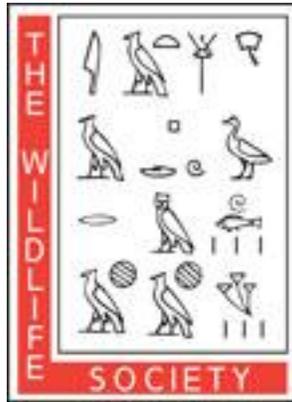


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The Roosevelt Elk on the Olympic Peninsula, Washington

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3. The rearing of leverets by foster mothers proved successful.

4. Even under close confinement there is reasonable tolerance in this species between sexes and between individuals of the same sex.

5. Females should not be mated with males prior to March 20 if a grouping of litters and a knowledge of their probable birth dates are desired.

6. The type of pen which proved most successful closely resembled that used by commercial rabbitries.

7. The production cost—to age of liberation—is estimated to be from \$1.25 to \$1.50 per hare.

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THE ROOSEVELT ELK ON THE OLYMPIC PENINSULA, WASHINGTON

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The materials here reported are based upon a three year study (1935-38) of the Roosevelt elk (*Cervus canadensis roosevelti* Merriam) and its range on the Olympic Peninsula, Washington. There was need of reliable information on the number of animals, their seasonal distribution, the annual net increase, and the food resources of the range. The wintering areas on several elk ranges were being over-grazed, elk had died in considerable numbers, and crop damage was occurring in farming areas. Factual data on the life history and on the conditions of the elk and their range were needed to prepare a successful plan of management.

¹ Field work and original mimeographed report (1942?, 65 pp., 18 figs.) by Schwartz; condensed by Mitchell.

The principal objectives were to determine:

1. Range limits and number of elk in each herd.
2. Existing sex ratios, age composition of herds, annual net increase, and losses and their causes.
3. Proper utilization standards for key forage species.
4. Food habits of the elk, key forage species, and the proper stocking of each range.
5. Damage done by elk to the range and to soil resources.
6. Test the effectiveness of salting to obtain better distribution of the elk.

The range of this elk formerly extended throughout western Washington and Oregon and into California. With the development of logging industries

and settlement of the lowlands, the range has steadily receded until the animals are now restricted principally to the remote timbered and mountainous areas of western Washington and Oregon with a remnant in northwestern California. The largest population, between 6,000 and 7,000, occurs on the Olympic Peninsula. Elsewhere in Washington, elk are in scattered bands in

larger, with more massive but shorter antlers, and greater contrast between the light and dark portions of the coat. Deer referred to in this paper are the Columbian black-tailed deer (*Odocoileus columbianus*).

LIFE HISTORY

A mature bull elk in prime condition will weigh 700 to 1,000 pounds and an

TABLE 1.—AVERAGE MEASUREMENTS OF ROOSEVELT ELK, IN INCHES.

	Mature male, 5 years	Adult female, 4 years	Male fawn, 9 months	Female fawn, 3-5 days
Total length	98	92	72	37
Height at shoulder ^a	60	59	50	29
Length of hind foot	28	26.5	23.5	16.5
Length of ear	8	8	8	4.75
Length of tail	4	4	3	1.5
Antlers:				
Spread	40.5			
Circumference	11			
Length	44.5			
Number of points	6×6			

^a Calves at 4 to 4½ months are 41 to 44 inches high at the shoulder.

several counties west of the Cascade Mountains.

In 1904 a bounty was offered for cougars and an intensified campaign was begun against predators. In 1905 the State Legislature made it unlawful to kill elk for a 10-year period; and in 1909, the Mt. Olympus National Monument was created to protect the elk. Signs of overpopulation and food shortage were evident by 1915. Important forage species had been seriously depleted and there was an extensive die-off during the winter of 1916-17. Since that time there have been periodic die-offs during severe winters.

This elk of the northwest coastal forest differs from the Rocky Mountain form (*C. c. nelsoni*) in being heavier,

average cow in good shape between 400 and 700 pounds. Two adult females weighed 405 and 425 pounds, respectively; both were in poor condition, and unquestionably from 100 to 200 pounds under maximum weight. Typical measurements are given in Table 1.

MOLTING

The spring molt commences in late April and is completed in June. The physical condition of individual animals influences the time of molt. By late June all elk have acquired their summer coats, which are short, thin, and reddish brown. By September the autumn coat has replaced that of the summer season; the hair then is relatively long, thick and grayish brown, except for darker

portions on the head, mane, and legs. The coat continues to become denser and heavier and reaches full development by early winter. On the skin of a yearling female taken in February, the length of hair ranged from 2 inches on the sides and belly to 5 inches on the neck and shoulders. It is usually longer on mature bulls.

HERDING TENDENCIES

The cows and younger animals are gregarious and remain together in bands of varying size most of the year. During the calving season, pregnant cows tend to isolate themselves but since calves are dropped over a 30-day period, there is no time at which a band breaks up completely.

Elk are scattered in small bands during the spring and early summer. Just prior to the rut there is a definite tendency to congregate in large herds, often numbering several hundred, but when breeding starts the herds again break into smaller bands. Even during this period, bands of more than 50 have been observed. In the winter the small groups again combine to form larger herds.

Throughout the breeding season bulls are generally with the bands, but as winter advances many older males drift onto the higher benches and slopes or into the lower areas not regularly used by the herds. Bulls are often in groups, with up to 15 together. Where snow was fully 6 feet deep, 5 bulls were observed standing in a creek with water 1 to 2 feet preferring it to the snow. In February two old males were seen in 5 to 6 feet of snow. Evidence of a snow-bound bull in a limited area on top of a ridge showed the ground much

trampled and the brush and trees severely browsed. This tendency to remain in high places during the winter may be responsible for considerable mortality among the bulls.

ANTLER DEVELOPMENT

Usually the antlers are shed between February 15 and April 15, and new growth starts soon after the old scars have healed. The earliest recorded shedding was on February 10, but adult bulls have been seen with antlers on April 19; most antlers are dropped during March. Studies of this process indicate some correlation between the condition and age of the animal and the dates of shedding.

New antlers grow quickly and by early June bulls may have 12 to 20 inches of growth with all points showing. By early August growth is complete and the velvet is shed by the first week in September. Spike bucks often retain the velvet throughout the year or until their antlers are shed.

The largest and most vigorous Olympic bulls have 6 points or more on each side, but most mature males grow 5-point sets. Thirteen sets of 5-point antlers measured during 1936 averaged a spread of 37.3 inches, a beam length of 38.2 inches, and circumference above the bur of 9.6 inches. The largest set recorded to date was 7×8 points with a spread of 52 inches. Further data are given in Table 2.

TABLE 2.—AVERAGE SPREAD OF 213 ELK ANTLERS MEASURED IN 1937 AND 1938.

<i>Points per side</i>	<i>Average spread, inches</i>	<i>Antler sets</i>
2	18.7	5
3	25.1	14
4	28.7	47
5	37.5	110
6	40.2	32
7	46.6	5

MATING AND BREEDING

Bugling starts shortly after the velvet has been shed. The earliest recorded date was August 24. It increases after September 1, reaches a peak between September 20 and October 1, diminishes throughout October, and by November is over except for an occasional call. The latest bugling was recorded on December 3, 1935.

Shortly after bugling starts, the herds break up and bulls collect their harems, which vary in size but usually contain 5 to 15 adult females. A band with a sex and age composition typical of most harems at this season contained a 5-point bull, 14 cows, and 3 calves. Usually some unattached bulls remain near a harem and, although the leader tries to keep them at a safe distance, he finds it difficult to do so. The leader sometimes is driven from the band by a challenger.

No fights between bulls were observed during the breeding season, but broken tines and evidence of pawing and skirmishing on the ground indicated a considerable amount of fighting. Several bulls were seen with broken main beams. Most fights consist of a few rushes and passes, with the larger and more powerful animal winning. No evidence of fatalities from elk fights was observed. There is friendly sparring of bulls after the breeding season and during the winter.

The only actual breeding record was observed by A. H. Lundgren; on September 18, 1938, he saw a bull make four covers of a young cow during a half-hour. Judging from the dates calves are dropped, most breeding takes place between September 15 and October 15.

CALVING

The average gestation period of elk is 249 to 262 days, or about $8\frac{1}{2}$ months (Leopold, 1933). Development of the fetus appears to be gradual and uniform throughout this period. One fetus from a cow that died on January 20, 1938, was approximately $3\frac{1}{2}$ months old and weighed 13.5 ounces. Another examined in late February 1936, in the fifth month of development, was one-third the size normally attained at birth.

