1952

Size distribution structure and harvest of a Kodiak bear population

Willard A. Troyer

The University of Montana

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SIZE, DISTRIBUTION, STRUCTURE AND HARVEST OF
A KODIAK BEAR POPULATION

by

WILLARD A. TROYER

B. S. Oregon State College, 1952

Presented in
partial fulfillment of the requirements for the degree of
Master of Science in Wildlife Technology

MONTANA STATE UNIVERSITY

1962

Approved by:

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Chairman, Board of Examiners

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Dean, Graduate School

MAR 2 1962

Date
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W.A.T.

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INTRODUCTION

Increased pressures of civilization have reduced or eliminated brown and grizzly bears from great portions of the Northern Hemisphere. In the Western United States where the grizzlies (Ursus arctos horribilis Rausch 1953) were formerly abundant, they now number less than 1,000, exclusive of National Parks (Cooney, 1956; Craighead, et al., 1960).

In Alaska, where vast wilderness areas still exist, large populations of grizzly and brown bears remain. An expanding human population and modern means of transportation to hunting areas have rapidly increased the bear harvest in Alaska during the last decade. Klein, Troyer, and Rausch (1958) indicated, however, that bear numbers remain at a high level.

The brown bear of Kodiak Island, more commonly known as the Kodiak bear (Ursus arctos middendorffi Rausch 1953), is one of the most coveted trophies on the North American continent. Because of its reputation of extreme size, hunting pressures are greater on Kodiak Island than on other Alaskan regions (Troyer, 1961). The Kodiak bear's reputedly larger size over that of the nearby Alaska Peninsula brown bear (Ursus arctos gyas Rausch 1953) may be questionable; however, this belief is somewhat substantiated by current Boone and Crockett Club records which list 12 of the first 13 brown bear
trophies as coming from Kodiak Island (Webb, et al., 1958). The bear's aesthetic value and trophy importance led to the establishment by Congress in 1941 of the Kodiak National Wildlife Refuge, which encompasses the greater portion of Kodiak Island. Refuge regulations permit controlled hunting and with proper management assist in perpetuation of the species.

The increased hunting pressures led biologists to inaugurate studies to obtain adequate knowledge needed in managing this species. Studies, from 1947 to 1956, were primarily concerned with bear-salmon relationships; however, limited data were gathered on population, food habits, and harvest. In 1957 the investigations were greatly expanded with a live-trapping and ear-tagging program. The author, as Refuge Manager of the Kodiak National Wildlife Refuge, was in charge of the bear studies from August 1955 through 1961.

This phase of the investigation was conducted in the Karluk Lake drainage on Kodiak Island. The area is considered optimum bear habitat and comprises approximately 10 per cent of the total refuge bear population. The primary objectives of the study were:

1. To determine the size, structure, and density of the Kodiak bear population in the Karluk Lake drainage.
2. To determine the harvest by hunters and its effect on the population.
3. On the basis of this information, to make suggestions for managing a brown bear population for trophy purposes.
DESCRIPTION OF THE STUDY AREA

Geographic Location

Kodiak Island lies within the Gulf of Alaska and is separated from the mainland of Alaska by 30 miles of water, the Shelikof Straits. The study area comprises an area of 96 square miles and includes all of the Karluk Lake drainage. It lies in the southwestern portion of Kodiak Island and is part of the Kokiak National Wildlife Refuge. The lake is situated approximately 100 miles southwest of the town of Kodiak, Alaska (Figure 1).

Climate

Because of the influence of the Japanese current, the climate is relatively mild. The range of the mean temperature is slight, with the coldest temperatures occurring during December and January and the warmest during July and August (Table I). The average annual precipitation is approximately 60 inches and the area is devoid of prolonged periods of dryness. Summers are characterized by periods of fog. Wind storms are common; gusts of 40 to 60 knots are not unusual during winter months, and stronger gusts up to 80 knots occur each year. These storms are not as prevalent during the summer and, when occurring, are of less intensity.
Figure 1. Location of the study area.
<table>
<thead>
<tr>
<th>Month</th>
<th>Precipitation Mean</th>
<th>Temperature Mean</th>
<th>Precipitation Mean</th>
<th>Temperature Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Snowfall</td>
<td>Precip.</td>
<td>Max.</td>
<td>Min.</td>
</tr>
<tr>
<td>Jan.</td>
<td>13.2</td>
<td>4.87</td>
<td>30.7</td>
<td>26.4</td>
</tr>
<tr>
<td>Feb.</td>
<td>10.7</td>
<td>4.98</td>
<td>32.7</td>
<td>28.0</td>
</tr>
<tr>
<td>Mar.</td>
<td>10.9</td>
<td>3.56</td>
<td>32.4</td>
<td>27.1</td>
</tr>
<tr>
<td>April</td>
<td>4.4</td>
<td>4.14</td>
<td>37.0</td>
<td>32.6</td>
</tr>
<tr>
<td>May</td>
<td>T</td>
<td>6.19</td>
<td>42.5</td>
<td>38.5</td>
</tr>
<tr>
<td>June</td>
<td>-</td>
<td>4.49</td>
<td>49.6</td>
<td>44.6</td>
</tr>
<tr>
<td>July</td>
<td>-</td>
<td>3.73</td>
<td>53.9</td>
<td>49.1</td>
</tr>
<tr>
<td>August</td>
<td>-</td>
<td>4.32</td>
<td>56.2</td>
<td>48.9</td>
</tr>
<tr>
<td>Sept.</td>
<td>T</td>
<td>5.51</td>
<td>49.9</td>
<td>44.9</td>
</tr>
<tr>
<td>Oct.</td>
<td>1.1</td>
<td>6.95</td>
<td>42.1</td>
<td>36.7</td>
</tr>
<tr>
<td>Nov.</td>
<td>3.3</td>
<td>5.45</td>
<td>35.2</td>
<td>30.9</td>
</tr>
<tr>
<td>Dec.</td>
<td>9.7</td>
<td>5.34</td>
<td>31.6</td>
<td>26.3</td>
</tr>
</tbody>
</table>

1 Observations made at Kodiak, 90 miles from the study area.
Physiography

Karluk Island lies 368 feet above sea level and is approximately 12.2 miles long and from 1 to 2 miles wide. Two smaller lakes drain into Karluk. Thumb Lake is situated about the middle of the east side of Karluk Lake and is 3/4 mile long and 1/2 mile wide. O'Malley Lake lies off the southern extremity of Karluk Lake and is 2 miles long and 1/4 mile wide. These two lakes are drained into Karluk by the Lower Thumb and O'Malley Rivers. Canyon Creek, Falls Creek and Upper Thumb River are the largest streams of the system. They meander for some distance through relatively wide valleys. A number of smaller streams flow into Karluk Lake as shown in Figure 2. The lakes are surrounded by mountains which rise abruptly to a height of about 1500 to 3500 feet. Only at the extreme southern end of O'Malley Lake and at the outlet on the northern end of Karluk Lake can the drainage be entered at low elevations. Karluk River, a stream of considerable size, drains the lake and flows a distance of 30 miles before emptying into Shelikof Straits. The river is not navigable, and the drainage can be entered only by aerial transportation or by foot.

