After that, they stayed in the track of C–D until the morning of July 20. On July 20, from about 1000 till the evening, they were in the sea again. Then, again they landed at F and stayed there until early morning of July 21. Later they went to the sea and on July 22, they landed at C and after staying there for several hours they returned to the sea.

From the above results, in the case that the bachelors go out to the sea for a short period of time and land on the same hauling ground again, they changed the position of landing and the position of staying on each occasion, and they seemed to have been moving freely each other.

III—c Daily cycle of movement of the bachelors at the hauling ground

The record of the daily cycle of movement of the three radio-tagged seals at the hauling ground was shown in Fig. 9, where the tagged seals' simple movement such as raising head when taking rest lying on their face or side was considered to be the state of repose. The lateral axis shows the time. The wave profile shows that the bechelors are moving and the straight profile shows that they are resting. The dotted-line portion shows the receiving of noise without normal radio signal. The observation period of each radio-tagged seal is shown in the figure.

The radio-tagged seal of No. 2 transmitter was sending clear radio wave until 0900 of August 5. Since then, reception of radio signal ceased, and at 0920, 1310 and 1700, intermittent slight electric wave suggesting that they were playing at the beach were received. After that the electric wave was not received at all. We thought they had already gone to the sea, and accordingly we stopped collecting records at 0059 of August 6. It is known from the Fig. 9 that daily activity pattern of a bachelor seal is continuation of short activity of 1–2 hours and short rest of 2–3 hours approximately from around 1600 to 0600. They usually rest from around 0600 to 1600, but sometimes move 30 minutes to 1 hour. They tend to repeat a pattern of taking a long rest and a short activity. There is a common tendency among each individual seal regarding periods of time for activity. These time zone are toward evening from 1600 to 1900, from 2100 to 2300 when it becomes so dark that they crnnot see well, during dark night from 0000 to 0200, and in the dawn from 0500 to 0700.

The activity level of a bachelor male with the activity observation transmitter No. 20 and one with the transmitter No. 21 was illustrated in Fig. 10. In this figure, the vertical aaxis shows accumulative active time of tagged seal and the horizontal axis is hour of a day. The bachelor's very simple short movement such as just raising his head and shaking it was con-

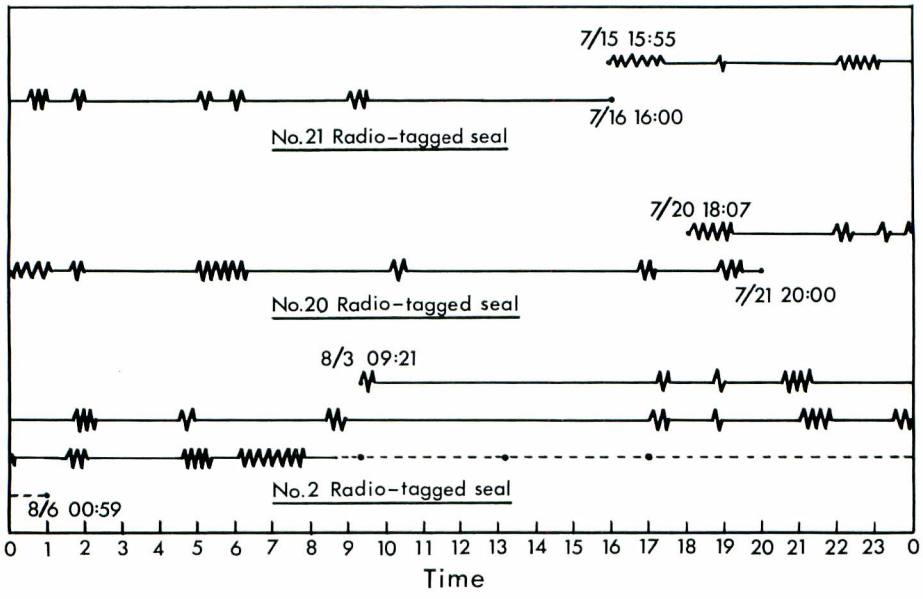


Fig. 9. Activity time three radio-tagged bachelors at the East Cliff Rookery.
(⌇ : Activity, ——: Not in activity, •: Received sound, ----: Noise)

sidered as the activity when the time of which was calculated from the recording paper (Therefore some active time might have added up in the Fig. 10 even though it is in the rest time zone in Fig. 9). The activity level of the seal tagged a simple tracker was omitted in this report since the record was only for the electric intensity. From the Fig. 10, one can see that they show more activity during night time than in the day time.