The main calving period extends from May 15 to June 15, most of the calves being dropped from June 1 to 10. The earliest record date is May 14, and the latest July 10. No evidence of twin pregnancy was found.

At birth, elk calves are long-legged, ungainly creatures, covered with soft reddish-brown hair interspersed with numerous white spots on the back and sides (Pl. 14, B). The rump patch is rather indistinctly defined, but soon becomes prominent and light buff-brown in color. The nose and hoofs are black.

Elk calves are rather helpless during the first 3 or 4 days and, except for feeding periods, remain hidden beside big logs, under bushes, or at the bases of large trees. Their growth is rapid and when 10 to 14 days old they are amazingly swift and active, being able to scramble over logs 3 to 4 feet in diameter and to swim readily. The calves then are able to follow their mothers. They soon mingle with other calves and during the day will bed down together while the band is grazing. Often one or more cows, evidently with younger calves, remain in the vicinity acting as guards.

When 3 to 4 weeks old, elk calves eat

grass and other vegetation, and when 2 to 3 months old graze regularly with the adults (Pl. 14, C).

Weaning evidently is accomplished by early October; on December 16 a calf was attempting to nurse but was resisted by the cow. In September the calves shed their juvenile coats and acquire a winter pelage similar to the adults (Pl. 14, D)

MIGRATIONS AND MOVEMENTS

SEASONAL MIGRATIONS

Olympic elk are both resident and migratory, and there are gradations between the two habits. Resident elk live on the lower drainages and seldom move more than a few miles in any direction.

Migratory elk remain in the lowlands during the winter months, but closely follow the receding snows until they reach their summer ranges. Some make only short vertical migrations, ascending to nearby higher ridges for summer range.

In the autumn and early winter the down-valley movement starts with increasing snows and storms at higher elevations. Most of the elk return each year to the same wintering areas on their respective ranges. Shortage of forage does not seem to prompt a band to change range and they will starve to death when there is plenty of forage in the next drainage. Occasionally, intense hunting, a severe storm or some unusual circumstance will result in part of a herd drifting into another valley where they start another herd.

In February 1937 a rancher placed a bell on a weakened cow elk that he found. She recovered, rejoined a band in the locality, and by late May was

working up-valley toward the head of the Quinault River. The course of her migrations and her location on certain dates are shown in Figure 1.

If the movements of this animal were normal, it appears that migratory elk return to the same locality to winter and they follow definite, well established routes of travel between the winter and summer ranges.

MOVEMENTS AND FEEDING

Daily movements are governed largely by feeding habits. In the winter the elk appear to have regular routes of travel in going to and from food and water. They usually feed in the bottoms from daylight until 9 or 10 A.M., then gradually work toward the benches and hillsides to bed down during mid-day. They commence to feed again at 4 or 5 P.M., working back toward the bottoms where they eat until after dark. On stormy and windy days they seek the shelter of heavily timbered areas. During the summer, elk will bed down on open river bars during the mid-day hours, apparently to avoid flies. However, they may feed at any time during daylight hours, even in summer. When most of the band is bedded down, during the middle of the day, a few usually will be foraging close by and it is seldom that all are down at one time. When the daylight hours are few and food is scarce, the feeding periods become longer, and under severe conditions the animals forage all day.

TAGGING STUDIES

Light metal ear tags, each bearing a serial number and instructions to return to the forest supervisor, were used in 1936 and 1937 when 16 calves

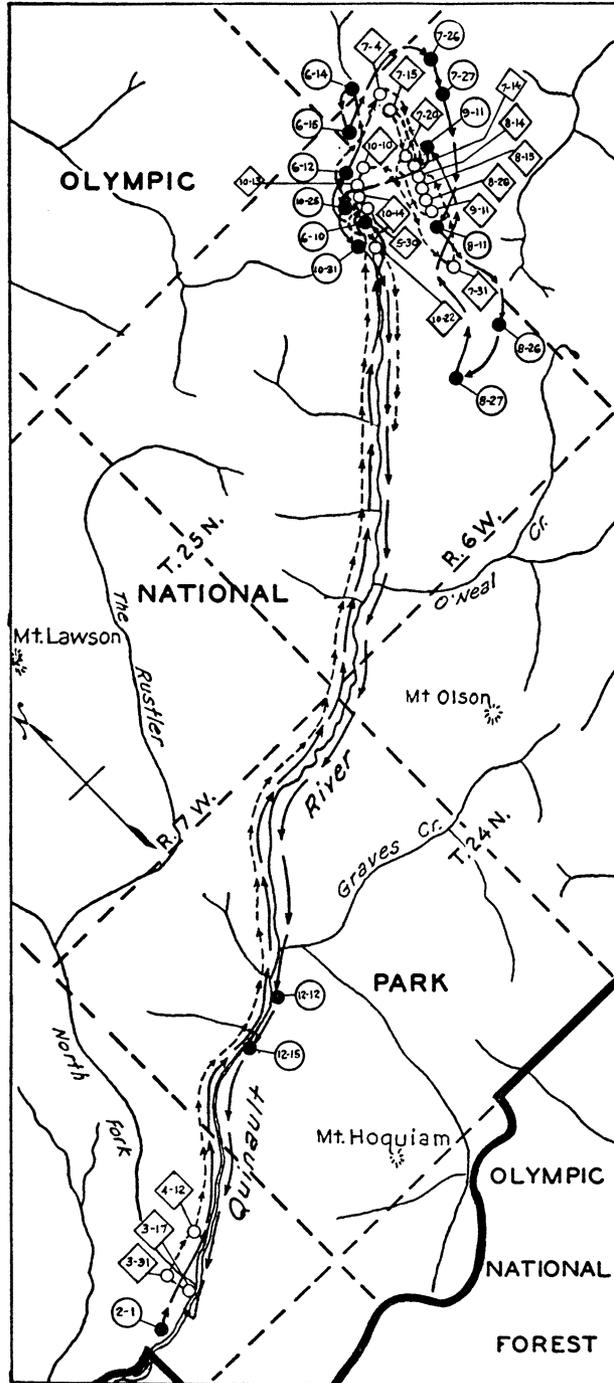


Fig. 1. Route (arrows) and location of belled cow elk. 1937: location, ●; route →; dates, 2-1 [= Feb. 1], etc. (in squares). 1938: location, ○; route, --- →; dates, 3-31, etc. (in circles).

were tagged. Tags of three were recovered by hunters in the season of 1937; two had been shot within two miles of where tagged, and the third about six miles away.

FEEDING HABITS

An important phase of the study was to determine the feeding habits on the seasonal ranges, particularly in winter. Elk eat a wide variety of plants, but depend chiefly upon a few common and abundant forms of browse, weeds, grasses, and ferns. Their use varies with season and locality.

Direct observation of feeding habits proved of little value when small herbaceous plants were being grazed. Competition between livestock and game is limited. Indirect observations were made by trailing bands to note the freshly grazed plants and by recording the utilization of various forage plants where evidence indicated elk had fed. This method proved most valuable. An analysis of stomach contents yielded considerable information on the proportions of plants taken, and served to check information by both direct and indirect observation (Table 4).

ACTIONS

Feeding elk move slowly in one general direction unless part of the band is bedded down, when the feeding individuals do not go far away. Normally an animal will alternate feeding along the ground and on higher clumps or browse. Usually the plant which is most palatable and abundant at the time receives the greatest use. The intensity with which elk feed over an area depends upon the season and the abundance of available forage. In

winter they feed longer and more closely on individual clumps of browse or patches of vegetation.

Elk normally browse to a height of about 6 feet, although large bulls reach higher. When branches at heights of more than 7 feet have been browsed, it indicates they were eaten when weighed down by snow. The Olympic elk both browse and graze. During the winter, when all herbaceous forms are buried by deep snow, they browse exclusively, but with the appearance of early spring plants 75 to 90 per cent of the food is of weeds and grasses. As the season advances, there is again an increased use of browse. New leaves of huckleberry, salmonberry, and vine maple are taken in large amounts and about balance the diet between browse and herbaceous forms. More grazing than browsing is done on the summer and autumn range.

Elk are more damaging to a range than deer, and sometimes even more so than domestic stock. Their habit of concentrating is responsible for trampling and packing of the soil on both summer and winter ranges.

PLANT UTILIZATION

The parts of plants used vary with the seasons. During spring and summer fresh, succulent leaves, stems, and tender twigs are mostly taken. In the late autumn and winter twigs, both dry and evergreen leaves, bark, and sometimes rotten wood fibers are eaten. Sporophores of certain fungi are also eaten. More than 100 different plants are taken by the Roosevelt elk, but those shown in Table 3 are the most important species.

