Ph. D. Thesis, Univ. of Mich. (Unpublished).

WALLACE, RAYMOND H. 1937. Methods of sampling visible radiation. Plant physiology, **12**: 647–666.

WIGHT, H. M. 1938. Field and laboratory technique in wildlife management. Univ. Mich. Press, Ann Arbor, Mich.

WRIGHT, J. G. 1943. Measurements of the degree of shading or crown canopy density in forest sites. Forestry Chronicle, **19**: 183–185.

TRANSPLANTING BEAVERS BY AIRPLANE AND PARACHUTE

Elmo W. Heter
Idaho Fish and Game Dept., McCall, Idaho

For a number of years Idaho's Fish and Game Department has been transplanting beavers from areas where they exist in abundance and may be causing damage to irrigation systems, orchards, and other plantings. In territories to which they are moved beavers usually set up colonies, multiply, and establish important fur-bearing populations. In addition, they do much toward improving the habitats of game, fish, and waterfowl and perform important service in watershed conservation.

Sites which are to receive beavers are selected by Conservation Officers of the Fish and Game Department, after consultation with the state Fur Supervisor, and with local Forest Service officials. Live animals are delivered by the Regional Caretaker-Trapper, who is required to supply for this purpose 10 per cent of the total number allotted to him for pelting in any given year.

Experience has shown that young animals, preferably from one colony, transplant most successfully. They are less pugnacious than older individuals; they do not tend to migrate readily; and they will give more years of service than mature beavers. However, the sexing of young beavers is difficult. The best results have been obtained by planting four beavers at a time; usually one male with three females. However, when the animals on hand make that sex ratio impossible, it is best to plant two females with two males.

July and August seem to be the ideal months for transplanting beavers. Earlier in the year they tend to migrate; later in the year, and particularly at high altitudes, they do not have time to become properly entrenched before winter is at hand.

In those states which are well populated and comparatively level, or have many miles of back country roads, the transportation of live animals is neither difficult nor expensive. In Idaho, the mountains, heavily forested country, lack of roads, and generally inaccessible wilderness areas have complicated the beaver-transplanting program.

The former method of transportation was arduous, prolonged, expensive, and resulted in high mortality among the beavers. A typical schedule might be the following: Beaver were packed on horses or mules for several days, from the locality where the animals were live-trapped, to the trapper's truck. After enduring a hot and dusty trip, they were delivered to a Conservation Officer. They arrived so late in the day that they must be held over night. Next day another truck ride was necessary to the end of the road nearest the site selected for planting. Once more they were loaded on pack stock and subjected to more handling, heat and jolting.

Beavers cannot stand the direct heat of the sun unless they are in water. During transportation they must be constantly cooled and watered. Sometimes they refuse to eat. Older individuals often become dangerously belligerent. Rough trips on pack animals are very hard on them. Horses and mules become spooky and quarrelsome when loaded with a struggling, odorous pair of live beavers. These problems involve further handling and too frequently result in a loss of beavers.

It was evident that a faster, cheaper, and safer method of transportation was a vital need. The use of planes and parachutes has filled that need.

