OKANAGAN LAKE

September 11, 1934 (1): Bones of 2 small suckers, *Catostomus* sp., and small *Cyprinidae*.

OKANAGAN RIVER

September 1934 (2): No. 1—1 sculpin, 4 small *Cyprinidae* and fragments of several crawfish. No. 2—2 crawfish and 1 small sucker.

Food Items Tabulated

Sixty-one specimens from Vancouver Island, including Valdez Island, collected in January, February, April, May, August, October, November and December.

Food Items	No. of Times Found
Salmonidae (Salmo and Oncorhynchus fry and fingerlings)	15
Kokanee—*Oncorhynchus nerka kennerleyi*	3
Decomposed salmon flesh	4
Salmon eggs (chiefly chum salmon, *Oncorhynchus keta*)	21
Herring—*Clupea pallasii*	1
Stickleback—*Gasterosteus aculeatus*	2
Sculpins—*Cottus asper*	24
—*Leptocottus armatus*	1
—*Cottidae* not identified	3
Sculpin eggs—*Cottus asper*	2
Unidentified fish remains	2
Sea lamprey—*Entosphenus tridentatus*	2
Crustaceans—Isopoda, Amphipoda	3
Caddis—Trichoptera (larvae)	6
Fly — Diptera (larva)	1
Beetle—Coleoptera (adult)	3
Aquatic insects—fragments not identified	3
Fresh water sponge—Porifera	1
Earthworm—Oligochaeta	1
Annelid worm—Polychaeta	2

Three Specimens from Tlell River, Queen Charlotte Islands, collected in April and May

Food Items	No. of Times Found
Salmonidae — fry	1
Sculpin—*Cottus asper*	1
—*Myoxocephalus polyacanthocephalus*	1
Sculpin eggs	1

Twenty-five Specimens from the Mainland Coast, collected in January, March, April, May, June, July, August, November and December.

Food Items	No. of Times Found
Salmonidae (Oncorhynchus fry)	5
Salmon eggs chiefly chum salmon—*Oncorhynchus keta*	6
Decomposed salmon flesh	6
Sculpin—*Cottus asper*	8
Cottidae not identified	2
Stickleback—*Gasterosteus aculeatus*	3
Perch—*Cymatogaster aggregatus*	1
Unidentified fish remains	4
Sea lamprey—*Entosphenus tridentatus*	1
Caddis—Trichoptera (larvae)	6
Stone fly—*Perla* sp. (adult)	1

Eleven Specimens from the Interior of Britisn Columbia collected in August, September and December.

Food Items	No. of Times Found
Eastern speckled trout—*Salvelinus fontinalis*	1
Sculpin—*Cottus asper*	5
Sucker—*Catostomus* sp.	4
Lake shiner—*Richardsonius balteatus*	1
Cyprinidae—not identified	6
Chub—*Mylocheilus caurinus*	1
Crawfish—*Potamobius* sp.	4
Dogwood—*Cornus (occidentalis?)* fruits	1

In paper No. 2 of this series it was stated that in order to obtain a comprehensive picture of the food chain culminating in the American Merganser, it would be necessary to consider the foods of some of the fish which enter into the food of the duck. Considerable progress has been made in this direction and in a following paper, data concerning the foods of squawfish, whitefish, stickleback, sculpin and ling will be presented.

THE BEAVER OF THE RIDING MOUNTAIN, MANITOBA

AN ECOLOGICAL STUDY AND COMMENTARY

By H. U. GREEN

(*Continued from Page* 23)

FEEDING HABITS AND FOOD SUPPLY

A close study of the beavers' feeding habits reveals that in the spring, summer and autumn they consume a measure of food during the periods of the day they are abroad. On many occasions adult beavers, singly and in pairs, were noticed conveying mouthfuls of succulent plant stems from the edge of the ponds to the lodge, which they either left to float on the water nearby or carried within. Quite often they were observed eating favoured vegetation growing at the water's edge, but nearly always a supply was taken away for future consumption after immediate hunger was satisfied.

As the beavers were never seen actually on land, except between dusk and early dawn I do not think that food plants growing on the

wooded slopes beside the ponds are consumed in the daytime, unless collected under cover of darkness and taken to the lodge. In consequence it may be said that the pond, for the most part, provides the food requirements of the day, and the preferred vegetation of the wooded slopes that which is eaten during the beavers' excursions at night.

Although it is quite evident that the soft bark, tender twigs, and the cambium layer of the Aspen Poplar constitute the bulk of the beaver's winter provender, there was no indication about the ponds under observation (and elsewhere in the Riding Mountain) that the Aspen is preferred during the open months of the year. On the contrary the consumption is limited to the bark and cambium occasionally stripped from the trunks of standing saplings. The wide variety of succulent plants and shrubs growing in and about the water of the ponds offers a selection of stems and leaves which, when available, are favoured in preference to coarser food. Not until early autumn, when sun and frost have withered the annual growth, are the aspen thickets invaded at night and branches conveyed to the pond to provide the food requirements of the day.

At this time the harvesting of winter food begins and, if not too windy and no heavy rain intervenes, continues every night until a sufficient quantity is secured to tide the family over the frigid months. The winter food, however, is not entirely confined to the cambium, tender bark and twigs of the aspen poplar, for a small proportion of willows is also gathered. I have never found any other species of plant life stored for winter food in the Riding Mountain.

The method of storage is both simple and effective. After severing the tops and branches of the felled trees and cutting them into suitable lengths, they are dragged over a selected route, cleared of interfering growth, to the water and towed or pushed to a deep place near the lodge. Willows, collected at the water's edge, are, unless too bulky, removed intact. Branch after branch is heaped one upon the other or entangled beneath the surface until the mass slowly sinks. By the time ice forms only a few twigs can be seen. The aspen trunks are not utilized.

There is seldom a surplus of winter food left over in the spring, and should any remain it is not consumed.