Fauna

The only big game animal inhabiting the drainage is the Kodiak bear, although a few wild reindeer (Rangifer tarandus) range along Karluk River. Small mammals include tundra
Figure 2. Map of the study area.
vole (*Microtus oeconomus*), river otter (*Lutra canadensis*), varying hare (*Lepus americanus*), short-tailed weasel (*Mustela erminea*) and red fox (*Vulpes fulva*).

The red salmon (*Oncorhynchus nerka*) migrates into the lake system during the summer months and utilizes the lake shores and all major streams for spawning purposes. Clark (1957, 1959) summed up the bear-salmon relationship and indicated that the red salmon was an important food item in the bear's diet, especially from July 1 through August 15. Because of commercial fishing exploitation, escapements of one or two million fish in the 1920's have now dwindled to around 320,000 annually (Table II). Other less important fish migrating into the lake are the silver salmon (*Oncorhynchus kisutch*), pink salmon (*Oncorhynchus gorbuscha*), chum salmon (*Oncorhynchus keta*), steelhead trout (*Salmo gairdneri*) and the dolly varden trout (*Salvelinus malma*).

Various birds, primarily shorebirds, and waterfowl inhabit the drainage.

**Vegetation**

The Karluk Lake drainage lies 75 miles beyond the limit of coniferous forest on Kodiak Island and, therefore, by the usual standards of life-zone allocation, would fall chiefly in the Arctic Zone. However, the climax plant growth covering most of the drainage differs from anything else described in the arctic.
TABLE II
ADULT RED SALMON MIGRATIONS THROUGH THE KARLUK RIVER WEIRS
FOR CERTAIN YEARS BETWEEN 1925 AND 1960

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925</td>
<td>1,621,000</td>
</tr>
<tr>
<td>1926</td>
<td>2,533,000</td>
</tr>
<tr>
<td>1930</td>
<td>1,096,000</td>
</tr>
<tr>
<td>1935</td>
<td>877,000</td>
</tr>
<tr>
<td>1937</td>
<td>1,265,000</td>
</tr>
<tr>
<td>1938</td>
<td>1,076,000</td>
</tr>
<tr>
<td>1940</td>
<td>719,000</td>
</tr>
<tr>
<td>1945</td>
<td>658,860</td>
</tr>
<tr>
<td>1946</td>
<td>442,000</td>
</tr>
<tr>
<td>1950</td>
<td>756,561</td>
</tr>
<tr>
<td>1951</td>
<td>672,922</td>
</tr>
<tr>
<td>1954</td>
<td>326,614</td>
</tr>
<tr>
<td>1957</td>
<td>220,000</td>
</tr>
<tr>
<td>1958</td>
<td>302,000</td>
</tr>
<tr>
<td>1959</td>
<td>330,000</td>
</tr>
<tr>
<td>1960</td>
<td>347,000</td>
</tr>
</tbody>
</table>

Griggs (1934, 1936), working on Kodiak Island and the Alaska Peninsula where vegetation is similar to that of Karluk Lake, found evidence that the present forest edge in the two areas is advancing. He believes that the forest in this region has not yet reached its climatic limit since the last glacial period. He further states, "The timberline vegetation of Kodiak finds its proper comparison not with the timberline in the Rocky Mountains, but with the lower part of the Hudsonian Zone many hundred feet below the limit of trees."

His findings are further substantiated by Bowman (1934) who sampled several peat bogs in the spruce forests of northeastern Kodiak and, from pollen analysis, established that spruce have arrived on Kodiak in fairly recent times.

It appears then that the Karluk Lake drainage is composed of two life zones: the high alpine areas belonging to the Arctic Zone and the remainder to the Hudsonian Zone, even though the latter is beyond the present forest area.

Conditions are right for vigorous plant growth. The vegetation is varied and a large proportion of the drainage is covered by dense thickets which provide ideal cover for bears. The great variety and abundance of grasses, sedges, and forbs provide ample greens and almost exclusively form the bears' diet in the spring, whereas the large berry crops provide the major food item in the late summer and fall. The major vegetative types found in the drainage appear to form a gradient, with many of the species of one vegetative type.
extending into the next. Ground moisture and elevation seem to be the major factors determining the type of vegetation growing on a site. For convenience these have been broken into five major types: sedge-willow association, cottonwood stand, alder-grass association, fireweed meadow, and alpine tundra.

Sedge-willow association - Sedge-willow associations occur primarily on the poorly drained soils. These are common, and most extensive along low swales of the Thumb and O'Malley River valleys. They also occur along the base of mountains, between ridges, along lake shores and on the damp sites at the higher elevations. The sedges are predominantly Carex lyngbei, C. macrochaita, and C. mertensii, all important food items for bears in the early spring. The willows (Salix spp.) are scattered in the extremely wet sites, but form dense thickets where moisture conditions are more ideal.

Cottonwood stand - Cottonwoods (Populus trichocarpa) seldom occur over 300 feet above the lake surface. They are found in intermittent groves near the lake shores and along streams on well-drained soils. They commonly grow 40 feet in height and 3 feet in diameter and are dense enough to form a closed canopy along some streams. Highbush cranberry (Viburnum edule) is an understory plant and an important bear food, as is the elderberry (Sambucus racemosus pubens). Various species of grasses and forbs are common. Bluejoint (Calamagrostis
canadensis) often forms dense stands under the cottonwood canopy.