GENTRY *et al.* (1979) state that activity level (fur seals' raising their heads from the ground) of the juvenile male reach the peak at about 0800 or before the time, and at about 1900 or later, and it becomes minimum from 1400 to 1700.

FISCUS *et al.* (1976 and 1977) point out that the activity (the movement of getting up) of the territorial male increases after 1500 and reaches the peak at about 2100, begins to decrease after 2100 and it becomes minimum from 0100 to 0200, then begins to increase again after 0200 and reaches the peak at 0500 and 0600. Afterwards, it extremely decreases until 0900. They also reported that the activity is more brisk at night than in the daytime.

When comparing the time period of peak activity levels explained in the reports by GENTRY *et al.* (1979) and FISCUS *et al.* (1976 and 1977) is compared with that of the present report some difference in the time range is confirmed, however all the reports share the same view point that they act mostly in the evening and early morning. But FISCUS *et al.* (1976 and 1977) says the time period when they shows the least activities is within the period from 0100 through 0200, which is different from the result of this investigation. This difference would have been caused due to the difference of the definition of their activities, place of investigation and age of seals observed.

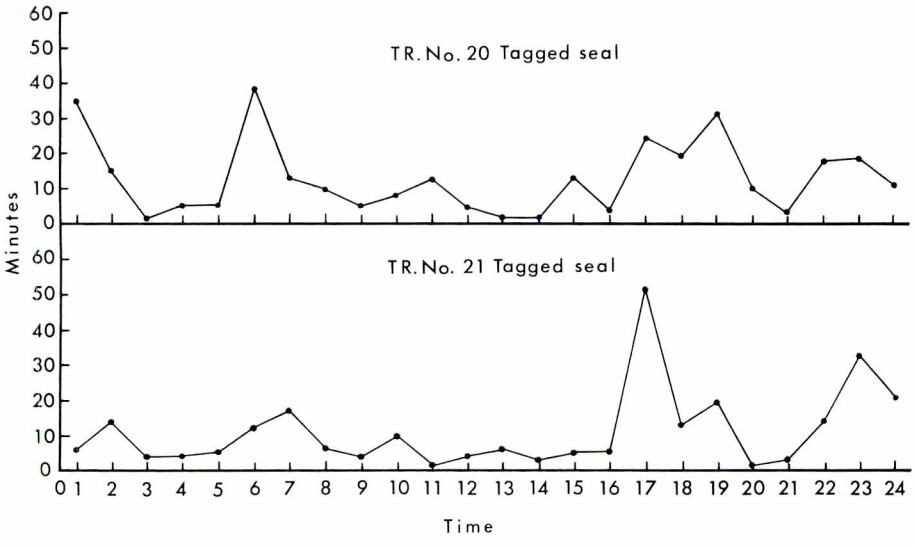


Fig. 10. Accumlative active time in each hour of two radio-tagged seals.

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Summary

Fur Seals Resources Section of Far Seas Fisheries Research Laboratories, Fisheries Agency of Japan, made an investigation of bachelors' activity and the behavior at the hauling ground, using radio wave telemetry system at the St. George Island, Pribilof Islands, the State of Alaska of the U. S. A. which had been designated as the fur seal intensive research area in 1974, 1976 and 1978. Visual observations were applied together with the biotelemetry method as much as possible, and the two way observation may be enhance the reliabilities of the records collected by the machine.