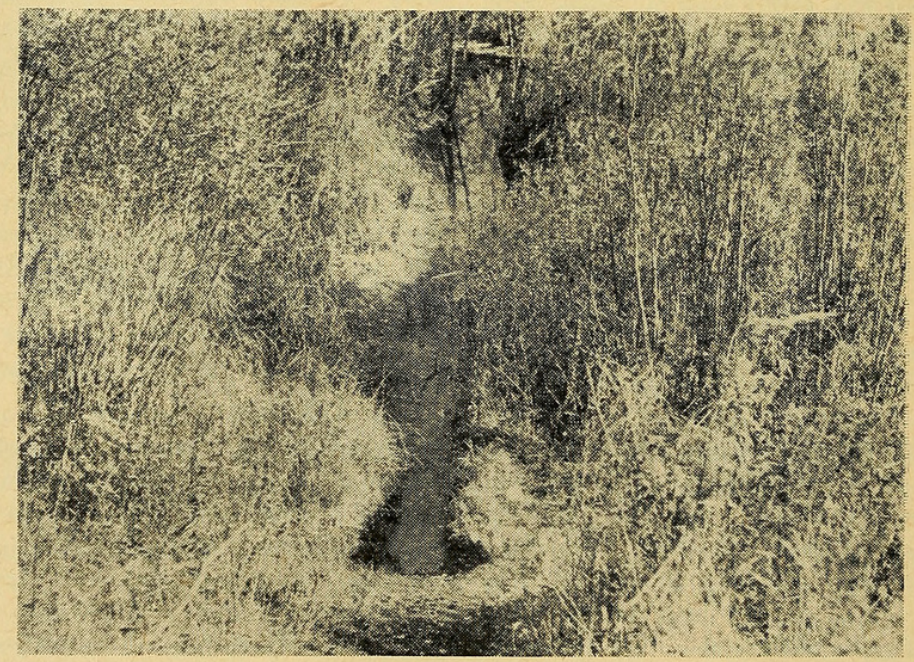
When ice forms on the ponds, food from the storage pile is, of necessity, consumed within the lodge, the beavers gathering what is required from time to time for their immediate use. It would be impossible, though, to convey much of the material inside without reducing it to suitable bulk and length. The heavier sticks, upon being denuded of bark and cambium, are returned to the water and, in the spring, drift down to the dam offering ample evidence that the inmates of the lodge wintered well. It is very probable that the roots of aquatic plants are also secured during the winter months and eagerly devoured.

While there is every reason to believe that aspen twigs and tender willow stems are eaten in their entirety, it may also be possible that sometimes coarse wood is consumed. I have seven records of the total absence of chips about stumps of beaver cut aspen saplings from 1 to 2 inches in diameter, and three records of narrow scarves cut in felled trees of the same species 3.5, 4.9 and 4.7 inches in diameter. The tooth marks in every instance were those of adult beavers. I can offer no other explanation for their absence, as wood chips appear to serve no other useful purpose.

The distance travelled on land to secure food and building material is limited. Both at Sites Nos. 1 and 2 (and other beaver locations in the Riding Mountain) there is evidence of the abandonment of aspen areas in favour of new stands closer to the ponds when the former are cut back about 75 yards. Signs of beaver industry about inhabited ponds were never encountered at a greater distance. This, however, does not refer to migratory habits.

The following seasonal list of food plants favoured by the beavers under observation was compiled from the evidence afforded by characteristic signs and tooth marks on trees and shrubs cut and denuded of foliage, direct observation, and specimens collected from within the lodges through a small hole made for this and other purposes in connection with the study. The list in respect to small plants must be considered incomplete.

Typical beaver lumbering area. Note that the smaller wood is all removed for food and building material.



Beaver-made canal connecting the path from the lumbering area with the pond. Site No. 2.

Photographs by H. U. Green.

	SPRING AND SUMMER	
Fragaria virginiana	Strawberry	Leaves and fruit.
Mentha sp.	Mint	Leaves and stems.
Nymphaea microphylla	Spatterdock	Roots.
Populus tremuloides	Aspen Poplar	Bark and cambium from standing trees.
Rosa blanda	Wild Rose	Leaves and fruit.
Rosa nitida	"	
Rubus idaeus	Raspberry	Leaves and fruit.
Salix longifolia	Willow	Leaves, tender growth, bark, and cambium.
Salix lucida	"	
Salix pedicellaris	"	
Spartina michauxina	Slough Grass	Tender part of stems.
Stellaria borealis	Chick Weed	Foliage and roots.
Typha latifolia	Cat-tail	Tender stems.
	AUTUMN (AFTER FROST)	
Populus tremuloides	Aspen Poplar	Tender bark, cambium, leaves, and twigs.
Nymphaea microphylla	Spatterdock	Roots.
Salix longifolia	Willow	Bark, leaves, and twigs.
	WINTER	
Populus tremuloides	Aspen Poplar	Tender bark, cambium, and twigs.
Salix longifolia	Willow	Bark, cambium, and twigs.
Salix pedicellaris	Willow	Bark, cambium, and twigs.

Although aspen poplar is the dominant growth about the ponds under observation and other beaver sites, occupied or otherwise, in the Riding Mountain, White Spruce, (*Picea canadensis*) Tamarac, (*Larix laracina*) White Birch, (*Betula pendula*) and Balsam Poplar (*Populus balsamifera*) also occur, but there is no evidence to indicate that they are used for food or any other purpose. I have, however, one record of an exposed lateral root of a white spruce which showed signs of having been stripped by a beaver. It is doubtful, though, if any of the bark was consumed or carried away, as the bulk of the parings lay beside the root. What little impression the teeth left suggested the work of a young beaver who was probably playing or wearing down its incisors. Neither is there any evidence that anything other than vegetation is favoured by beavers for food.