Alder-grass association - The alder-grass association is the dominant and most abundant type in the Hudsonian Zone. Both the alder (Alnus crispa) and the grass, which is almost exclusively bluejoint, require well-drained and deep, rich, humus soils. This type grows profusely on 30 to 35 degree slopes, and occurs from the lake shores to elevations of 1500 feet and over. The bluejoint often forms small meadows between dense thickets of alder, but becomes a dense understory plant in scattered alders. Elderberry and salmonberry (Rubus spectabilis) are closely associated with this type as well as other important bear food plants, such as horsetail (Equisetum arvense), cow parsnip (Heracleum lanatum) and seacoast angelica (Angelica lucida) (Clark, 1957).

Fireweed meadow - Next to the alder-grass association, the fireweed meadow is the most abundant. The two types are closely associated and the fireweed meadow seems primarily to occur on the poorer soil sites which will not yet support the dominant vegetation. It is also often indicative of disturbed areas, especially burns, and occurs at the lower elevations on the drier sites and along the mountain slopes to heights of 2000 feet and over. The fireweed (Epilobium angustifolium) gives the colorful reddish pattern to the vegetation in the fall. At the lower elevations it often reaches shoulder height,
but progressively recedes in size as it extends up mountain slopes. Various grasses and ferns are interspersed in these meadows, as are angelica, wild geranium (*Geranium erianthus*) and lupine (*Lupinus nootkatensis*).

**Alpine tundra** - At the higher elevations and on the extreme mountain tops are found the usual plants associated with the Alpine Zone. Some of the most common are crowberry (*Empetrum nigrum*), bearberry (*Arctostaphylos alpina*), alpine azalea (*Loiseleuria procumbens*) and various mosses and lichens. In wetter areas sedges are common.
METHODS AND TECHNIQUES

Trapping and Marking

Live-trapping was initiated in 1957 when two culvert-type traps were employed. The culverts were similar to those used in Michigan for trapping black bear (Erickson, 1957). Because of poor trapping success, they were discontinued in the summer of 1958. In 1959, 1960 and 1961 live-trapping was accomplished by the use of steel traps, with offset jaws, and foot snares, developed by Jack Aldrich of Castle Rock, Washington. A drag with 8 feet of chain was attached to each trap and snare. These were then placed in bear trails along streams and lake shores. The sets were covered and blocked off with stepping sticks in such a fashion as to guide the bear's foot into the set. When captured, bears soon became entangled in brushy thickets.

Traps were checked each morning. A small outboard-powered boat was used to transport equipment and personnel to the vicinity of the traps. Personnel then hiked along the streams to check sets and, when a trap was missing, the drag trail was followed to the bear. If the bear was a cub or yearling and accompanied by a sow, the sow was harassed by rifle shots, shell-crackers and other noises until she departed from the scene. Usually this took but a few minutes, but sometimes several hours, depending upon the aggressiveness

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of the female and the bravery of the crew.

When other bears had been evicted from the site, the captured bear was then immobilized by the use of succinylcholine chloride and pentobarbital sodium. These techniques of trapping and handling Kodiak bears have been described in detail by Troyer, Hensel and Durley (1961).

Live-trapping efforts were confined to the months of July, August and October. During this period the greatest red salmon spawning activity occurs. Bears are concentrated on the streams and along the lake edges, and are available for trapping. A total of 132 bears was handled, of which 16 were recaptures.

All bears were ear-tagged with monel metal cattle-size ear tags and during the last two summers were tattooed under the left foreleg with a number corresponding to that of the tag on the left ear. In 1960, 47 individual bears were color-marked with plasticized polyvinyl chloride tape. These streamers were placed in both ears as described by Craighead, et al. (1959). In 1961 Stony ear tags, consisting of 2-inch square colored plastic, were employed for marking 26 bears. In addition, 7 adult females were marked with collars made from colored polyethylene rope.

Census and Composition Counts

Ground Counts - Ground counts were taken to determine the population size and composition. This census was obtained
from July 5 to August 15, when bears were feeding on spawning salmon and could be readily observed on the streams and during a period when their movements were relatively confined. After August 15th the abundant elderberry crop ripened and the bears moved into this dense vegetation and were not readily visible. Color, size, and other characteristics of each individual bear and family groups on the different streams were recorded to avoid duplication. The bears on the smaller and shorter streams were censused by hiking up the streams and recording the bears seen. Five or 6 counts were made on each stream during the course of the censusing period. At the main bear concentration points in the Thumb and O'Malley areas, the counts were conducted from a mountain observation point overlooking each area. Three overnight trips were made to each of these points and counts were taken in both the evening and the morning. Binoculars and spotting scopes were used for observing at the greater distances. Distribution of salmon appears to be consistent from year to year and, even though salmon numbers have declined, escapements are still sufficiently large to provide the same attraction to bears as in the past. Thus the decline in salmon runs should not reduce the proportion of the bear population seen.

Aerial Counts - From 5 to 7 aerial counts were made during this same period, but only in late evening and early morning hours during the height of bear's daily activity.
The major streams and lake shores were censused from an elevation of 400 to 500 feet. Either a 150 HP Supercub or a 150 HP Champion airplane was used to conduct the flight. In this type of census the bears were recorded as to singles and family groups, but no attempt was made to differentiate between marked individuals which may have been seen during previous flights.

Collection of Harvest Data

Hunting data were obtained by contacting the individual hunter or his guide after completion of the bear hunt or by direct contact in the field during the hunt. Prior to 1960 each hunter was required to obtain an export permit before exporting any part of a big game animal from Alaska. These permits were available only from designated Bureau of Sport Fisheries and Wildlife personnel, and at this time hunting kill data were recorded (Troyer, 1961). Present regulations require each hide to be sealed within 30 days after the kill, thus providing a means of recording harvest data.
The Kodiak Bear Population

Population Enumeration

To manage bears effectively, it is necessary to establish population trends and, where possible, it is desirable to determine total numbers of their near approximation. In Kariuk Lake, ground counts and aerial counts were used to obtain minimum bear numbers and population trends. Total population figures were obtained by recording the number of marked to unmarked bears observed and trapped, and computing the population by the use of indices. These data and methods are presented; and conclusions concerning the size and status of the population are based on an analysis and comparison of this information.