As the results of the present investigation the authors gained confidence that the radio wave telemetry system developed jointly by Fur Seal Resources Section and Makita Electronic Institute can be effectively used to investigate the activity and ecology of animals. Concerning the activity and ecology of the bachelors, the following results were obtained.

1. The period of bachelors' staying in the sea is between one day to 34 days, and it is roughly devided into two; A short term stay (one day to 2 days), and a long term stay (11 days to 34 days).

2. The short period of staying in the sea is not for seeking food but for escaping from the uncomfortable weather or any other disturbances. The long term staying in the sea averaged 25.6 days and it is considered to be the activity for feeding.
3. The ratio of returning to the islands after long term stay in the sea was 74.0%.
4. Daily moving distance of the bachelors at the hauling ground is approximately 400 m. The longer axis of their home range is approximately 150 m, and their moving directions were not always fixed.
5. Even in the case that they land in the same hauling ground again after staying in the sea for a short period of time, their landing positions and staying positions differ in each occasion and there is no rule in their behavior.
6. Daily bachelors' activity cycle is roughly divided into two: From about 1600 to about 0600 they repeat 1 to 2 hours of short time activity and 2 to 3 hours of long time rest. They mostly take rest from about 0600 to about 1600. However in this long rest time zone, they repeat 30 minutes to 1 hour of short time activity at intervals.
7. It seems that bachelors behave commonly active time zone in a day, that is, the time toward evening from 1600 to 1900, from 2100 to 2300 when it becomes dark night and their visual range is poorer, during dark night from 0000 to 0200, and in the dawn from 0500 to 0700.
8. Their activity in the daytime is considerably less than that at night, and it was confirmed that they were nocturnal.

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繁殖島のオットセイ動態研究への電波テレメトリーの利用

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摘　　要

水産庁遠洋水産研究所オットセイ資源研究室はオットセイ調査強化区域であるアメリカ合衆国アラスラ州プリビロフ諸島セント・ジョージ島において，1974, 1976 と 1978 年に電波テレメトリーシステムを用いてホーリンググランド内における雄独身獣の行動生態調査を行なった。

機器による観測と同時に，可能な限り目視観察をも併用し，本機器の性能を確認するとともに，収集した記録の信頼性を高める方法をとった。その結果，オットセイ資源研究室と牧田電子研究所が共同で開発試作した電波テレメトリーシステムはオットセイの陸上における行動生態調査に十分使用出来るとの確証を得た。

繁殖時期における雄独身獣の行動生態について下記の知見が得られた。

1. 雄独身獣の海上滞在期間は 1 日から 34 日間の範囲であり，短期間（1～2 日）の海上滞在と長期間（11～34 日）の海上滞在に大別出来る。
2. 短期間の海上滞在は索餌を目的とした行動ではなく，天候や何らかの妨害からの逃避行動である。長期間の海上滞在期間は平均 25.6 日であり，索餌を目的とした行動と考えられる。
3. 長期間の海上滞在後の帰島率は 74.0%であった。
4. ホーリンググランドにおける雄独身獣の 1 日の移動距離は約 400 m 前後である。その行動域の長径は約 150 m 前後であり，移動方向には一定の方向性がみられない。
5. 短期間海上に出た後同じホーリンググランドに再上陸する場合にも，その上陸場所及び滞在場所はその都度まちまちであり規則性がない。
6. 雄独身獣の 1 日の活動周期は 2 つに大別出来る．16:00 頃から 06:00 頃までの間は約 1～2 時間程度活動しては約 2～3 時間休むといった短時間の活動と短時間の休息の繰り返しである。06:00 頃から 16:00 頃までの間は殆んど休息しているが，時おり約 30 分～1 時間動くといった長時間の休息と短時間の活動の繰り返しである。
7. 活動の時間帯は 16:00～19:00 の夕暮れ時，21:00～23:00 の暗夜になり始める頃，00:00～02:00 の暗夜，05:00～07:00 の朝方に共通する傾向がある。
8. 昼間の活動は夜間の活動に較べかなり少なく，夜行性であることが確認された。