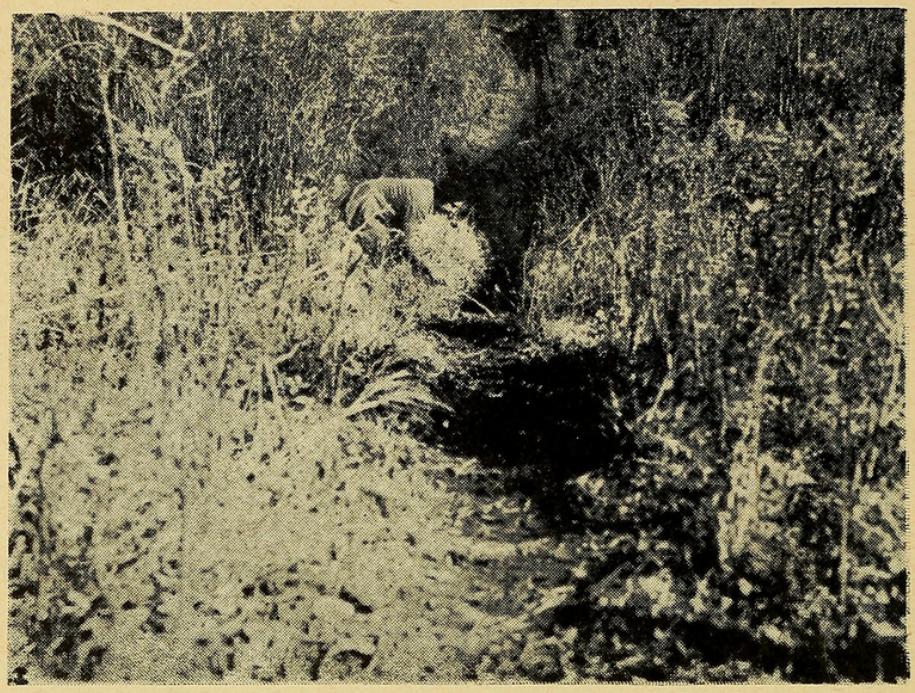
At Site No. 1, I was in the habit of leaving apples, carrots, and bread, beside the lodge and watching the result from cover a few yards away. For some time these delicacies were ignored, but finally they were accepted and quickly devoured on the spot. When placed together, the apples were always eaten first, followed by the carrots, and lastly the bread. It did one good to see how they mouthed the unusual food with every sign of enjoyment.

Apart from the satisfaction derived from feeding this family of beavers, I have been impressed by the possibility of reducing certain other families in the Riding Mountain to a state of semi-domesticity, so that naturalists and visitors to the park could obtain first-hand knowledge of this wonderful mammal in a natural environment without encountering the many perversions which tame beaver acquire through too close contact with humans.

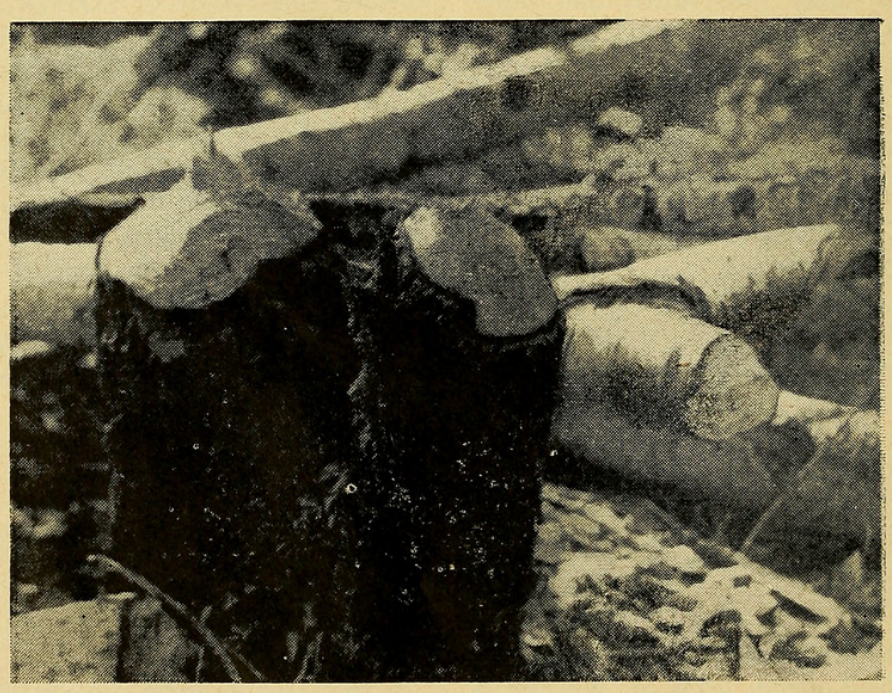
Beside using their "hands" to pick up food from an upright position and convey it to the mouth in typical rodent manner, beavers also use their "hands" individually to pluck leaves from aspen branches and other light vegetation while on all fours. Bark and cambium from aspen limbs, too heavy or awkward to lift, is peeled where it is and eaten forthwith in the process. Bark and cambium from standing trees may be peeled while on all fours, but it is generally stripped while standing.

I have never observed beavers eating while floating on the surface or in swimming water. Food secured in the pond is either taken to the nearest shallows and consumed, or conveyed to the lodge.

The peculiar habit of sitting on the tail while eating in an upright position is very noticeable. Standing for a moment on one hind leg, the



The path continues down the steep slope to the landing place and canal.



Twin stumps with upper portion of another tree lying nearby, severed to secure the leafy branches and small wood from the crown.

Photographs by H. U. Green.

other is raised and the tail brought to the front with a sweeping motion and promptly sat on. The upright posture is perhaps more comfortable with the tail in this position.

LUMBERING AND ASSOCIATED ACTIVITY

The most interesting phase of beaver activity is the felling of trees. In this, and other wonderful work the beaver performs, a high degree of intelligence is apparent, surpassing that of any other forest mammal.

The following is my conception of the procedure, determined from the evidence offered by many aspen trees in various stages of decapitation, and from visual observation when intensive lumbering was undertaken by the occupants of the several ponds:

Assuming an erect posture beside a selected tree with tail extended as a brace against the exertion of muscular jaws and "arms" clasped about or against the trunk, two horizontal furrows are made above and below shoulder height, about a quarter of an inch deep and from three to four inches apart. The intervening material is then pried out in the form of a large chip. Other chips are removed to the right and left in like manner, and as the resulting scarf is cut deeper into the trunk additional material is taken from the upper and lower faces to permit the beaver to labour more expediently. Continuing the operation, the upper and lower margins of the scarf are cut wider apart and the faces narrow up and down past the centre of the tree until over two-thirds of the diameter is severed. Up to this time, the part of the trunk directly opposite to where the beaver began its work, is untouched. This unsevered portion is always attacked last and the material removed from each side at right angles to the beaver's original position until the trunk is completely girdled and only a small shaft of wood connects the tree proper to the stump. When the operation is finished, the scarf cut from the sides of the trunk, to the right and left of the beaver's original position is, generally, not only smaller than the main scarf, but much higher and more narrow. Therefore, the lower face of the main scarf presents a less acute angle than the upper face. However, slight variations in technique are evident from time to time.