Ground Counts - Ground counts were conducted, as previously described, in the study area from 1954 through 1956 and from 1958 through 1961. These surveys were useful in arriving at minimum population counts and in determining population trends from year to year. In the 7-year period the counts of bears have varied from a low of 106 to a high of 141, with an average of 125. The counts dropped from 1956 to 1958, but increased in the last 3 years (Figure 3).

The dense vegetation on many of the smaller streams prevented observation of all the bears inhabiting these areas.
Figure 3. The Karluk Lake bear population trend, 1954-1961.

* The 1957 counts were not completed.
It was also noted that a few of the bears did not utilize the salmon streams for extended periods of time and were probably missed during the ground censusing period. Inasmuch as these factors seem to be fairly constant from year to year, it is believed that the counts reliably reflect trends in population size and also express a minimum population figure.

**Aerial Counts** - Aerial counts were used in Karluk Lake the past 3 years. The highest counts recorded each year were used to arrive at a minimum population figure for this method. These were 36, 27 and 34 respectively and constituted about 25 per cent of the ground counts. Vegetation along the streams in the study area is quite dense and makes viewing difficult. This results in a small proportion of the bear population being seen.

Extreme variations in counts during different hours of the day and from one day to another have also been noted. As an example, on July 20, 1960, during the peak of bear concentration, 27 bears were tallied in the late evening. The same areas were covered the following morning in the same fashion but revealed only 12 bears. Variations in morning and evening counts sometimes reverse themselves.

Aerial counts reveal a much smaller proportion of the population than the ground counts, and therefore they are not as good a trend indicator, especially when sampling a small population such as is found in Karluk Lake. An advantage of
the aerial counts over the ground counts is that they are much less time-consuming and therefore under certain conditions may be a practical means of surveying vast areas. In the larger areas, variations encountered would have a greater tendency to average out in the overall counts. Since bears are attracted to the streams by salmon, trends obtained by both ground and aerial surveys are applicable only on streams where the numbers of salmon remain essentially stable from year to year.

**Total Population Estimate by the Schnabel Method** - In July and August of 1960, 41 bears were live-trapped and marked with colored ear streamers. In early October, after the bears had had an opportunity to disperse over the drainage, a census was taken. At this time bears were again feeding on salmon at the lower elevations but were primarily congregated along the lake shores, although not in as large numbers as in the early summer. The census was obtained by making daily trips around the lake shores by boat and recording marked and unmarked bears observed. Only those which could be approached close enough to make positive identification were used in the sample. In a 9-day period from October 7 through October 16, 44 bears were closely checked, of which 10 were marked. Trapping continued and 6 additional bears were color-marked. Applying this information to the Schnabel method (Schnabel, 1938) gave a population mean of 148 bears (Table III). This is based
TABLE III
THE 1960 BEAR POPULATION ESTIMATE IN THE KARLUK LAKE DRAINAGE AS DETERMINED BY THE SCHNABEL METHOD IN OCTOBER, 1960

<table>
<thead>
<tr>
<th>Date</th>
<th>Total bears seen (A)</th>
<th>Bears marked</th>
<th>Marked bears in area (B)</th>
<th>Product (A)(B)</th>
<th>Sum of (A)(B)</th>
<th>Marked bears seen</th>
<th>Sum of marked bears seen (C)</th>
<th>Estimated population ≤ (A)(B) (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/7</td>
<td>3</td>
<td>0</td>
<td>41</td>
<td>123</td>
<td>123</td>
<td>1</td>
<td>1</td>
<td>123</td>
</tr>
<tr>
<td>10/8</td>
<td>3</td>
<td>0</td>
<td>41</td>
<td>123</td>
<td>246</td>
<td>2</td>
<td>3</td>
<td>82</td>
</tr>
<tr>
<td>10/9</td>
<td>2</td>
<td>1</td>
<td>41</td>
<td>82</td>
<td>328</td>
<td>0</td>
<td>3</td>
<td>109</td>
</tr>
<tr>
<td>10/10</td>
<td>4</td>
<td>2</td>
<td>42</td>
<td>168</td>
<td>596</td>
<td>1</td>
<td>4</td>
<td>149</td>
</tr>
<tr>
<td>10/11</td>
<td>3</td>
<td>1</td>
<td>44</td>
<td>132</td>
<td>728</td>
<td>1</td>
<td>5</td>
<td>146</td>
</tr>
<tr>
<td>10/13</td>
<td>8</td>
<td>0</td>
<td>45</td>
<td>360</td>
<td>1088</td>
<td>2</td>
<td>7</td>
<td>155</td>
</tr>
<tr>
<td>10/14</td>
<td>4</td>
<td>0</td>
<td>45</td>
<td>180</td>
<td>1268</td>
<td>0</td>
<td>7</td>
<td>181</td>
</tr>
<tr>
<td>10/15</td>
<td>9</td>
<td>0</td>
<td>45</td>
<td>405</td>
<td>1673</td>
<td>2</td>
<td>9</td>
<td>186</td>
</tr>
<tr>
<td>10/16</td>
<td>8</td>
<td>2</td>
<td>45</td>
<td>360</td>
<td>2033</td>
<td>1</td>
<td>10</td>
<td>203</td>
</tr>
</tbody>
</table>

Mean 148
on the assumption that all bears remained in the drainage and that no mortality of bears or loss of markers occurred. The results indicate that the ground survey count of 118 obtained earlier in the summer was 20 per cent below the number of bears computed by the Schnabel method.

Total Population Estimate by the Petersen Index - In July of 1961, the 1960 population was estimated by the Petersen Index method (Petersen, 1896). Based on the examination of 12 bears, one-fourth of the 48 bears marked in 1960 had lost their colored streamers by 1961, thus leaving 36 color-marked. From July 1 to July 28 daily counts were again obtained around the study area. Only the bears which could be approached close enough and positively identified as marked or unmarked were used in the sample. In the 18-day period 76 bears were examined, of which 20 were marked. The Petersen Index formula was then applied:

\[
P = \frac{M \cdot C}{R}
\]

where:  \( P \) = total population estimate  
\( M \) = total bears marked  
\( C \) = total bears seen  
\( R \) = total marked bears seen

This resulted in a total population estimate of 137 bears for 1960 which is slightly lower than the 148 estimate obtained by the Schnabel method in October, 1960, and is 14 per cent above the ground survey count for 1960.
Ideally in a trapping and tagging program, marked bears recaptured the following year should give an index to the total population, provided that an adequate sample of the population was marked and recaptured. In 1960, 49 bears were ear-tagged. In the 1961 season 24 bears were captured, excluding the current year's cubs, but only 5 were recaptured from the previous years' tagged bears. The Peterson Index was again applied to the data and resulted in a total population estimate of 235 bears for 1960. This estimate is much higher than those obtained by the former two methods. The recapture sample was small and may not reflect the true marked to unmarked ratio. In addition, definite trap-shyness has been noted of bears previously captured which would tend to reduce the number of marked bears recaptured and thus increase the estimate. It is therefore believed that the estimate obtained by this method is unreliable.