Forage conditions and other factors

vary so widely over the entire Olympic Peninsula and between different drainages that no attempt has been made to evaluate the approximate percentages of each important plant utilized.

one of the first to show evidence of overuse; nevertheless, it survives the effects of overbrowsing most successfully and when given adequate protection makes rapid recovery.

TABLE 3.—PLANTS EATEN BY ROOSEVELT ELK.^a

Name	Parts eaten	Seasons used	Distribution	Life Zones	Abundance	Palatability	Relative importance
TREES AND SHRUBS							
Vine maple (<i>Acer circinatum</i>)	L-T-B-RW	Y	G	T-C	A	E	H
Sitka alder (<i>Alnus sinuata</i>)	L-T	Su	G	C-H	A	F	M
Willow (<i>Salix scouleriana</i>)	L-T-B	W-Sp	G	T	C	C	M
Willow (<i>Salix sitchensis</i>)	L-T-B	W-Sp	G	T-C	C	G	M
Western hemlock (<i>Tsuga heterophylla</i>)	L-T-RW	F-W	G	T-C	C	G	H
Salal (<i>Gaultheria shallon</i>)	L	F-W-Sp	G	T-C	A	F	M
Salmonberry (<i>Rubus spectabilis</i>)	L-T	Y	G	T-C	C	G	H
Black huckleberry (<i>Vaccinium membranaceum</i>)	L-T	Sp-Su-F	G	C	A	G	M
Blue huckleberry (<i>Vaccinium ovalifolium</i>)	L-T	Y	G	T-C	A	G	M
Red huckleberry (<i>Vaccinium parvifolium</i>)	L-T	F-W-Sp	G	T-C	A	G	M
SEDGES, FERNS, ETC.							
Sedge (<i>Carex abblata</i>)	L-H	Su-F	G	H-A	A	G	H
Sedge (<i>Carex leptopoda</i>)	L	Sp	G	T	A	G	M
Spring beauty (<i>Claytonia sibirica</i>)	L-Fl	Sp-Su-F	G	T	A	E	M
Youth-on-age (<i>Leptaxis menziesii</i>)	L	F-W-Sp	G	T	C	G	M
Wood-sorrel (<i>Oxalis oregana</i>)	L	Sp-Su	W	T-C	A	G	M
Sword fern (<i>Polystichum munitum</i>)	Fr	Y	G	T-C	A	F	M
Deer fern (<i>Struthiopteris spicant</i>)	Fr	F-W-Sp	G	T	C	G	M
Threeleaf coolwort (<i>Tiarella trifoliata</i>)	L-Fl	F-W-Sp	W	T-C	A	G	M
Grey moss (<i>Usnea barbata</i>)	All	W-Sp	G	C-H	C	G	M

^a 18 other shrubs and 17 other plants used are of low importance.

Key: Parts eaten: L., Leaves; T, twigs or tips; B, bark; RW, rotten wood; Fl, flowers, S, stems; Fr, fronds; H, heads.

Seasons used: F, fall; W, winter; Sp, spring; Su, summer; Y, yearlong.

Distribution: E, eastern; W, western; G, general.

Life Zones: T, transition; C, Canadian; H, Hudsonian; A, Arctic Alpine.

Abundance: A, abundant; C, common; R, rare.

Palatability: E, excellent; G, good; F, fair; P, poor.

Relative importance: H, high; M, medium; L, low.

Vine maple (*Acer circinatum*) is a key species on most important winter ranges of the Peninsula. It is a good indicator of range conditions, being

At least five species of huckleberry (*Vaccinium*) are browsed. All except evergreen huckleberry (*V. ovatum*), are important sources of food on both

winter and summer ranges and furnish much of the elk diet. They are about as palatable as vine maple, and one or more species are browsed during every month.

Salmonberry (*Rubus spectabilis*) occurs commonly along the lower stream courses, in swamps, and on mountain slopes up to about 4,000 feet. It does not receive the heavy winter use generally considered. From spring until late autumn, the palatability is high and salmonberry is also an indicator of range saturation and over utilization.

The important evergreens used include the following:

Western hemlock (*Tsuga heterophylla*) is the principal conifer browsed. Observations and stomach analyses indicate that elk depend to a considerable degree upon the leaves and slender twigs during the winter and, to a lesser extent, during spring and autumn. It is less palatable than western red cedar, but of more importance because of its greater abundance and availability.

Western red cedar (*Thuja plicata*) is very palatable to elk and fallen limbs or branches within grazing reach are usually trimmed closely. Reproduction is sometimes killed on the more heavily populated drainages. It ranks only fair in relative importance because much of its growth is above the reach of elk.

Douglas fir (*Pseudotsuga taxifolia*) is widely distributed throughout the Peninsula; most of the foliage is above browsing reach and reproduction is scarce except in forest openings and on logged-off lands. Wherever trees are windthrown or branches are broken off, they are eagerly sought by elk and all edible portions are utilized. Storms and heavy snows usually occur with enough

frequency during the winter to make the supply of fallen trees and limbs a fairly dependable food source.

Sitka spruce (*Picea sitchensis*) is common only in the Transition and lower Canadian zones of the west-side drainages. Despite the sharp-pointed needles, it is eaten in moderate amounts during the winter even on slightly utilized ranges. The foliage from limbs broken off near the tops of trees seems to be preferred. Spruce reproduction is far less palatable and is taken only when other foods are scarce.

Lichens (*Usnea barbata*, *U. plicata*, and *Ramalina reticulata*) are common on the trunks and limbs of trees and referred to as "grey moss." During the winter, especially at higher elevations, they are important in the diet and are taken from as far up as the animals can reach. On the high ridges at this season, the elk apparently depend largely upon lichens and the browse from broken limbs of fir and hemlock.

A fairly large number of grasses (Gramineae) occur on the Olympic Peninsula, but few are abundant. The wide, low valleys in the western half of the peninsula and the subalpine meadows of the higher portions of the range support the most extensive stands. Even through these areas, however, the usually associated species of sedges are much more abundant.

STOMACH ANALYSES

Of the 23 stomach samples analyzed, 14 were from animals killed during the autumn hunting season and 9 from animals that died during the winter. Besides the plants listed in Table 4, 15 others were identified only by traces. Not enough samples were included to

TABLE 4.—ANALYSES OF ELK STOMACH SAMPLES.

Species	Occurrence	Percentage of total volume	Species	Occurrence	Percentage of total volume
AUTUMN MONTHS (14 stomachs)			WINTER MONTHS (9 stomachs)		
Deer fern (<i>Struthiopteris spicant</i>).....	13	9.4	Western hemlock (<i>Tsuga heterophylla</i>).....	9	13.1
Black cottonwood (<i>Populus trichocarpa</i>).....	7	9.0	Sword fern (<i>Polystichum munium</i>).....	8	9.2
Salal (<i>Gaultheria shallon</i>)....	5	8.9	Sitka spruce (<i>Picea stichensis</i>)	5	7.3
Grass.....	13	5.6	Vine maple (<i>Acer circinatum</i>)..	4	5.4
Salmonberry (<i>Rubus spectabilis</i>).....	10	4.1	Black cottonwood (<i>Populus trichocarpa</i>).....	3	5.4
Threelobed coolwort (<i>Tiarella trifoliata</i>).....	11	3.0	Salal (<i>Gaultheria shallon</i>)....	5	5.0
Western hemlock (<i>Tsuga heterophylla</i>).....	14	2.7	Sedge (<i>Carex</i> sp.).....	4	4.6
Vine maple (<i>Acer circinatum</i>)	10	2.5	Douglas fir (<i>Pseudotsuga taxifolia</i>).....	5	3.4
Lady fern (<i>Athyrium filix-femina</i>).....	7	2.5	Red cedar (<i>Thuja plicata</i>)....	4	3.4
Moss (<i>Hylocomium</i> sp.).....	12	1.7	Longleaf hollygrape (<i>Oostemon nervosus</i>).....	3	3.2
Western red cedar (<i>Thuja plicata</i>).....	5	1.0	Grass.....	4	3.2
Sitka spruce (<i>Picea sitchensis</i>)	5	1.0	Elk fern (<i>Struthiopteris spicant</i>).....	2	1.8
Wood-sorrel (<i>Oxalis oregana</i>)..	5	1.0	Blackberry (<i>Rubus macro-petalus</i>).....	2	1.2
Huckleberry (<i>Vaccinium</i> sp.)..	2	1.0	Coolwort (<i>Tiarella trifoliata</i>)	2	1.0
Blackberry (<i>Rubus macro-petalus</i>).....	2	1.0	Youth-on-age (<i>Leptaxis menziesii</i>).....	1	1.0
Brake fern (<i>Pteridium aquilinum</i>).....	2	1.0	Huckleberry (<i>Vaccinium</i> sp.)..	2	1.0
Fungus (Polyporaceae).....	1	1.0	Mitrewort (<i>Mitella ovalis</i>)....	2	1.0
Bigleaf maple (<i>Acer macrophyllum</i>).....	1	1.0	Moss (<i>Hylocomium</i> sp.).....	1	1.0
Alder (<i>Alnus rubra</i>).....	3	1.0	Chickweed (<i>Stellaria washingtoniana</i>).....	1	tr.
			Unidentified.....	9	29.6

furnish an accurate picture of the autumn food. Huckleberry, for instance, is considered one of the most important autumn browse plants, but was recorded from only two stomachs and composed less than 1 per cent of the total volume. Vine maple, on the other hand, according to field observations is lightly browsed during the autumn, but appears as one of the more important. If a greater amount of the unidentified material, largely of woody fibers, could have been accurately determined, different proportions of these species probably would have been obtained.