No attempt is made to sever the small shaft of wood connecting the tree proper to the stump and, in consequence, several minutes may elapse before the tree crashes to the ground. This would appear to indicate, as the shaft has considerable strength, that it is deliberately left at a certain thickness as a protective measure to create a lag in the fall, and to offset the possibility of the butt "jumping" when the tree strikes the ground, as almost invariably the trunk and stump remain connected by tenacious slivers. Thus, the beaver has ample time to leave the danger zone with a generous margin of safety.

There is no reason ever to suppose that a tree is felled by working in circles round the trunk, or that beavers "worry" through the trunk by gnawing. The presence of chips up to four inches long, one and a half inches wide, and over a quarter of an inch thick, becoming smaller as the scarf narrows, at once dispels the thought as upon serious investigation many other fallacious beaver attributes fall from the pedestal of imagination.

When cutting a standing tree, the beaver's head is turned sharply sideways, simulating as closely as possible the natural working position assumed while severing limbs and branches on the ground. Willow stems and aspen twigs up to half an inch in diameter are severed with one bite and the cut surfaces are angular. Heavier limbs, lying on the ground, are scarfed in the same manner as a standing tree, with the exception, of course, that the work is performed entirely from the upper side with the head in a natural position.

An examination of beaver-cut areas about the ponds under observation, and elsewhere in the Riding Mountain, reveals that lumbering operations are, for the most part, pursued on the slopes and slanting benches close to the water's edge. Consequently, there is a marked tendency for trees growing thereon to lean towards the downward incline and, assisted by the manner of scarfing, which is always done from the higher side of the slope, fall in the direction of the water when severed near the roots.

The direction in which a beaver-cut tree will fall, even without the assistance of a natural lean is, with few exceptions, away from the widest part of the scarf within an angle of 70 degrees to the right and left of the centre of the stump, and so, unless deterring influences intervene, or the technique varies slightly from established form, is determined by the position the beaver assumes during the first part of the operation.

This contention is supported by the following summary resulting from a careful study of 207 beaver-felled aspens selected at random about the sites under observation:

Falling directly away from widest part of scarf within 10 degrees to the right and left of stump centre:	47
To the right, within an angle of from 10 to 70 degrees:	75
To the left, within an angle of from 10 to 70 degrees:	73
To the right or left, within an angle of from 70 to 90 degrees:	4
Falling directly towards the widest part of scarf, within 10 degrees to the right and left of stump centre:	1
To the right, within an angle of from 10 to 70 degrees:	4
To the left, within an angle of from 10 to 70 degrees:	3
To the right or left within an angle of from 70 to 90 degrees:	Nil.

There is also evidence to support the belief that the beavers knowingly take up a position when commencing to fell a tree which is advantageous to them. For instance, when aspen areas on level and comparatively level ground are first invaded, the initial scarf cut in the trees on the margin of the stand is on the inside, and they fall outwards into the clear. If the reverse were the case they would fall inwards and probably entangle with standing trees. However, when a space is partially cleared, the trees may fall in any direction depending, for the most part, on the position of the main scarf, which is then given scant consideration. The same procedure is adopted when invading new aspen areas on slopes and slanting benches; the outside trees are cut first, falling into the clear as the beavers work upward and backward.

Fouled trees are seldom encountered among stands of aspen growing upon an incline. The lean of the trees and the influences assisting the direction of fall, prevent the possibility to a marked degree. This is not the case on level, and comparatively level ground, for such accidents sometimes occur after a space is partially cleared of trees. For the most part, though, the labour and material are not lost, as the entangling tree is eventually felled, or the entangled one released by heavy winds. I do not wish to infer that an entangling tree is cut down with the deliberate intention of permitting an entangled one to fall, but rather that this happens in the ordinary course of events. Should, however, the branches of a cut tree within a lumbering area foul another standing on the border beyond, the entangling tree is never felled, unless the area is extended and it comes directly within the sphere of the beavers' later activity.

When endeavouring to arrive at some conclusion as to whether or not beavers can, with a degree of forethought, drop a tree in a desired direction, I quite realize that I am on the threshold of a much discussed psychological problem, and that the individual who entertains the idea of the feat bordering upon the realms of possibility, opens wide the doors of derision. However, I would feel that my study is incomplete did I not offer an opinion based upon my observations which suggest, I think, a compromise with existing thought.

Considering first the sloping aspen areas, the general rule that a beaver-cut tree falls away from the widest part of the scarf, offers little evidence unless we know why they work on the higher side of the incline. Do they assume this position without realizing the assistance of the slope because it is the easiest side of the tree to work, or is the position chosen with premeditated intent without thought of comfo t?

Applying the rule to aspen areas on level and comparatively level ground, we find that the outside trees fall outward into the clear, and not until a place within the stand is cut over is the direction of fall more or less haphazard. I am inclined to believe that the obvious intelligence responsible for the technique employed on level and comparatively level ground can be logically applied to the manner of the beaver's lumbering on slopes and inclined benches, for the reason that although the higher side of the slope or incline is undoubtedly the most comfortable and expedient place to work, it merely happens that it offers a fortuitous combination of comfort and correct position to attain a desired end.

I think, from what I have learned, that I can justly infer, without finality or fear of ridicule, that while a beaver may not, with direct premeditation, drop a tree in a predetermined position it is, nevertheless, conscious of the general directon in which it will fall, and thus, barring difficulties it can not foresee or understand, realizes in a general way the cause and effect of its endeavours. Faulty technique may be ascribed to lack of individual skill and, perhaps, to a lesser degree of intelligence. In any event, one could naturally expect variations of both, as individualism among mammals is not confined to the human race. There are many things undreamt of in a true philosophy of the wilderness incapable of proof by laboratory methods and study under unnatural conditions.