In summary it should be said that the problems involved in obtaining an accurate total population figure for the Kodiak bears are enormous. Their brushy habitat and constant movements made total counts by direct enumeration methods impractical on this study. The primary difficulty involved in obtaining a total population estimate by the various indices used is that the sampling methods are inadequate. It is believed that the estimate obtained by trapping ratios is excessive, while estimates obtained by the Schnabel method and color-marking index are closer to the true population of...
1960. The population for 1960 probably lies somewhere between 135 and 175 bears. For present management purposes it was estimated at 155 animals. The 1960 total population estimate was slightly below the 7-year average, and therefore a total mean estimate of 160 was used for the 7-year period.

The overall population may change somewhat during the course of the year as a certain amount of ingress and egress occurs in the drainage. This is especially true in the spring when males have a tendency to move more during the breeding season. Observations of color-marked bears and tag returns indicate this to be insignificant. Of 16 tagged bears returned by hunters, only 2 were taken outside of the drainage. The greatest movement recorded from the point of capture has been 10½ miles, and the furthest movement outside of the drainage was 8 miles.

**Distribution**

The distribution of the bear population as recorded during the 1961 ground census is shown in Figure 4. This varies slightly from year to year, but is typical of the months of July and early August when bears are attracted to the salmon spawning streams. Few occur in that portion of the study area where salmon are not available. The major portion of the population is located in the Thumb and O'Malley regions. The streams in these drainages are wider and longer and harbor a greater number of salmon for a longer period of time than the smaller lateral streams. Spawning continues
Figure 4. Distribution of the bears during the 1961 censusing period. Each dot represents one bear.
from July 1 through October, while in the smaller lateral streams, spawning ceases by August 15. The number of bears inhabiting these smaller streams seems to be directly related to the length of the stream, size of the drainage and to the distance salmon are capable of traversing the stream from the lake shore. Most of these are blocked by falls impassable to salmon within a few hundred yards of the mouth.

Later in the summer the distribution changes. Bears relish elderberries and, as the abundant crop ripens, they forsake the salmon and scatter through the valleys and brushy mountain slopes in search of this food item. In the late fall a large number of salmon spawn along the lake shores and, as the berry crop disappears, the bears return to the lake.

After emerging from hibernation in the spring, they remain on the higher mountain slopes where they feed on new succulent vegetation, but even during this period, the greatest portion of the population still occurs in the Thumb and O'Malley areas. This concentrated distribution is thought to be due to the many long, deep, brushy canyons and steep mountain slopes bisecting the valleys. These provide ample food and cover and are favorite denning areas.

Population Density

The 96 square miles encompassing the Karluk Lake study area includes portions of the higher mountain peaks which are
rarely inhabited by bears and 17 square miles of lake waters. Applying the mean population estimate of 160 bears to the total area gives a density of one bear per .54 square mile. The bears, however, are not evenly distributed and the densities of the different areas vary with seasonal use as indicated in Figure 4.

Food seems to be the primary factor in regulating population densities. In areas where food is concentrated but plentiful, bears tend to congregate in great numbers. In the study area the greatest density occurs at O'Malley during the peak of the salmon run. Here 40 to 50 bears feed daily for a period of several weeks in an area of about one square mile. Plenty of cover is available and from past observations, it has been determined that most of the bears remained within a mile or so of this food supply. The total habitat utilized during this period at O'Malley is only about 4 or 5 square miles; thus the population density in this vicinity is about 10 bears per square mile.

Dufresne and Williams (1932) estimated the brown bear population on Admiralty Island, Alaska, to be 900, or approximately 1 bear per 1½ square miles. Working in Mount McKinley National Park, Dean (1958) estimated the grizzly bear density at 1 bear per 15 square miles. Compared with these estimates the Karluk Lake bear density is much greater and can therefore be considered optimum bear habitat. The brushy cover is plentiful and the abundance and varieties of vegetation
provide ample food for their spring diet, while the salmon and berries are available in large quantities in the summer and fall. These factors are thought to be primarily responsible for the large densities of bears occurring in this drainage.

**Population Structure**

**Litter Size** - Sixty-seven sows with litters were recorded while conducting the 1959, 1960 and 1961 ground counts (Table IV). Of this sample, 26 sows had 60 cubs for a mean litter size of 2.31, while 41 sows with 88 yearlings averaged 2.15 per litter. This sample included only those litters which could be observed for a long enough period of time to assure that all members of the litter were seen. As the smaller cubs were often missed (see further explanation under Age Ratios), the cub sample was less than the yearlings. The reduction in litter size would indicate that a mortality of about 7 per cent occurred between the first and second summers of life. This mean litter reduction for the study area compares closely with the litter reduction found on other nearby drainages of the Kodiak National Wildlife Refuge. From 1958 through 1961, 96 cub and 169 yearling litters were tallied during aerial surveys. This sample yielded an average cub litter of 2.26 per sow and a mean yearling litter of 2.15. The latter data give a mortality of a little less than 5 per cent.
TABLE IV
SIZE AND FREQUENCY OF OCCURRENCE OF KODIAK BEAR LITTERS IN KARLUK LAKE, ALASKA, 1959-1961