Most of the winter samples were from

animals that had died of malnutrition and disease on overgrazed ranges; the proportions and species probably would

TABLE 5.—WEIGHTS OF ELK PAUNCHES.
(in pounds)

No.	Sex	Date	Paunch ^a and contents	Contents only
155	Ad. ♀	Feb. 12	98	—
166	Ad. ♀	Mar. 31	85	—
167	Ad. ♀	Mar. 31	60	—
179	Ad. ♂	Oct. 26	89	71
180	Ad. ♂	Oct. 26	84	66
181	Ad. ♂	Oct. 27	79	63
183	Ad. ♂	Oct. 26	83	67
186	Ad. ♂	Oct. 28	—	51
187	Ad. ♂	Nov. 3	—	78
188	Spike ♂	Nov. 4	—	44

^a Average net weight of the paunch (rumen), 16 to 19 pounds.

have been different had they lived under better conditions. It is significant that 27 per cent of the identified material was of coniferous browse.

The weights of paunch contents are summarized in Table 5.

MINERAL REQUIREMENTS

No natural licks or springs, attractive to elk or deer, were found on any western drainages, but on the east side of the peninsula a number of licks are used by both. Salt placed at six places on the west side was not used by either species and apparently the coastal elk have little desire or need for salt (Murie, 1935).

RANGES

WINTER RANGE

Each of the 16 major drainages of the Olympic Peninsula supporting elk includes well defined winter ranges. These occupy the valleys and lower slopes, from a few hundred feet to about 2,000 feet above sea level. The climate of all, except the extreme northeastern section, is excessively rainy during the autumn, winter, and spring; on the south and west sides the annual rainfall often exceeds 150 inches. Part of the winter precipitation is as snow, from about 6 inches on the lower west side to more than 4 feet on the upper limits of the occupied ranges. Most of the snow is heavy and wet, subject to frequent thawing and freezing, with resulting crusts that often seriously handicap deer and elk in their search for food. Heavy snow, however, frequently weighs down or breaks off branches which would otherwise be unavailable as forage. In general the greatest use on the normal winter range occurs from November until June.

The logged-off lands also are used in winter and make excellent elk range because they support a much larger growth of browse, weeds, and grasses as compared with timbered areas. For about 10 years after logging, or until grown up with conifer reproduction, these areas furnish abundant natural forage. Logged areas that contain small islands of standing timber at frequent intervals to provide the necessary cover are more favored.

Since some areas are occupied by resident elk throughout the year, the winter ranges have been classified on the basis of either yearlong use or winter use only (Fig. 2).

WEST-SIDE DRAINAGES

The river systems draining westerly into the Pacific Ocean are the Soleduck, Calawah, Bogachiel, Hoh, Clearwater, Queets, and Quinault. They are low, wide valleys, usually heavily timbered, and provide extensive wintering areas with variable amounts of the more important forage plants. The upper limits of winter range in most of them are at elevations of 1,500 to 2,000 feet.

Because of the mild and wet climate, the plant growth is more profuse and forage productivity is greater there than on other parts of the Peninsula. Of the total elk population on the Olympic Peninsula, 85 per cent is on these ranges. Hence, problems of overpopulation and range depletion are most common in these watersheds, although some are underpopulated.

Prior to 1936, overbrowsing and range depletion had progressed farther on parts of the Hoh River than on any other Olympic range, and a distinct elk line was evident on shrubs and trees

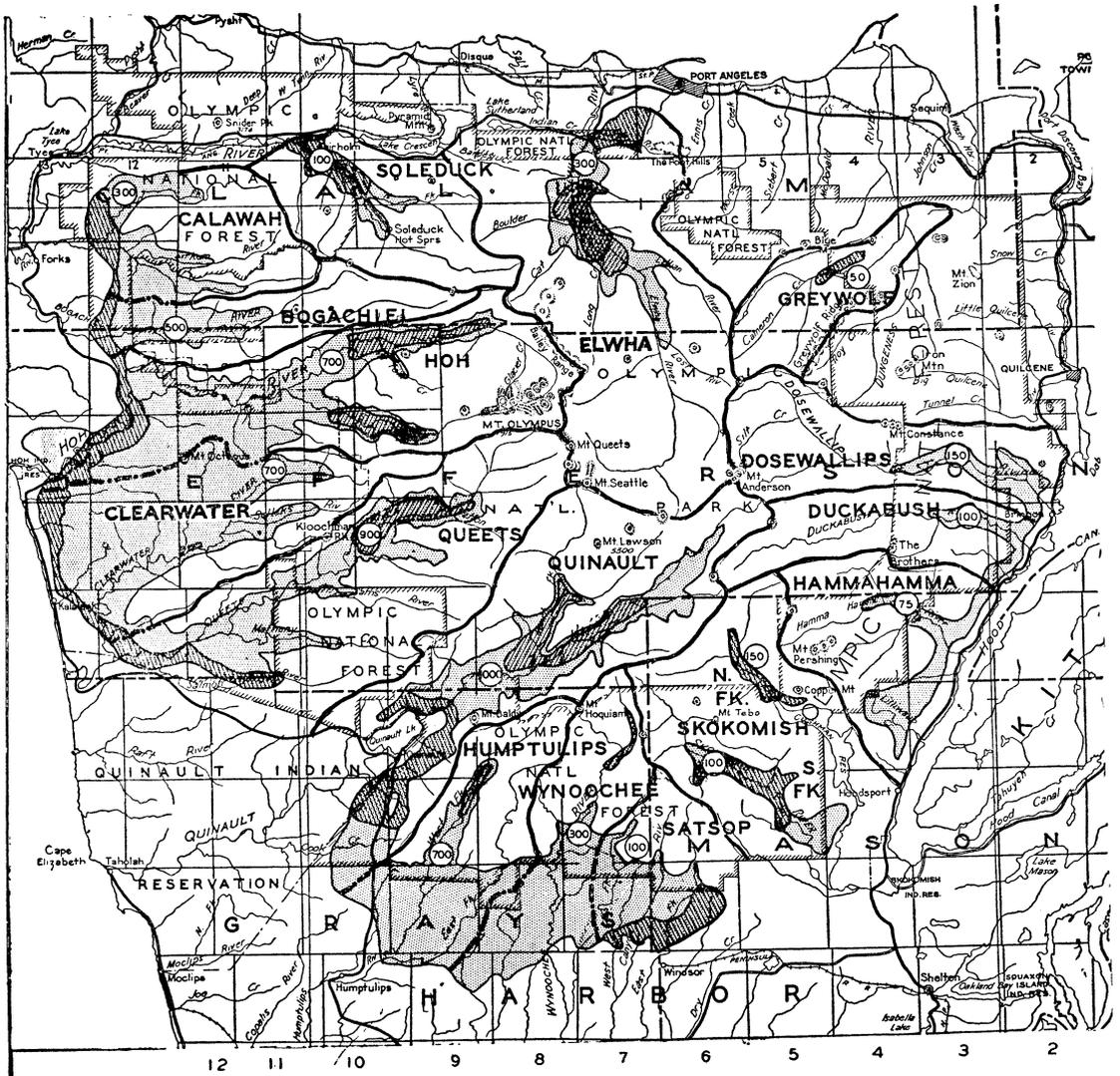


Fig. 2. Winter range of Roosevelt elk on Olympic Peninsula in 1938. \\\/, used mainly during winter; ///, winter range overpopulated; circled figures, estimates of elk present. Total estimated population, 6,225 elk.

throughout the area. Estimates of the degree of seasonal utilization on over-browsed portions of the Hoh drainage by percentage of annual growth were as follows:

WINTER, twigs only

	Vine maple	Huckleberry
1936	90	80
1937	75	70
1938	40	50

SPRING AND SUMMER, twigs and leaves

	Vine maple	Huckleberry
1936	60	70
1937	50	60
1938	—	—

From the forks of the Hoh River to the ocean the range is understocked and could support several hundred more elk.