It is evident that the extent of lumbering activity within a given area is not regulated by

the number of available trees, but rather by the distance from water, which increases as the cutting is extended farther from the pond. When the distance becomes too inconvenient or dangerous to warrant further work, a new stand is invaded. No deserted areas were observed exceeding one acre in extent, and many measure only a few square rods, depending upon surrounding associations.

Aspens growing beside beaver ponds in the Riding Mountain seldom exceed 10 inches in diameter, and so I am unable to say how large a tree beavers would fell if afforded the opportunity. I have never observed a neglected tree up to and slightly exceeding this size, for if it is green it is favoured, irrespective of diameter. Thus, the space within lumbering areas is cleared to the last living tree.

Lumbering, especially in the autumn, when winter food is being harvested and sticks and stems gathered to fortify the lodge against the ravages of winter, is not a haphazard venture but a project undertaken with preparation, deliberation, and foresight. The amount of material required varies, of course, according to circumstances. During the summer months the demand for sticks for minor repairs to the dam is small, consequently they are usually gathered from the willow clumps in and about the ponds without organized effort.

In an endeavour to describe the lumbering activities of the beaver of the Riding Mountain graphically, I am recording in detail the work performed at Site No. 2 during the autumn of 1933, not because it differs from the other ponds under observation, but for the reason that the environment demanded greater effort to accomplish the desired end. The pond, it may be said, was uninhabited by beavers from the spring of 1932 until I introduced a two-year-old pair in June, 1933. Therefore, there was more than the usual deterioration of dam and lodge which, however, was partially taken care of before the autumn work commenced.

For several years the autumn cut of aspens for winter food and building material at Site No. 2 has been taken from a comparatively level bench 50 yards in a direct line from the pond and 63 yards by way of a beaver-made path through the underbrush to the head of a beaver-made canal dug slightly into the bank and extending some 20 yards through a willow swamp to the open water of the pond. From the canal head to the margin of the bench, 59 feet above the level of the pond, the path inclines sharply upwards until the margin of the cutting area is reached, where it ceases abruptly.

It was not strange that the introduced pair should profit by the labour of their predecessors and use the canal and path to the aspen stand. This they did within a week after being placed in their ready made home, to gather material to repair the lodge and dam.

The actual autumn work was first in evidence on the morning following the night of September 6th, when two aspens, 3.5 and 4 inches in diameter were felled and the limbs severed from the trunks. The limbs, minus the leafy twigs, were dragged down the path and through the canal to the pond. The material was used during the night of September 7th for building up the spillway of the dam. The aspen stand was also visited and the leafy twigs, left the previous night, removed to the water beside the lodge. During the night of September 8th, which was very windy, no cutting was done in the aspen stand, but 13 green willow stems were harvested in a thicket close beside the pond and added to the limbs already placed on the spillway of the dam.

No further activity was noted until the morning of September 11th, when it was found that three more aspens 2.5; 2.8; and 3.9 inches in diameter, had been felled and the branches and leafy twigs taken to the pond and left beside the lodge. This, I believe, was the initial contribution to the winter food pile. When visiting the site on September 12th, an additional felled aspen 4.9 inches in diameter, was observed. The branches were taken to the food pile. A smaller aspen, 3.5 inches in diameter, was also severed, but in falling fouled another tree.

I left Site No. 2 on September 12th and did not return until September 23rd. In the meantime the branches of seven felled aspens had been removed from the stand, including those from the fouled aspen since released from the entangling tree, probably by wind, and an undetermined number of willows cut beside the pond. Previously the naked trunks were not utilized. Now it was evident that the tops of six had been severed, placed on the sides of the lodge and imbedded in mud. Willows, too, were loosely stacked about the apex. The food pile, which on September 11th consisted of a few leafy branches of aspen, now reached considerable size, and all the material, with a small proportion of willow stems, was now be-

low the water. The aspens felled between September 12th and September 23rd measured 7; 6.5; 6; 5.3; 5.2; and 3.4 inches in diameter. On the night of September 24th, one aspen 5.2 inches in diameter, was felled and the branches removed. The top was also severed, but could not be traced. After the night of September 24th, there was no evidence that the aspen stand was again invaded. Willows, however, were cut in small quantities. By September 27th all lumbering activity evidently ceased and the beavers settled down to await the advent of winter.

The lumbering activity of the two beavers at Site No. 2 during the autumn of 1933 totalled 14 aspens, the branches of which were conveyed to the pond via the path and canal; the naked tops of 7 of these trees, removed by the same route, and a quantity of willow stems. The amount harvested slightly exceeded the average at the sites under observation. The usual autumn cut at these locations during the period of investigation averaged 10 aspens of about the same average diameter and a similar quantity of willows.

Dead trees and those showing obvious signs of advanced decay are never felled, neither are any portions of felled trees from which the branches have been severed, utilized, other than the slender tops. Consequently, at all beaver sites in the Riding Mountain, cut-over areas are littered with dry and decaying trunks, the soundest of which are often hauled away for firewood by settlers from the surrounding district.

There is no evidence to suggest that any other species of trees or shrubs beside aspen and willow are used for any purpose by the beavers as constructional material.