<table>
<thead>
<tr>
<th>Litter Size</th>
<th>One</th>
<th>Two</th>
<th>Three</th>
<th>Four</th>
<th>Total Litters Sampled</th>
<th>Ave. Litter Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sows/cubs</td>
<td>6</td>
<td>7</td>
<td>12</td>
<td>1</td>
<td>26</td>
<td>2.31</td>
</tr>
<tr>
<td>Sows/yearlings</td>
<td>8</td>
<td>19</td>
<td>14</td>
<td>0</td>
<td>41</td>
<td>2.15</td>
</tr>
<tr>
<td>Total sows/litters</td>
<td>14</td>
<td>26</td>
<td>26</td>
<td>1</td>
<td>67</td>
<td>2.21</td>
</tr>
</tbody>
</table>

TABLE V
COMPARISON OF CUB AND YEARLING AGE CLASS COUNTS

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Cubs</th>
<th>Total Yearlings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>1955</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>1956</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>1958</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>1959</td>
<td>29</td>
<td>33</td>
</tr>
<tr>
<td>1960</td>
<td>11</td>
<td>34</td>
</tr>
<tr>
<td>1961</td>
<td>25</td>
<td>24</td>
</tr>
</tbody>
</table>

Mean 21.4 25.5
Age Ratios - Bears were classified into cubs, yearlings, and $2\frac{1}{2}$-year-plus age groups during the ground surveys. No attempt was made to classify older bears into separate age groups as it is not possible to distinguish these age classes at a distance with any degree of accuracy. Over the 7-year period the cubs consistently constituted a smaller segment of the population than the yearlings (Table V).

Biologically this ratio cannot be correct; therefore it is assumed that cubs and yearlings have been misclassified or that a large portion of the cub population was not observed during the ground counts. All personnel conducting counts were experienced in classifying cubs and yearlings; therefore it is believed the error was due to the difficulty in seeing cubs.

Cubs are extremely small during censusing period and consequently are not always sighted in the dense vegetation and brush. They rarely accompany the sow into the open stream when fishing as do yearlings, but usually remain along the brushy banks, and this confined activity prevented accurate counts. It was noted that sows traveling through dense meadows would be classified as singles but a longer period of observation, during which the sows came into the open, would reveal that they had cubs.

In Table VI the age ratios are given for 115 bears live-trapped from 1958 through 1961. Bears were aged by tooth replacement and wear. Since aging techniques still
### TABLE VI

**SEX AND AGE RATIOS OF 115 BEARS LIVE-TRAPPED**

**IN KARLUK LAKE, ALASKA, 1957 - 1961**

<table>
<thead>
<tr>
<th>Age class</th>
<th>No. Males</th>
<th>Per Cent</th>
<th>No. Females</th>
<th>Per Cent</th>
<th>Total Number</th>
<th>Per cent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cubs</td>
<td>15</td>
<td>53.6</td>
<td>13</td>
<td>46.4</td>
<td>28</td>
<td>24.3</td>
</tr>
<tr>
<td>1½</td>
<td>14</td>
<td>50.0</td>
<td>14</td>
<td>50.0</td>
<td>28</td>
<td>24.3</td>
</tr>
<tr>
<td>2½-3½</td>
<td>17</td>
<td>53.1</td>
<td>15</td>
<td>46.9</td>
<td>32</td>
<td>27.9</td>
</tr>
<tr>
<td>4½+</td>
<td>9</td>
<td>33.3</td>
<td>18</td>
<td>66.6</td>
<td>27</td>
<td>23.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>55</td>
<td>47.8</td>
<td>60</td>
<td>52.2</td>
<td>115</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### TABLE VII

**AGE RATIOS OF THE SEVEN YEAR MEAN KARLUK LAKE BEAR POPULATION AFTER CALCULATING THE NUMBER OF CUBS AS DETERMINED FROM GROUND COUNTS¹**

<table>
<thead>
<tr>
<th>Age group</th>
<th>Total Number</th>
<th>Mean Number</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cubs</td>
<td>192</td>
<td>27.4</td>
<td>21.0</td>
</tr>
<tr>
<td>Yearlings</td>
<td>180</td>
<td>25.7</td>
<td>19.6</td>
</tr>
<tr>
<td>2½ years and over</td>
<td>545</td>
<td>77.9</td>
<td>59.4</td>
</tr>
</tbody>
</table>

¹Number of cubs based on yearling count of following year and 6.8 per cent mortality indicated by change in litter size.
lack absolute accuracy in the older age groups, the $2\frac{1}{2}$ to $3\frac{1}{2}$ age classes were grouped and no attempt was made to age bears beyond $4\frac{1}{2}$ years. Of the 56 cubs and yearlings examined, the age ratio was exactly 50:50 which would indicate a good survival. The combined cub and yearling classes composed 48.6 per cent of the total bears trapped. This is high, because live-trapping with steel traps and snares is selective toward the smaller animals. Greater foot-size of larger bears reduces chances of capture (Troyer, et al., 1961).

Data from trapped bears show no differences in numbers of bears in the cub and yearling age classes, whereas a reduction during this age interval would be expected. Ground counts indicated more yearlings than cubs (Table V); however, as pointed out, the low cub count is not thought to be valid because many cubs are missed. In contrast, the reduction of litter size from cubs to yearlings in Table V indicates that a mortality of about 7 per cent occurs during this age interval. This possibly reflects the true mortality from cub to yearling stage. The cub population is therefore not determined by direct count, but is calculated by adding this indicated annual mortality of 7 per cent to the yearling count of the following year. An average age ratio of the ground counts for the 7-year period, after the cub population was calculated, is given in Table VII. This ratio is 21.0 per cent cubs, 19.6 per cent yearlings and 59.4 per cent older than yearlings.

Age ratio counts are valuable as they serve as an index
to the condition of the population; however, since cub counts are biased, the yearling counts should be used to evaluate productivity and future harvest plans in Karluk Lake. It is significant to note that the 21 per cent cub crop in Karluk Lake closely approximates the 20 to 25 per cent calf crops found in some other big game species, such as moose (Pimlott, 1959) and caribou (Kelsall, 1957).