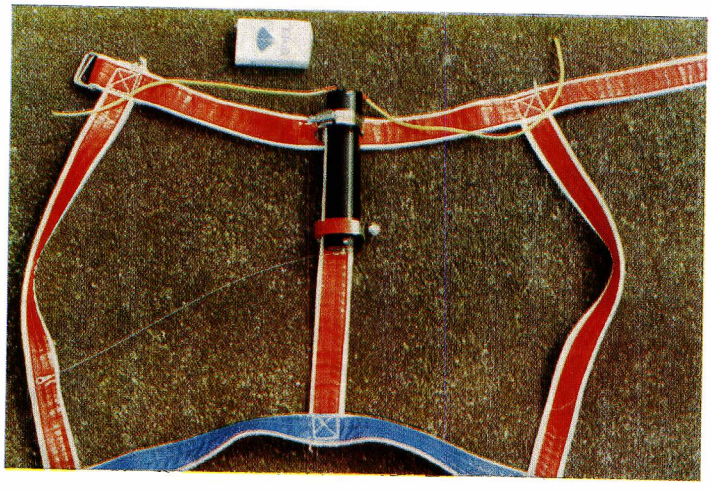
Explanation of Plate I

Fig. 1. Harness and transmitter. (The transmitter attached harness)

Fig. 2. Harnessing of transmitter to a seal.

Fig. 3. A seal with a transmitter.

Plate I



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2

3

Explanation of Plate II

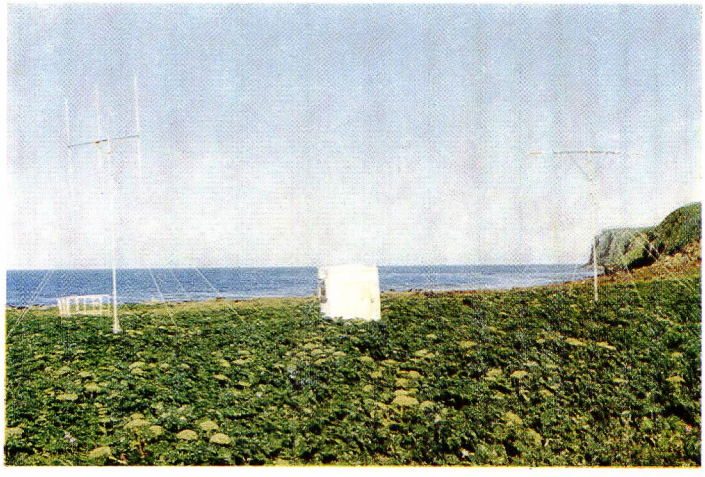
Fig. 1. Observation facilities at the East Cliff Rockery.

Fig. 2. Receiving apparatus in a blind.

Fig. 3. Observation using a handy antenna and a portable receiver. (North Rookery)

Plate II

1



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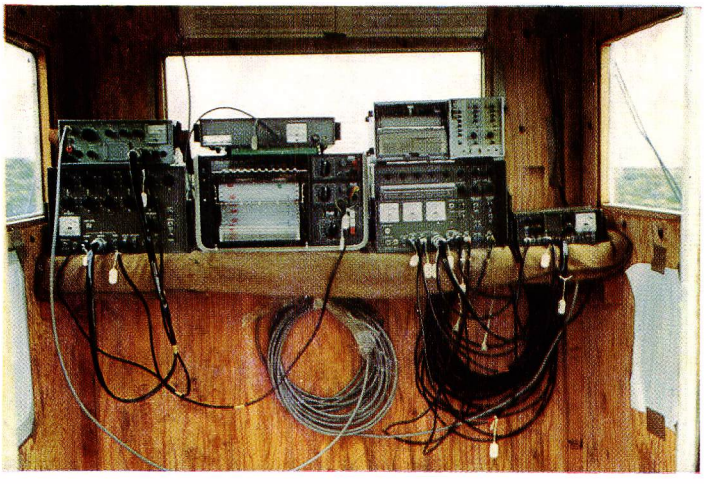

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