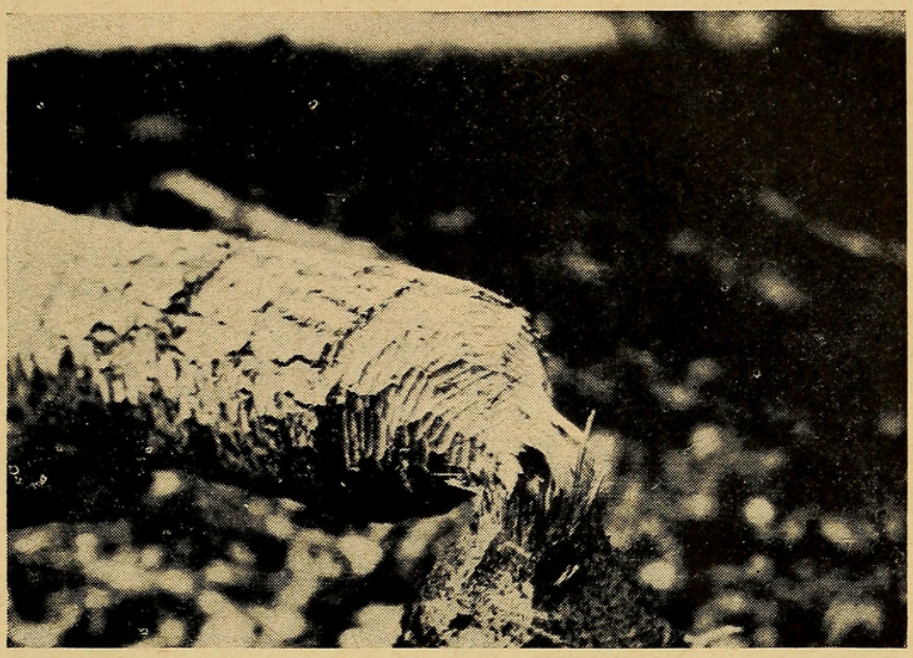
Although every effort was made to ascertain the time taken by the beavers to fell a tree, no information of any value could be secured. The difficulty of approaching the vicinity of the ponds when the beavers were working on land, even under favourable wind conditions, is always complicated by the presence of intervening trees and the beaver's extreme caution when away from its natural element. Any suspicious noise or a breath of alien odour is sufficient incentive for work suddenly to cease, often not to be resumed that night. I have, however, on moonlight nights been fortunate enough to glimpse dusky shapes labouring among the aspens, busily engaged felling trees, severing branches, and dragging them to the water, but it was always a case of the ear assisting the eye to know exactly what was going on.

I am unable to offer any information regarding whether beavers work in pairs when felling trees. My opinion is that it is an individual operation. However, once the tree is down team work is evident to remove the branches and convey them to the pond.

Repairs to the lodge and dam are performed with less caution and during twilight. The beavers at the sites under observation were often seen during the autumn, plastering and building up these structures with muck and sticks. The muck is usually secured from the bottom of the pond, but quite often from the neighbouring shallows. It is carried clasped tight with the "hands" to the beaver's breast which, when on land, means that the animal walks on its hind legs, balanced by the tail.

At this time sticks are gathered from the nearest willows, or branches taken from a supply recently brought to the water when lumbering operations were in full swing. Sticks and branches that happen to be of a length unsuitable to the beaver's needs are either cut on the incline of the lodge or crest of the dam, as the case may be, never in the water.

The method of handling long sections of material brought to the dam or lodge to be utilized for construction purposes or repairs is interesting, and indicates a degree of perception in order to avoid unnecessary exertion incidental to dragging an awkward load up steep banks or inclines. The technique employed is similar to the manner in which a human being would work under like cirsumstances, except, with the beaver, teeth are substituted for hands. Arriving at the water's edge with the material in tow, the beaver emerges and places the end of the stick or limb on land. It is then skidded up the slope a few inches by a side movement of the beaver's head. A fresh hold below is then taken, and the operation repeated until the load is clear of the water and either located in a permanent position, or placed where it can, if necessary, be conveniently severed. Shorter material of less weight is dragged directly from the water to wherever desired. To move heavy sections of aspen and small severed trees cleared of branches, the weight of the body using the shoulders or breast as the point of contact, is employed. The tail assists as a brace. I do not think, though, that this method of moving material is applied, except to shift heavy and unwanted pieces out of the way.



Aspen poplar. Note the lateral tooth grooves in this and succeeding photographs showing that the beaver's head is held sideways while scarfing a standing tree.

The crown of this aspen poplar became entangled in the branches of a nearby tree. It fell some days later.

Photographs by H. U. Green.

Mention has been made of beaver paths, and as they are also associated with lumbering activity they may, at this time, be described and discussed.

My observations indicate that the making of a path is the first consideration after a cutting area is selected, for otherwise it would be impossible to remove material from elevated benches to the water owing to interfering growth. Aspen stands situated immediately beside the ponds seldom present any difficulty, especially when close to the water. In this case, the use of prepared and well-defined routes is seldom necessary.

When clearing a path the vegetation is removed to a width of from four to five feet and the length determined with due consideration to an unnecessary distance intervening between the canal, or the water's edge, and the margin of the selected stand. Should a windfall tree lying close to the ground be encountered, the part forming the obstruction is cleared away, unless it is posible to remove the tree in its entirety. On the other hand, if sufficient space beneath the obstruction permits the passage of branches without fear of entanglement, the path passes underneath. When stumps occur, singly or together, a detour is invariably made.

After a lumbering area is extensively cut over, it often happens that the head of the original path becomes too far removed for convenience. Should this occur and the stand is not abandoned, a new path is prepared if the working location is closer to the pond by another route. My contentions are based upon observations made at Site No. 2, where a change of route was deemed advisable during the harvesting operations of 1930. For some reason which I was unable to determine, the new, or second path, was neglected in favour of the original route by the beavers introduced to the pond in 1933.

When an inclined beaver path exists beside the water's edge or, as at Site No. 2, at the head of the canal, it is believed locally that the beavers keep it in a wet state when harvesting operations are in full swing, for the purpose of aiding the descent of material en route from the cutting stand to the pond. How the water is conveyed from the pond to the inclined path, is not disclosed! I think, however, that the belief arises from the fact that dripping bodies emerging from the pond naturally keep the landing place and the immediate vicinity in a muddy condition. There is usually an explanation for ill-considered local lore.

PONDS

The discovery of an inhabited beaver pond is like finding an unknown family in the forest. The dam, the lodge, and other evidence of a wide understanding necessary to make the valley of a small stream a habitable place in which to live through the years, cannot fail to excite the admiration of every enquiring mind. To work with sympathy, yet with scientific exactitude, seeking to recognize the beavers' works and ways, is to be impressed that something beyond mere instinct, specialized though it may be, enables them to accomplish feats of engineering skill that are the wonder of mankind.