Several other drainages are relatively overgrazed, but the intensity of use varies. Overbrowsing is much in evidence, but localized in creek bottoms. On the Queets drainage the percentage use was:

WINTER, twigs only

	Vine maple	Huckleberry
1936	—	—
1937	80-100	70-90

SPRING AND SUMMER, twigs and leaves

	Vine maple	Huckleberry
1936	50-60	40-60
1937	50-60	40-60

Because of the lack of uniform use of the concentration areas in the Quinault watershed, it has been difficult to determine average utilization of the more important browse species, but the percentage estimates were:

WINTER, twigs only

	Vine Maple	Huckleberry	Salmonberry
1936	70	55	70
1937	75	55	70
1938	65	50	65

SPRING AND SUMMER, twigs and leaves

	Vine Maple	Huckleberry	Salmonberry
1936	50	40	45
1937	50	40	45
1938	—	—	—

The west side is typical elk range. Intensive hunting on the overstocked areas should tend to reduce numbers and force the elk to spread to the less used ranges.

SOUTH-SIDE DRAINAGES

The river valleys on the south side are similar in climate, vegetation, and topography to the larger west-side drainages. From the national forest boundary north they comprise low, heavily timbered ridges and valleys. Below the boundary much of the land has been logged and on many parts there has been considerable regrowth of important food plants.

The valleys support typical growths of vine maple, salmonberry, ferns, huckleberry, wood-sorrel, and other plants. The benches are likewise well vegetated.

The principal watersheds in the eastern part of the Olympics all drain into Hood Canal. On the Canal side the mountains attain high elevations a short distance inland and the short rivers flow through steep narrow canyons; bottom lands and benches are limited. The per-acre carrying capacity is estimated at 50 to 75 per cent less than on the west side. On the lower parts of the drainages there are extensive cut-over lands which produce considerable forage and compare favorably with other peninsula ranges in that regard.

The annual precipitation is less than that along the west side, but the snowfall is usually greater on the winter elk ranges, mainly because most of them lie at higher elevations where seasonal temperatures are slightly lower.

The principal browse plants are

Ceanothus, *Arctostaphylos*, and *Cornus*, found exclusively on the east side; otherwise, the variety of forage species is approximately the same as that on the west- and south-side ranges.

The drier east-side ranges are more suitable for deer and, except for the South Fork of Skokomish River, management should favor deer over elk.

NORTH-SIDE DRAINAGES

This area is characterized by narrow deep valleys of moderate gradient, containing limited bottom lands and narrow benches which merge into steep mountain slopes. The surrounding ridges and peaks are 5,000 to 6,500 feet in elevation. The snow averages about 2 feet at 2,000 feet elevation, but consistently deeper above. Elk range up to 2,500 feet, and a few go even higher.

There is a great variety of plants; the understory browse and herbaceous species, comprising the winter elk diet, correspond with those of the drier Hood Canal drainages. There are limited stands of vine maple along the lower portions of the river. Grey moss is common and is taken as high as the elk can reach. Low plants such as salal, Oregon or holly grape, and ferns are available virtually all winter. When snow covers the low browse, the elk depend upon fallen limbs of Douglas fir and cedar together with the moss on them or that blown off the trees.

Overbrowsing of huckleberry, salmonberry and vine maple is evident on much of the winter range. Red huckleberry has suffered most, showing from 60 to 90 per cent utilization; it is the best indicator of present conditions and trends. Salmonberry is not abundant. Salal, Oregon grape, deer fern, and

sword fern, show moderately heavy use, and locally salal and deer fern are overutilized.

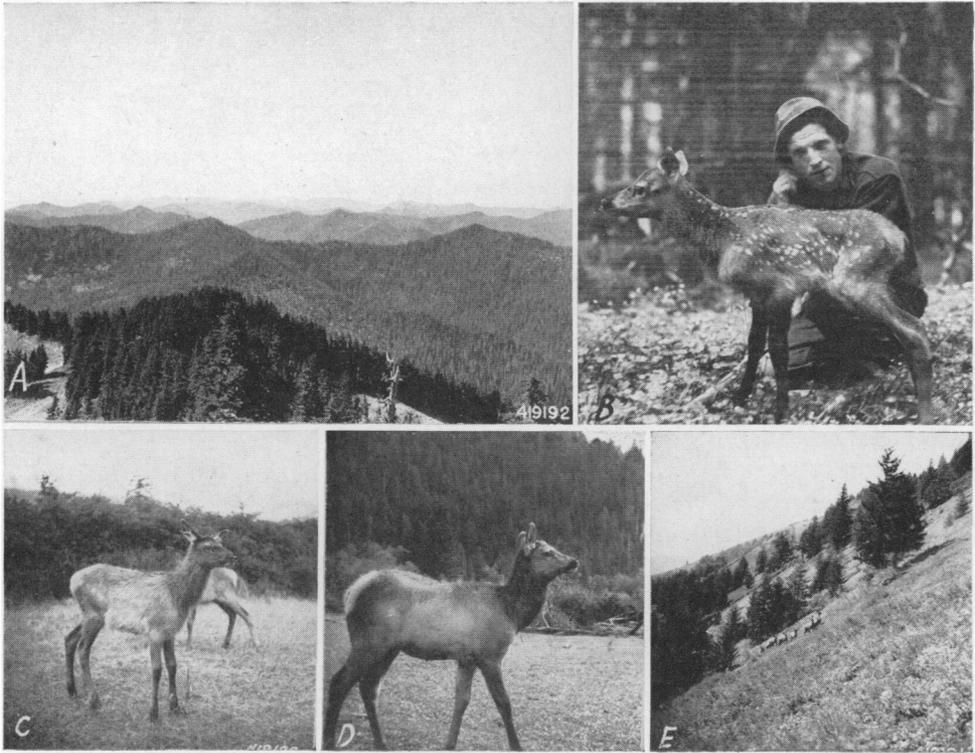
Game on this area has been under complete protection since October 1935, when much of the range was set aside as the Elwha Game Refuge. Deer have been responsible for most of the overgrazing. Both elk and deer are too numerous and should be reduced. The Elwha is one of the best deer ranges on the peninsula and reductions should favor the deer.

SUMMER RANGE

The summer range includes the upper timbered valleys and ridges and the higher, open subalpine areas (Pl. 14, A). The extreme northeastern part of the Forest is probably the only area without elk in summer. The greatest concentrations are near the headwaters of the Hoh, Elwha, Queets, and Quinault drainages (Pl. 14, E).

The tendency of elk to remain long on favorite feeding and bedding grounds has resulted in overbrowsing on certain areas; in every instance there are adjacent areas with adequate forage. Overutilization appears to have been underway for sometime, but through a period of years a gradual shifting of the elk concentration areas may occur, thus permitting a slow recovery of some heavily grazed places.

The most heavily browsed plant species were mountain ash, 80-90 per cent; salmonberry, 75-100 per cent; and spirea and black huckleberry, 50-90 per cent. The greatest damage occurs in the order listed. Herbaceous plants such as valerian, caltha, and arnica, likewise were closely grazed.



Roosevelt elk in the Olympic Peninsula, Washington. A. Principal summer range on low timbered ridges of Queets and Quinault drainages (photo near Kimta Peak, Sept. 1937). B. Calf 2 to 3 days old when tagged on East Fork, Quinault River, June 1936; killed about one mile away and tag recovered, October, 1937. C. Calf, 2½-3 months old, adult winter coat replacing juvenile pelage, September 1938. D. Calf, about 4 months old, juvenile pelage replaced, October 1938. E. Small band on typical summer range, Elwha River, May 1938.

FORAGE STUDIES

Intensive studies of range conditions on the overbrowsed portions of certain valleys were made. A number of enclosures were built to protect typical overgrazed portions from further use, and sample plots established, both inside and outside these areas. Take-down enclosures to control grazing use also were provided.