**Sex Ratio** - The sex ratio of a big game population is usually obtained by a direct count in the field or by recording the harvest data. The lack of obvious external sexual differences in bears makes it impossible to obtain this information by field observation. Because of selective hunting for the large male bears on Kodiak Island, sex ratios in the kill are biased and do not reflect true population ratios (Troyer, 1961). In this study, a sex ratio was obtained by the direct examination of live-trapped animals. Of the 115 bears examined, 47.8 per cent were males and 52.2 per cent were females. From these data it appears there is no significant sex differential in the younger age groups; however, in the ages of 4 and over, the females outnumber the males by a ratio of 2:1 (Table VI). This is to be expected as hunting methods differentiate against the sexes. This would not be evident among the younger age classes because regulations do not permit the taking of yearlings and cubs, and selective hunting for larger bears generally eliminates the 2 and 3-year age classes from the kill (Troyer, 1961).
Hunting Regulation and Seasons

Prior to 1954, hunting regulations permitted a bag limit of 1 bear taken between the seasonal dates of September 1 through June 20. In 1954 the season was reduced to September 16 through May 31, and in 1960 the opening date was delayed to October 1. The taking of females accompanied by young and the young was declared illegal in 1957. All non-residents are required to employ licensed guides.

Hunting Methods

Kodiak bears are usually in hibernation from November 15 until emergence in early April; therefore hunting is divided into spring and fall seasons. In the spring the bears are found at the higher elevations feeding on vegetation, while in the fall they are concentrated around the lake edges and streams feeding on salmon; thus hunting techniques vary. Nearly all fall bears are killed at the lower elevations. Hunters hike up streams or cruise the lake shore by boat. In the spring, boats are used to cruise the lake shore and search the adjacent hillsides for suitable trophies. Once the trophy is spotted, the stalk is made on foot. A larger portion of the spring hunters, however, hike into the smaller drainages at the higher elevations and view the slopes for a prospective kill.
Annual Harvest

The annual bear harvest in the study area has been recorded since 1950. In this 12-year period the harvest has varied from 10 to 31 animals, with a mean of 19.2 (Table VIII). The harvest was reduced from a 21.3 mean from 1950-1955 to a 17.0 mean from 1956-1961. The primary reason for the reduction was less hunting effort because of reduced hunting seasons. The lower kill since 1956 may be the reason for the increase in the population trend since 1958 as was shown in Figure 3. These kill data indicate that, on the average, about 12 per cent of the total estimated population is taken each year.

About two-thirds of the kill occurs during the spring hunt with the larger number being taken in May. Depending on weather conditions, Karluk Lake often remains frozen until early May; thus few hunters enter the area in April as movement is restricted to foot travel. In addition, bears progressively emerge from hibernation from early April to late May, and this gradual emergence is reflected by a progressively greater kill. The earliest portion of the fall season is the most productive, the number of kills gradually declining as bears enter hibernation.

Hide Measurements

Most sportsmen selectively hunt for the larger trophy animals. Although Boone and Crockett Club trophy standards
TABLE VIII
TOTAL ANNUAL BEAR HARVEST IN THE KARLUK LAKE DRAINAGE, 1950-1961

<table>
<thead>
<tr>
<th>Year</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>10</td>
</tr>
<tr>
<td>1951</td>
<td>26</td>
</tr>
<tr>
<td>1952</td>
<td>19</td>
</tr>
<tr>
<td>1953</td>
<td>23</td>
</tr>
<tr>
<td>1954</td>
<td>19</td>
</tr>
<tr>
<td>1955</td>
<td>31</td>
</tr>
</tbody>
</table>

1950-1955 Mean 21.3

<table>
<thead>
<tr>
<th>Year</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956</td>
<td>17</td>
</tr>
<tr>
<td>1957</td>
<td>13</td>
</tr>
<tr>
<td>1958</td>
<td>15</td>
</tr>
<tr>
<td>1959</td>
<td>19</td>
</tr>
<tr>
<td>1960</td>
<td>18</td>
</tr>
<tr>
<td>1961</td>
<td>20</td>
</tr>
</tbody>
</table>

1956-1961 Mean 17.0

Mean 1950-1961 19.2
are based on skull measurements, hunters still characteristically appraise their trophy by the hide size. These measurements are taken by stretching the open-skinned hide to its full length and width and measuring the distance from nose to the end of the tail, and the width between the tip of the middle claws on opposite forelegs. The measurements are then added and divided by two which yields an index for the hide measurement. A 10-foot hide is considered a top trophy. These indexes are believed to reflect size trends if taken in a similar manner over a period of years.

The mean annual hide size for the past 10 years has varied from 8'3" to 9'4", but has remained relatively uniform. The 1951 to 1955 mean was 8'8" as compared to 8'9" for 1956 to 1960 (Table IX). The percentage of bears measuring 10 feet and over appears to have slightly diminished. The mean for the 5-year period of 1951 through 1955 was 27.2 per cent, compared to 19.8 per cent for the years from 1956 to 1960. However, the Mann-Whitney test at the 5 per cent confidence limit indicated that no significant change had occurred.

**Sex Composition of the Harvest**

Sportsmen selectively hunt for the larger trophies; therefore males comprise a larger percentage of the kill than females as female hides rarely measure over 8-3/4 feet. It is believed that a substantial increase in the female kill would denote overcropping of the larger bears. Table X shows
**TABLE IX**

**MEAN HIDE MEASUREMENTS OF KARLUK LAKE**

**BEAR KILLS, 1951-1960**

<table>
<thead>
<tr>
<th>Year</th>
<th>Sample Size</th>
<th>Average Size</th>
<th>Per cent 10 foot plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>17</td>
<td>8'10&quot;</td>
<td>12.0</td>
</tr>
<tr>
<td>1952</td>
<td>12</td>
<td>8'8&quot;</td>
<td>42.0</td>
</tr>
<tr>
<td>1953</td>
<td>19</td>
<td>8'10&quot;</td>
<td>32.00</td>
</tr>
<tr>
<td>1954</td>
<td>15</td>
<td>8'9&quot;</td>
<td>27.0</td>
</tr>
<tr>
<td>1955</td>
<td>22</td>
<td>8'6&quot;</td>
<td>23.0</td>
</tr>
</tbody>
</table>

1951-1955 Mean 8'8" 27.2

<table>
<thead>
<tr>
<th>Year</th>
<th>Sample Size</th>
<th>Average Size</th>
<th>Per cent 10 foot plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956</td>
<td>15</td>
<td>8'3&quot;</td>
<td>7.0</td>
</tr>
<tr>
<td>1957</td>
<td>12</td>
<td>9'8&quot;</td>
<td>58.0</td>
</tr>
<tr>
<td>1958</td>
<td>13</td>
<td>9'0&quot;</td>
<td>15.0</td>
</tr>
<tr>
<td>1959</td>
<td>19</td>
<td>8'7&quot;</td>
<td>11.0</td>
</tr>
<tr>
<td>1960</td>
<td>15</td>
<td>8'8&quot;</td>
<td>7.0</td>
</tr>
</tbody>
</table>

1956-1960 Mean 8'9" 19.8

Mean 1951-1960 8'8-3/4" 23.5

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that the ratio of males to females has remained essentially constant over the years. Males have comprised about 65.8 per cent of the harvest and females 34.2 per cent. In comparing the sex ratio of 1950 through 1955 to the last 6 years of 1956 through 1961, no significant change was noted.