Well I remember the day in August, 1929, when exploring the valley of the Vermilion River for signs of beaver and wapiti. Many old dams and lodges had been investigated and photographed. Then, near evening, almost at the moment I began to retrace my steps toward the Dauphin — Clear Lake road and home, the resounding slap of a beaver tail on the surface of the water, caught my ear. It seemed too good to be true. Within a week three inhabited beaver ponds had been found a stone's throw from a passable road thirty miles from home, and near a comfortable cabin which later became the base for beaver and wapiti investigation.

But for the discovery of these inhabited ponds my study would have been impossible. And, as they are directly connected with the beavers under observation, they alone have been selected for description. Each is representative of ponds which exist, and have existed, elsewhere in the Riding Mountain. As previously stated they received their identification as Sites Nos. 1, 2 and 3.

Site No. 1 is situated in a beautiful location between heavily wooded slopes of aspen poplar, interspersed with an occasional white spruce. Almost a mile in length, with an extreme width of 137 feet, the pond is the largest inhabited beaver site I have found in the Riding Mountain. Through its entire stretch the well-defined submerged channel of the Vermilion flows, entering the pond by way of a narrow gorge, beyond which the Kennice Meadow lies in a deep forest-fringed basin approximately a quarter of a mile wide and over a mile long. The Kennice Meadow is flooded in the spring and early summer by backed-up water from the pond. At the

Beaver-cut trees are sometimes hung up. This aspen poplar fouled another on the edge of the stand.

Game trail beside the lower pond at Site No. 2 used on occasion by the beavers to cross a bend in the Vermilion River.

Photographs by H. U. Green.

gorge, the Vermilion is within a mile of its source,—a number of small overflowing springs. The springs and the natural drainage from the Kennice Meadow basin provide the water supply for the pond, which often fluctuates during the summer months depending upon the amount of local precipitation.

The deepest part of the pond is the submerged river channel, where depths of from 6 to 8 feet have been recorded within 300 feet of the dam. Towards the gorge, the channel has evidently silted up, as only from 3 to 5 feet of water is general at normal pond level. Near the dam, several water-killed aspen poplars and small white spruce stand stark and grey amid broken stumps protruding a few feet above the surface, creating anchorage for rafts of pond weed floating at the whim of every changing breeze. Towards the Kennice Meadow basin the shores are flanked with tules, sedges, cat-tails and lush vegetation, and here and there lily pads blotch the surface of sheltered coves. Many mallard and pin-tail ducks hatch broods of fluffy youngsters among the grass near the shallows, finding enjoyment and sanctuary where the sound of guns is never heard. In the spring and fall, flights of migrant waterfowl dip to the surface to rest while pursuing a hurried way to or from the breeding areas of the north. For several years a solitary bittern has built her nest in the rank vegetation below the dam. Muskrats too, and even tiny fish, profit by the beavers' labour which, in truth, has created a generous environment for many creatures. And so, in the basin of the Kennice Meadow, marsh grass grows where, but for the beaver pond, there would be little available to winter herds of hungry wapiti and provide tender forage and water during the heat of summer days. To me there is an indescribable something about this pretty location always so tranquil amid the sheltering trees, except for an eternal breeze moaning through the valley when all else is still. Not a mar or scar of human origin is near to dispel the thought that a hundred, yes, a thousand years, could have witnessed what one sees to-day.

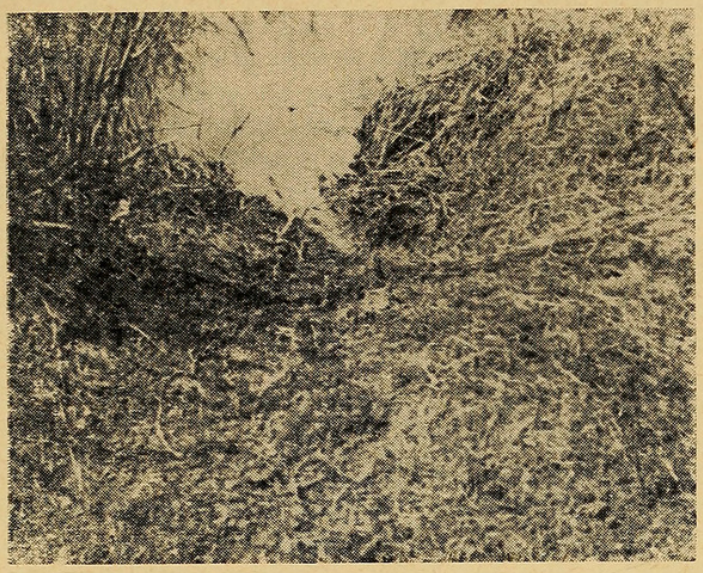
The pond at Site No. 2, situated in the same valley two miles below Site No. 1, is bare and drab in comparison, and entirely different in character and surroundings. Only the south bank is treed with aspen poplars and a few white spruce. The north bank is bare, lined with game trails, and strewn with many boulders of limestone, granite, and gneiss. It forms the southern border of the Kennice Plains, a semi-open area of aspen poplar and willow growth, intersected by shallow ravines.

Site No. 2 is in reality two ponds, separated by a short stretch of the river's course. The upper pond, 158 feet across at its widest part, terminates 607 feet above the dam and spreads out to create a soggy marsh filled with nigger-heads and willow clumps through which the river overflows. The lower pond is 105 feet wide and approximately 160 feet long, almost clear of obstructions with the exception of a few water-killed willows near the water's edge. In this respect it is similar to the upper pond. As near as I was able to ascertain, the surface of the lower pond at the time of calculation was about 7 feet below the surface of the upper one.

Although nearly sufficient river water is restrained at the time of the spring freshets and summer rains to keep the ponds full, neither is entirely dependent upon these sources of supply, for both are generously fed by several springs which, except during severe winter weather, flow throughout the year. For this reason the ponds, barring damage to the dams, are always brim full. In this respect they differ slightly from Site No. 1, for although the pond at this location is in a measure also spring fed, the distance from the source of supply precludes the possibility of receiving more than a small percentage of the output. Thus it was found that the level of Site No. 1 during the summer months was below normal when the ponds at Site No. 2 were full. The lower pond at Site No. 2 in addition receives the overflow from the upper pond.