ENCLOSURES

Twelve fenced enclosures, from 45×45 to 100×200 feet, were established

cover. The composition of each area by species indicated an increase in browse of 18.6 per cent, and corresponding decrease in weeds and grasses of 10 and 8.6 per cent, respectively.

Of particular interest was the seemingly rapid recovery of salmonberry in some enclosures. Except for Enclosures 3 and 4 on the Quinault, none on either the Hoh or Quinault in 1935 contained more than a trace of this plant, but in 1938 all had 1 to 4 per cent of salmonberry. Judging from the then rapid rate of recovery, much more would be pres-

TABLE 6.—DENSITY OF GROUND COVER AND PLANT COMPOSITION WITHIN ENCLOSURES; ESTABLISHED 1935, RETYPED IN 1938.

Enclosure	Year	Density of ground cover	Percentage composition		
			Grass	Weeds	Browse
Hoh					
No. 1	1935	7	6	60	34
	1938	8	tr.	37	63
No. 2	1935	7	25	45	30
	1938	9	5	44	51
No. 3	1935	4	11	50	9
	1938	7	1	33	16
Quinault					
No. 1	1935	5	10	65	25
	1938	7	4	59	37
No. 2	1935	3	—	60	40
	1938	5	—	48	52
No. 3	1935	6	8	37	55
	1938	8	—	30	70
No. 4	1935	7	10	30	60
	1938	8	1	5	94

on representative portions of the overgrazed ranges each containing typical samples of one or more key forage species. Studies were made on the rate of recovery and other vegetative changes of the protected plants. In addition there were controlled clipping experiments simulating various degrees of grazing use. The plant growth was measured on sample plots inside each enclosure. There was an average gain of 18 per cent in the density of ground

ent during the next few years. An outstanding example occurred in Enclosure 3, where in 1935 only 10 per cent of the vegetation was salmonberry but in 1938, it comprised fully 50 per cent. The west quarter of the plot was densely covered by salmonberry 5 to 8 feet in height, whereas outside the plot it was only 6 to 24 inches in height.

SAMPLE PLOTS

In order to measure the vegetative

trends on overgrazed ranges, 92 permanent sample plots were established, each 10 feet square. These were of sufficient size so that the browse vegetation within could be measured and charted to scale. Nineteen of the plots were located within the enclosures to determine plant recovery under complete protection. The remainder were staked out at various places on the typical ranges. The number of sample plots on each drainage according to key plant species were as follows:

	<i>Vine maple</i>	<i>Huckle- berry</i>	<i>Salmon- berry</i>	<i>Totals</i>
Hoh.	20	20	3	43
Queets. . .	7	6	3	16
Quinault.	10	11	12	33
Totals.	37	37	18	92

Thirty of the plots established in 1935 were remeasured in 1938. There was a marked recovery in growth and vigor of the plants on protected and grazed plots.

UTILIZATION STUDIES

Effort was made to determine the extent to which the principal forage plants may be browsed and still maintain normal growth. Three methods of study were used: (1) actual utilization of the plants on the range, (2) clipping studies, and (3) analysis of regulated browsing by use take-down enclosures. Most information was obtained by the first method. This originally was intended to supplement the other two, but was largely the basis for conclusions because sufficient time had not elapsed at the close of the project, to draw definite conclusions from the others.

Repeated observations on the effects of actual grazing use of important forage species and of ranges with various degrees of annual utilization were made to determine the maximum use differ-

ent species could stand and still maintain normal vigor and growth. The following tentative standards were established for the Olympic ranges:

	<i>Percentage use</i>
Vine maple	40-60
Huckleberry	50-70
Salmonberry	40-60

POPULATION STUDIES

ESTIMATED ELK POPULATIONS

Organized counts of elk were made on the Hoh, Queets, and Quinault drainages during the winters of 1935 and 1936, and on the Elwha Valley in 1938. Because of the generally mild conditions during both winters, the elk were rather scattered and results were disappointing. The estimated population and the carrying capacity by ranges for 1938 were as follows:

<i>Drainage</i>	<i>Popula- tion</i>	<i>Capacity</i>
Soleduck	100	100
Calawah	300	400
Bogachiel	500	700
Clearwater	700	700
Hoh ^a	700	400
Queets ^a	900	600
Quinault ^a	1000	700
Humptulips ^b	700	800
Wynoochee	300	300
Satsop	100	100
South Fork Skokomish ^c	100	100
North Fork Skokomish ^d	150	50
Hamma Hamma	75	150
Duckabush ^d	100	100
Dosewallips ^d	150	150
Greywolf ^d	50	50
Elwha ^d	300	100
Total	6225	5500

^a Overgrazed.

^b Poor distribution.

^c Best for elk.

^d Best for deer.

AGE CLASSES AND SEX RATIOS

Counts of all elk on 5 different drainages during the study totaled 7,049 definitely identified by sex and age (Table 7).

Determination of the percentage of

yearlings of both sexes is made by doubling that for spikes. This would give 8 per cent as the yearling population and would subsequently reduce the cow population by that amount. The number of breeding cows is figured by eliminating the aged females and 2-year olds. About 40 per cent of an elk population may be estimated as breeding females (Rush, 1932), but our study

predators and accidents are also of importance, particularly during the summer and autumn. Of 94 calves examined from the fetal stage to about 10 months, 39 per cent were males, a ratio of 64 males to 100 females.

The most accurate tally on the proportion of bulls in any herd was on the Humptulips where they represented 16 per cent of the total herd (Table 8).

TABLE 7.—SEX AND AGE CLASSES OF ELK, BY DRAINAGE AREAS.

Drainage	Bulls		Spikes		Cows		Calves	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Elwha	23	6.3	5	1.4	284	77.5	54	14.8
Hoh	123	4.3	121	4.2	2,115	73.7	515	17.9
Quinault	180	6.6	124	4.5	1,829	67.2	588	21.2
Queets	68	7.3	17	1.8	645	69.8	193	20.9
Humtulpis	27	16.4	12	7.3	91	54.5	35	21.2
Totals and averages	421	6	279	4	4,964	70	1,385	20

indicates a slightly higher percentage among the Olympic elk. Counts of all cows and calves seen during July and August in 1936, 1937, and 1938 totaled 419 cows and 255 calves. This would indicate that about 61 per cent of all cows had calves; allowing for reasonable mortality among the calf drop during May and June, it would seem safe to place the percentage even higher. Assuming that 66 per cent of all elk are adult females (not including yearlings) and 65 per cent of them produce calves, the breeding cows would average 43 per cent in a typical herd.

Comparing the monthly percentages for calves shows a marked decrease in this group. (After May, all remaining members of this group were classed as yearlings.) Apparently there is heavy mortality within this age class. The losses are from malnutrition and parasitism during the winter, but losses from

There had been no hunting in this area since 1933.

The adult bulls are estimated to constitute 10 to 20 per cent of the total population. If 15 per cent is considered normal and breeding cows average 43 per cent, the ratio would be one bull per 2.8 breeding females. In actual breeding, however, the ratio is wider because probably not over 30 per cent of adult bulls participate, the remainder being immature and overaged.

LOSSES

During the winter and spring of 1936, 1937, and 1938, 112 elk were found in either dead or dying condition. From the frequency of dead animals found on typical areas of heavy elk concentration it is estimated that at least 400 succumbed during 1937 on the Hoh, Clearwater, Queets, and Quinault drainages.

During mild winters, two-thirds of

all those that die are adults, mostly aged, but in severe winters (e.g., 1937) deaths among calves almost equal those of adults. Animals 2 to 6 years or older

sponsible for the poorly nourished condition. The coarse material produces lesions in the mouth from wounds by the

TABLE 8.—SEX AND AGE CLASSES OF ELK OBSERVED ON THE HUMPTULIPS DRAINAGE, 1936–38.