The stable sex compositions and the insignificant change in hide measurements, indicate that no significant over-harvest has occurred in the population as a great portion of the harvest still consists of large male trophy bears. There is a possibility that the annual kill, which now constitutes approximately 12 per cent of the total population, might be further increased without substantially lowering the average trophy size; however, with the present information available, the maximum kill the population is capable of withstanding is not known.
TABLE X
SEX COMPOSITION OF THE BEAR HARVEST IN KARLUK LAKE
1950 - 1961

<table>
<thead>
<tr>
<th>Year</th>
<th>Sample size</th>
<th>Per cent Males</th>
<th>Per cent Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>10</td>
<td>70.0</td>
<td>30.0</td>
</tr>
<tr>
<td>1951</td>
<td>26</td>
<td>62.0</td>
<td>38.0</td>
</tr>
<tr>
<td>1952</td>
<td>16</td>
<td>69.0</td>
<td>31.0</td>
</tr>
<tr>
<td>1953</td>
<td>23</td>
<td>61.0</td>
<td>39.0</td>
</tr>
<tr>
<td>1954</td>
<td>18</td>
<td>67.0</td>
<td>33.0</td>
</tr>
<tr>
<td>1955</td>
<td>31</td>
<td>70.0</td>
<td>30.0</td>
</tr>
</tbody>
</table>

1950-1955 Mean 66.5 33.5

<table>
<thead>
<tr>
<th>Year</th>
<th>Sample size</th>
<th>Per cent Males</th>
<th>Per cent Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956</td>
<td>15</td>
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</tr>
<tr>
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</tr>
<tr>
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<td>15</td>
<td>73.0</td>
<td>27.0</td>
</tr>
<tr>
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<td>19</td>
<td>53.0</td>
<td>47.0</td>
</tr>
<tr>
<td>1960</td>
<td>17</td>
<td>59.0</td>
<td>41.0</td>
</tr>
<tr>
<td>1961</td>
<td>19</td>
<td>63.0</td>
<td>37.0</td>
</tr>
</tbody>
</table>

1956-1961 Mean 65.2 34.8

Mean 1950-1961 65.8 34.2
RECOMMENDATIONS

This study is only one phase of a long-term investigation of the bears in Karluk Lake, and further studies are necessary to modify methods presently used and to gain additional knowledge desirable in managing the population. Further investigations should include the following:

1. It would be desirable to manipulate the harvest in the future in such a manner as to gain additional information on the effects of increased and decreased hunting pressures on the population.

2. Studies should be continued to improve methods of obtaining total population estimates and trends.

3. More information on movements should be gathered to gain data on the amount of ingress and egress that occurs on the study area. This is necessary to completely evaluate total population, densities, and distribution.

4. An aging technique, usable under field conditions, needs to be determined. Such a technique would permit classification of the harvest by ages rather than hide size and would be a better method of determining the condition of the population.

5. A comprehensive productivity study should be inaugurated. The variation in the harvest should then be correlated with its effect on productivity.
6. Additional information is needed in food and other environmental requirements to adequately evaluate their influence on population densities, movement, productivity, etc.

7. Skull measurements would be a much better criterion for determining size trends of the harvest rather than hide measurements. It is therefore recommended that, in the future, regulations require hunters to present skulls as well as hides for sealing.
SUMMARY

1. The study was conducted in the Kariuk Lake drainage on Kodiak Island, Alaska, which encompasses an area of 96 square miles. The drainage is characterized by steep mountains, rising 1500 to 3500 feet above sea level, which are covered with a dense brushy vegetation. Numerous small streams flow into the 12-mile long Kariuk Lake, and from July 1 through October these streams and lake shores are used by red salmon for spawning.

2. Between July 5 and August 15 when bears are concentrated on the salmon spawning streams, an annual trend census was conducted. The population trend varied from 106 to 141 in the past 7 years with an average of 125. Because of the dense vegetation and habits of the bear, a portion of the population is missed in the census. By live-trapping and color-marking, various indices to the population have been obtained which indicate the total population average for the 7-year period was around 160.

3. The density of the population was determined to be 1 bear per .54 square mile. The distribution varies during the different seasons of the year. In the summer and fall, bears are primarily concentrated on the streams and lake shores, but during other periods are scattered along mountain sides and valleys.
4. The average cub litter size was 2.31 and the mean yearling litter size was 2.15. The age ratio of the population as calculated from census counts was 21 per cent cubs, 19.6 per cent yearlings and 59.4 per cent 2\(\frac{1}{2}\) years and older. The age ratios of 115 bears live-trapped was 24.3 per cent cubs, 24.3 per cent yearlings, 27.9 per cent 2\(\frac{1}{2}\) to 3\(\frac{1}{2}\) years and 23.5 per cent 4\(\frac{1}{2}\) years plus. The larger percentage of cubs and yearlings, as compared to census counts, was thought to be due to the method of trapping which was selective to younger bears. The sex ratio was 50:50 in the younger age classes, but in the adults of 4\(\frac{1}{2}\) plus, the females outnumbered the males by a ratio of 2:1.

5. Hunter harvest data were obtained for the past 11 years and indicate the kill has varied from 10 to 31 animals annually with a mean of 19.2. This was approximately 12 per cent of the total estimated population. Hide measurements and sex ratios of the kill were recorded. The average annual hide measurements have remained relatively uniform. Males comprised 65.2 per cent of the kill. Hunters selectively hunt for the larger animals, and since female hides rarely measure over 8-3/4 feet, more males are taken than females. These statistics indicate that the harvest has not greatly affected the average trophy size or the total population estimate.
LITERATURE CITED