The deepest part of the upper pond at Site No. 2, as at Site No. 1, is the submerged channel of the river, where a depth of 6′ 8″ has been recorded, and in the lower pond, the deepest place found, in this instance near the south bank, was 5′ 6″. Both ponds fill the valley from bank to bank. A strip of willow growth, however, intervenes between the two, broken by the river's course.

Site No. 3 is situated in the valley of Spruce Creek, a tributary stream of the Vermilion River, which is joins a little over a mile away. The location is somewhat similar to Site No. 1, except that the valley is deeper, of greater width, and more heavily wooded with aspen poplar. An ever-flowing spring, the source of Spruce Creek, one and a half miles above the pond, ensures a constant water supply during the open seasons, even in the driest years. Only



Beaver landing place in upper pond at Site No. 2. No paths lead away to the vicinity.

Photograph by H. U. Green.

in very severe winter weather is the output subdued. Generally the creek is found flowing beneath shelving sheets of ice when the temperature is low. When the winter is comparatively mild, or constantly broken by periods of warm weather, the water may reach the pond. This occurred on several occasions during the winter of 1930-1931. In the spring, freshets of melted snow and rain come tumbling down the creek, quickly filling the pond if the supply from the spring has been negligent during the winter months or much leakage to the dam has inadvertently occurred.

The greatest width of the pond at Site No. 3 is 156 feet, and the length about 750 feet. The extreme depth at normal water level was found to be 6′ 5″. Little or no lush grass grows about the water's edge, except towards the upper reaches, which spread out to the right and left of the pond proper to form a small marsh. Cattails and sedges are entirely absent, but many willows flourish beside the banks, and water-killed clumps almost obscure the site from view.

Throughout the length of the pond no definite creek channel could be located, which led me to believe that it has long since silted up level with the submerged banks.

The locality is pervaded with an atmsophere of extreme loneliness. For want of shelter and lack of suitable nesting sites no waterfowl frequent the pond, and, except for evidence of beaver activity, not a sign of animal life is visible in the surrounding forest. To be sure a game trail here and there follows the slopes of the valley, but for some reason best known to themselves passing animals decline to drink from the pond, sweet and fresh though it is. As at Site No. 1, an eternal breeze moans through the valley when the forest above gives no hint of wind. No wonder the local Indians believe the Riding Mountain to be the abode of evil spirits, for many times, especially at night, I have been tempted to think so myself.

About the banks of each pond there are several recognized landing places used by the beavers when leaving the water for their excursions on land. These were never found in exposed positions. They are invariably well sheltered by shrubs and bushes and usually connected with the pond by a short canal cut into the bank, filled with water of swimming depth. From the head of each canal well worn paths are in evidence, leading to places a short distance away where favoured food can be found. The paths have no connection whatever with lumbering activities in a general sense. These were found to be separate and distinct in the localities under observation and used for no purpose other than to convey the harvest of winter food to the pond and to secure material for building and repairs. At each pond, too. one or more places were observed indicating that the beavers left the water without proceeding further on

land,—much frequented, usually wet, and smelling strongly of urine and possibly castoreum. Reference has been previously made to this observation.

It is a rather significant fact that, with few exceptions, all the beaver ponds in the Riding Mountain surveyed by myself depended to a great extent on the output of nearby springs for a water supply. Thus it would seem that the beavers when seeking a location to build a home give as much consideration to this very desirable attribute as to the presence of a generous food supply. Without a constant addition of water to the pond it is very doubtful whether the occupants could exist with any degree of certainty from year to year, for while freshets give sufficient depth during the early part of the open season the streams often cease running throughout their course by midsummer. The necessity of a water supply not entirely dependent upon precipitation to replace evaporation and the large quantity consumed by game animals is of vital importance when it is realized that deep water is essential for winter survival. Should the pond be of insufficient depth near the lodge the winter food supply would be frozen in and in all probability the beavers, imprisoned beneath the ice, would perish from starvation. To rely upon autumn rains to brim the ponds is to flirt with disaster. In consequence I am led to believe that the selection of locations for home building near where springs exist is not a random choice, but an intelligent decision.

The depth of ice that will form on a beaver pond (as in water elsewhere) depends not only upon low temperatures, but is governed in no small degree by the amount of snow, which acts as a protective blanket on the ice surface. The heavier the snowfall the thinner the ice. This is particularly noticeable if, soon after freeze-up, a heavy fall occurs. When this happens the ice never attains the same thickness as it would if heavy snow fell later in the season.

Sometimes during the winter a small leak will occur in the retaining dam and the water beneath the ice is slightly lowered, thus creating an air space between the ice and the water. In this case the ice above is prevented from attaining additional depth. The water beneath, however, eventually freezes over. To what extent beavers take advantage of an air space, I cannot say, but there seems no doubt that a wonderful opportunity would present itself to swim about with their heads above water until ice formed. A subsequent chapter relates how otters breached a beaver dam presumably for the purpose of creating an air space beneath the ice in order to fish in the pond.

The following is a comparative table of the depth of ice and snow on the ponds under observation recorded in the month of January during the winter seasons 1930-1931 and 1931-1932:

	1930-1931		1931-1932	
	SNOW	ICE	SNOW	ICE
Site No. 1	4″	20″	22″	16″
Site No. 2				
Upper pond ...	4.5″	21″	23″	16.5″
Site No. 2				
Lower pond	4.7″	20.5″	23″	17″
Site No. 3	5″	22″	25″	19″

The age of the ponds at Sites Nos. 1, 2, and 3, is questionable. All, though, are many years old, judging from the appearance of the dams and cut-over areas thereabouts.

No mention has been made of the beaver of the Riding Mountain inhabiting lakes, for the reason that to date there is no evidence that would show that they have ever favoured large bodies of water in preference to ponds of their own creation. They are "creek" beavers if one may use a coined term of differentiation.

(To be continued)