	Bulls		Spikes		Cows		Calves	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
January	63	4.2	60	4.0	1,141	75.8	241	16.0
February	83	4.4	84	4.5	1,366	72.5	350	18.6
March	46	6.0	41	5.4	566	74.4	108	14.2
April	35	9.0	20	5.1	295	76.0	38	9.8
May	13	7.5	3	1.7	140	80.9	17	9.9
June	12	5.2	2	.8	176	75.9	42	18.1
July	39	6.9	4	.7	319	56.6	202	35.8
August	8	4.9	1	.6	100	61.7	53	32.7
September	33	14.3	12	5.1	128	55.4	58	25.1
October	21	10.0	6	2.9	147	70.3	35	16.7
November	23	7.6	14	4.6	185	61.0	81	26.7
December	45	7.0	32	5.0	401	62.8	160	25.1

survive a severe winter better than other age groups. The winter losses were as follows:

Year	1936	1937	1938
Total carcasses	25	66	21
Adults, percentage	85	52	67
Calves, percentage	15	48	33

MALNUTRITION AND DISEASE

Losses among elk on the west side drainages are both direct and indirect results of overpopulation. Malnutrition induced by eating coarse woody browse and coniferous growth has been the principal contributing factor. Post-mortem examinations of animals dying during the winter all disclosed characteristic symptoms of malnutrition, the most pronounced being emaciation; the watery, gelatinous appearance of fatty tissue beneath the skin; and much coarse and relatively unpalatable forage in the paunch. The quality rather than quantity of food taken was re-

sharp, woody portions. According to Murie (1935), such lesions frequently are invaded by *Bacillus necrophorus*, the causative organism of necrotic stomatitis, and the most important bacterial disease of deer and elk in the Olympic region. In all 32 autopsies were made besides partial examinations of incomplete or putrefied carcasses. The parasites and necrotic lesions found in the 32 autopsies were:

	Number	Percentage
Lungworms (<i>Dictyocaulus viviparus</i>)	23	72
Ticks (<i>Dermacentor albipictus</i>)	13	47
Lice (<i>Bovicola americanum</i>)	14	44
Tapeworms (<i>Thysanosoma actinioides</i>)	7	22
Intestinal worms (<i>Oesophagostomum venulosum</i> and <i>Trichouris</i> sp.)	5	15
Sarcosporidia (<i>Sarcocystis</i>)	4	12
Bot fly larva (<i>Cephenomyia</i>)	2	6
Lesions in mouth	5	15

Lungworms (*Dictyocaulus viviparus*) were widespread and important para-

sites. Of all elk examined during the winter and spring months 72 per cent showed infestations from light to heavy. In some, the worms completely occluded many large air passages. As the summer advances and feed becomes more abundant, elk gain rapidly in condition and seem largely to rid themselves of these worms, but many remain lightly infested throughout the summer since 5 of 13 examined during the hunting seasons in October of 1936 and 1937 contained a few (O'Roke, 1936).

A liver fluke (*Fascioloides magna*) is the only trematode thus far observed in elk and deer of the Olympic Peninsula; records of its occurrence are limited to certain west-side drainages but it probably is rather widespread. Practically all fluke infestations were found during the autumn, when the degree of infection varies by drainage basins. The greatest concentration was found on the South Fork of the Hoh, where 81 per cent of the elk killed contain flukes. None was reported from the Quinault, where most other parasites were found.

Sarcosporidia (*Sarcocystis* sp.) appears to be common; about 40 per cent of the hearts examined from elk shot by hunters showed this parasite on the inner lining and throughout the muscle tissue. It has also been observed in the tongue and cheek muscles.

A tapeworm (*Thysanosoma actinoides*) is one of the more common internal parasites; heaviest infestations are usually during the winter and spring, but some have been observed even in autumn.

Intestinal worms (*Oesophagostomum venulosum* and *Trichuris* sp.) appear to be common in the intestinal tracts, and

in somewhat greater abundance and frequency in calves than in adults.

The moose tick (*Dermacentor albipictus*) is the most widely distributed and commonest parasites on Olympic elk. It apparently occurs on every watershed, but the heaviest infestations were found on the Elwha.

The biting louse (*Bovicola americanum*) was first described in 1935 and is the only kind heretofore found on Olympic elk.

Bot fly larvae (*Cephenomyia* sp.) apparently do not occur in elk with the same frequency as in deer. They were found in only two, both calves, and neither contained a heavy infestation.

A few cases were diagnosed as calf diphtheria (necrotic stomatitis) in post-mortem examinations. This disease is present among elk on the crowded ranges and probably is a contributing cause to some deaths. Murie (1935) concluded that it was a major cause of elk loss on the Peninsula. About 15 per cent of the animals autopsied showed one or more necrotic lesions on the jaws or other membranous portions of the mouth. In addition, several adults had molars missing and the tooth sockets entirely healed over.

An attempt was made during the hunting season of 1937 to determine whether Bang's disease was present but no evidence was found. There may be some relationship between barrenness and conditions of malnutrition and parasitism, but no definite determinations were possible.

CALF LOSSES

Each year during calving season a few young one or more days old were found dead. The evidence indicated all deaths

resulted either from general weakness or pneumonia.

PREDATORY ANIMALS

Four principal predators occur on the Olympic Peninsula, the mountain lion or cougar (*Felis concolor oregonensis*), bobcat (*Lynx rufus fasciatus*), coyote (*Canis latrans lestes*), and bear (*Euarctos americanus altifrontalis*). The cougar is the most destructive to deer and elk because it preys on both young and adult animals throughout the year. Bobcats, coyotes, and bears are largely seasonal in their killing and confine themselves chiefly to fawns and younger animals.

COUGAR

The role of large cats in elk and deer mortality is imperfectly known. The materials collected were from ranges where elk are abundant and it would appear that cougars have definite preference for deer. This assumption is upheld by many experienced cougar hunters and by residents of the Peninsula. There is abundant evidence that cougars can kill elk without difficulty. In February 1936 a cougar killed an adult elk. A few hours later it was tracked down and shot, proving to be a yearling that weighed only 76 pounds. The elk, apparently healthy, was judged to weight about 600 pounds. The evidence in the snow indicated there had been little struggle between the two.

The food items in 28 cougar scats from the Olympic National Forest, were as follows:

	Num-ber	Per-centage
Washington varying hare (<i>Lepus washingtoni</i>)	11	32
Deer (<i>Odocoileus columbianus</i>)	8	23

Elk (<i>Cervus canadensis roosevelti</i>)	3	9
Pine squirrel (<i>Sciurus douglasii</i>)	2	6
Mountain beaver (<i>Aplodontia rufa</i>)	2	6
White-footed mouse (<i>Peromyscus</i>)	2	6
Wood rat (<i>Neotoma</i>)	2	6
Meadow mouse (<i>Microtus</i>)	1	3
Flying squirrel (<i>Glaucomys sabrinus</i>)	1	3
Bones	1	3
Hair	1	3

BOBCATS

Bobcats are fairly numerous throughout the Olympic Peninsula. To big game their destructiveness is limited mainly to deer, and of these young fawns, although they occasionally kill yearlings and even adults during the winter.

Analyses of 6 stomachs and 99 scats from the Hoh, Queets, Quinault, and Elwha drainages in 1935-38 showed the following:

	Num-ber	Per-centage
Washington varying hare (<i>Lepus washingtoni</i>)	65	43.9
Pine squirrel (<i>Sciurus douglasii</i>)	27	18.2
Deer (<i>Odocoileus columbianus</i>)	8	5.4
Wood rat (<i>Neotoma</i> sp.)	7	4.7
Salmon	8	5.4
Meadow mouse (<i>Microtus</i> sp.)	6	4.0
Flying squirrel (<i>Glaucomys sabrinus</i>)	7	4.7
Jumping mouse (<i>Zapus</i>)	2	1.3
White-footed mouse (<i>Peromyscus</i>)	3	2.0
Mountain beaver (<i>Aplodontia rufa</i>)	2	1.3
Western mole (<i>Scapanus</i>)	1	.7
Grouse (<i>Dendragapus obscurus</i>)	1	.7
Winter wren (<i>Nannus hiemalis pacificus</i>)	2	1.3
Grass (Poaceae)	2	1.3
Feather quills	4	2.7
Bones	1	.7
Fir needles	1	.7
Fish bones	1	.7
Total	148	

COYOTES

Coyotes inhabit the lower, logged-off lands on the south, east, and north sides of the Olympic Peninsula. They seem to be entirely absent from the heavily timbered valleys of the west-side drainages, and only on the more open northeast portions of the range are they found at higher altitudes. (6,000 to 7,000 feet). Little is known of the present trend of the population; the local consensus is that the animals are increasing slowly, but are not yet abundant.

BLACK BEAR

The Olympic black bear ranges throughout the Peninsula and has been condemned by local residents as most destructive of elk fawns. Many people advocate drastic reduction in its numbers and some favor complete elimination. Bears do prey on deer and elk fawns, but seemingly the habit is developed in certain individuals and not among bears as a group, and observations during the summers of 1936, 1937, and 1938 substantiate this belief. All bear scats found were examined for evidence of elk and deer; of more than 100 samples, 8 per cent contained evidence that fawns had been part of the diet.

The causes of mortality among elk on winter ranges during 1936-38 were: disease and malnutrition, 21; predators, 10; accidents, 8; undetermined, 73; total, 112.

ELK DAMAGE

Damage to crops and property is frequent in parts of the Olympic Peninsula where agricultural areas are within or near the winter range of elk or deer. In

the Hoh, Clearwater, Queets, Quinault, and Elwha districts, farmers suffer periodic losses from elk. Hay, both in fields and in stacks, is eaten or trampled, garden crops are grazed and trampled, and stampeding herds destroy fences. Damage during the spring and early summer largely by resident bands. The Washington State Game Department has attempted to relieve the situation by delegating men to patrol farms and frighten away the elk. Flares, bombs, and scarecrows have been used with varying success, but none proved entirely satisfactory. Trapping elk for transplanting has been tried to remove the elk from the vicinity of ranches. In the winter of 1938, a corral trap was built on the Elwha and baited with hay, but only eight animals were trapped because of the mild winter and abundance of natural forage. Trapping as a solution to elk damage is of limited value because of the expense. The only practical method of protecting both the farmers and the elk is to construct elk-proof fences.

HUNTING SEASON

During this study, elk hunting was permitted on the Peninsula each year in October. A total of 1,187 elk were taken, 268 during the first year, 811 the second, and 108 the third (Tables 9, 10). The territory opened to hunting differed somewhat each season. The limit for 1936 restricted each hunter to one male with branched antlers. In 1937 one of either sex and any age was allowed. The 1938 season was restricted to a small area and the bag limit allowed only male elk, including spike bucks.

The Hoh is the most accessible to

TABLE 9.—KILL OF ELK BY DRAINAGE BASINS.

Hunting season Drainage	1936		1937		1938	
	Number	Percentage	Number	Percentage	Number	Percentage
Bogachiel	10	4	21	3	4	4
Hoh	115	42	374	43	45	42
Clearwater	41	16	118	15	21	19
Queets	49	18	133	16	22	20
Quinault	50	19	184	22	14	13
Coastal drainages	3	1	8	1	2	2
Totals	268		811		108	

TABLE 10.—PERCENTAGE COMPOSITION OF ELK KILL IN 1937 HUNTING SEASON.

Drainage	Number	Percentage			
		Cows	Calves	Spikes	Bulls
Bogachiel	21	34	5	19	42
Hoh	347	64	13	10	13
Clearwater	118	64	11	9	16
Queets	133	51	14	13	22
Quinault	184	47	18	11	24
Coastal drainages	8	38	—	24	38
Total	811	57	13	11	19

TABLE 11.—ANTLER DATA FROM MALE ELK KILLED DURING HUNTING SEASONS.

Drainage	Total for each drainage			Percentage								
				4 points or less			5 points			6 points or over		
	1936	1937	1938	1936	1937	1938	1936	1937	1938	1936	1937	1938
Hoh	109	36	36	28.4	33.3	41.7	44.0	47.2	47.2	27.5	19.4	11.1
Queets	39	22	19	10.2	22.6	15.8	66.6	54.6	57.8	23.0	22.7	26.4
Clearwater	31	21	16	35.5	38.0	37.5	38.7	47.6	62.5	25.8	14.2	—
Quinault	34	35	12	5.8	31.4	16.7	47.0	54.3	58.3	47.0	14.3	25.0
Bogachiel	9	8	3	22.2	12.5	67.0	44.4	50.0	33.0	33.3	37.5	—
Soleduck	7	—	—	—	—	—	57.1	—	—	42.8	—	—
Coastal drainages	1	3	2	—	—	50.0	—	66.6	—	100.0	33.3	50.0
Totals	230	125	88									
Averages				21.7	29.6	32.0	47.8	51.2	52.3	30.4	19.2	14.8

hunters and the elk on that range are widely distributed. Most of the hunting was done in the river bottoms and lower slopes of drainages penetrated by roads; hence the less heavily stocked portion of the valleys, mainly with resident

bands of elk, were hunted most heavily. Migratory elk still on the summer range were less disturbed (Fig. 3).

The hunting seasons were intended to relieve the overpopulated ranges, but that objective was only partially real-

ized because much of those ranges are inaccessible. Only on parts of the Hoh (North Fork) and on the Quinault were reductions enough to effect improvement in forage conditions by the summer of 1938.

ANTLER CLASSES

Data for the three seasons show that the percentage of 5-point bulls killed was approximately the same each year, but the take of bulls with antlers of 6 points or more decreased, from 30 per cent in 1936 to 15 per cent in 1938 (Table 11). There was a corresponding increase in the numbers of younger males with antlers of 4 points or less. The decrease in old and increase in younger animals indicated that the adult bull population was being depleted.

SUMMARY

A cooperative study of Roosevelt elk on the Olympic Peninsula, Washington, was made by the U. S. Forest Service, U. S. Fish and Wildlife Service, and Washington State Game Department, to obtain information for a comprehensive elk management plan in respect to overgrazed elk ranges on the Hoh, Queets, and Quinault rivers. Between 6,000 and 7,000 live on the Peninsula.

The Roosevelt elk is somewhat heavier and larger than the Rocky Mountain form, but in most respects the life histories of the two are the same.

Breeding occurs between September 15 and October 15, harems are of 5 to 15 adult females, and calves are born from about May 15 to June 15.

The elk usually return to the same winter range each season, even when the ranges are depleted. They browse

during the winter, but in spring, summer, and autumn, grazing and browsing are about equal. Over 100 different species of plants are eaten, but 25 form the main diet. The principal browse species are vine maple, huckleberry and salmonberry, but western hemlock, western red cedar, Douglas fir, and Sitka spruce, are much used.

Ranges on the west side support more elk than the drier east-side drainages. The winter ranges are a few hundred feet to about 2,000 feet above sea level, and logged-off lands are important wintering grounds.

Hunting and heavy winter losses have effected some improvement in forage conditions. The Hood Canal drainages and the Elwha, on the north, are better for deer than for elk. The Elwha ranges are depleted because of an overabundance of deer.

Plants protected within fenced experimental enclosures showed marked recovery in growth and vigor. The permissible degree of utilization was determined to be from 40 to 60 per cent for vine maple, 50 to 70 per cent for huckleberry, and 40 to 60 per cent for salmonberry.

Of 7,049 animals identified by sex and age there were 70 per cent adult cows, 20 per cent calves, 6 per cent adult bulls, and 4 per cent spike bulls; 43 per cent of all adult cows were breeding. There is heavy mortality among calves. Bulls constitute from 10 to 20 per cent of the total elk population.

In all, 112 elk were found dead during the study, 21 from malnutrition and disease, 10 were cougar kills, and 8 accidents. The heaviest losses were in 1937, when more than 400 died of malnutrition and disease on the Hoh, Clear-

water, Queets and Quinault drainages. During that winter, calf losses equaled those of all other age classes combined. The excessive losses on the west-side drainages resulted from malnutrition. Overpopulation is a factor in increasing the incidence of parasitic infection among the elk. Findings from 32 post-mortem examinations showed the usual infection by sarcosporidia, lungworms, tapeworms, intestinal worms, bot flies, ticks, and lice.

Cougar, bobcat, coyote, and bear are the principal predators in the Olympics, and cougar are the most destructive to elk and deer. Other small mammals, in addition to deer and elk, are included in the cougar diet. Analyses of 99 bobcat scats indicate the food of the animal to be largely neutral in character. About 8 per cent of a few bear

scats contained remains of elk fawns.

A total of 1,187 elk were killed during the three seasons, 42 per cent from the Hoh drainage. Hunting helped to relieve the pressure on some ranges.

The number of bulls with antlers of 6 or more points decreased from 30 per cent in 1936 to 15 per cent in 1939.

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SYMPTOMS OF MALNUTRITION IN DEER

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To a casual observer, a deer may look strong and healthy after having spent the winter on an overbrowsed range or on a range that has been covered with deep snow for many weeks. But is it? Deer food on the winter range at its best does not put fat on a deer. The diet available, even in moderate winters, is at the most merely a subsistence diet. If deep snow covers the greater portion of the choice deer browse or if the range has been overutilized, thereby forcing the deer to take more and more of the forage of low palatability to keep its stomach full, we are then headed for malnutri-

tion in the deer herd and the eventual death of the deer.

During the summer and early autumn months deer build up reserves of fat distributed throughout various parts of the body. This fat is stored during the plant growing season when good nutritious food plants are abundant. If you kill a deer in the autumn, when many states have an open season, this is about the picture you will find. You will be impressed, when you dress the deer, by the handfuls of fat inside the body—fat that can be stripped from the intestines. Also there will be fat around the kidneys and a spot of