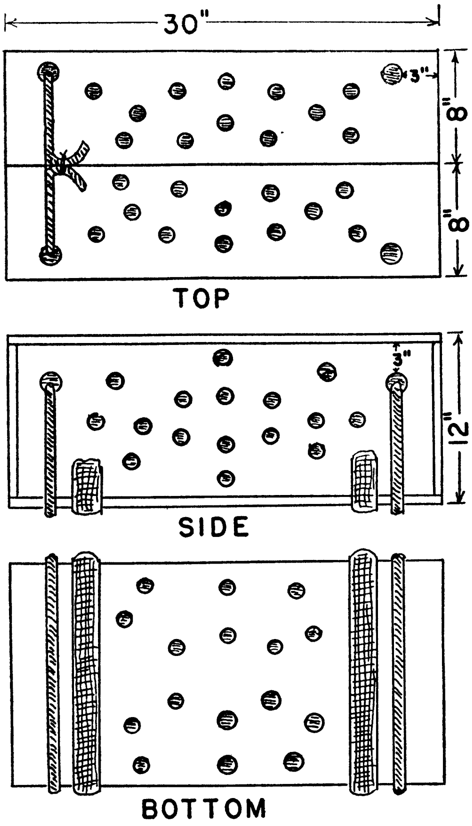
Parachutes of various sizes and materials were employed during experiments with dummy weights. The most satisfactory results were obtained with a 24-foot rayon parachute of war surplus stock, procured from the Forest Service. The Forest Service was using a modified pack which travels right along with the 'chute. It is a heavy canvas sack in which any recovered parachutes may be replaced quickly without intricate folding, This parachute has a carrying capacity of 140 pounds. The box now in use, holding two live beavers, weighs between 80 and 105 pounds. Such a load is great enough to open the 'chute readily and keep the box securely shut during the descent, yet it is light enough to land very gently.

The first box tried had ends made of woven willow. It was thought that, since willows were a beaver's natural food, the animal would gnaw his way to freedom. This method was discarded when it was discovered that beavers might chew their way out of these boxes too soon, and be loose in the plane, or fall out of a box during the drop. Packing a pair of beavers in one box made it possible to halve the number of 'chutes used, and the cost of a double capacity container was not nearly double that of a single container. Also it was found that when two animals land at the same time there is less tendency for either to migrate immediately.

The box consists of two lidless boxes fitted together to open as a suitcase does (Figure 1). It is made of four-quarter surfaced lumber, #4 common grade. It is 30 inches long, 16 inches wide, and 12 inches deep, and weighs about 20 pounds. One-inch holes drilled through the walls provide ventilation. Two ten-foot lengths of half-inch sisal rope are fastened across the bottom, approximately 3 inches from the ends. These ropes are secured to both sides of the bottom with box nails, put through and clinched. The ropes thus act as hinges. The ends of the ropes are carried up each side, put through holes about 3 inches below the box top, and emerge through a second set of holes about 1 inch in from the outer edge of the box top. These holes are drilled at an angle from the outer and lower surfaces so that when the ropes are drawn through and strain put on them, no binding or cutting occurs. The two ends of each of these sling ropes are joined in a square knot. Approximately 1 inch in from each sling rope, and crossing the bottom of the box but not fastened to it, is a heavy 2 inch rubber band. These elastic straps extend 3 inches up each side of the box, and are fastened there with fence staples. They are cross-sections of heavy duty truck tubes so that they form double spring hinges. Each band exerts about 10 pounds of tension, which is sufficient to snap the box open and free the beavers as soon as the much greater tension of the shroud lines is removed when the box lands on the ground and the 'chute collapses.

When two beavers are put into one of these boxes it is shut and the sling ropes drawn together at the opening. Two turns of four strand linen cord are wrapped around each of these joinings, and tied with a surgeon's knot. This lashing is quite strong enough to prevent the box's opening during loading or flight, but the shock which occurs when the box is tossed out of the plane breaks them. The weight of the loaded box is more than enough to keep the box closed during the descent.

The hook up for plane, parachute, and box, is described in the order of its arrangement. In the plane is installed an ordinary cargo dropping static line, usually from 6 to 12 feet of $\frac{1}{2}$ inch manila rope, which allows the beaver box to clear the open door by one foot. To the end of this static line is spliced a heavy harness snap. The canvas bags for the parachutes have draw strings at both top and bottom. At the top of the pack, and affixed to the apex of the



BEAVER DROPPING BOX

FIG. 1. Diagram of box in which beaver are dropped by parachute.

chute by two turns of eight strand linen cord, is a sturdy harness ring. One long piece of six strand linen cord is laced back and forth through the grommets at the mouth of the pack, and should be passed through the harness ring at least twice. This lacing, which is broken later, is used instead of a drawstring to hold the pack securely closed. The ends of the shroud lines at the bottom of the pack are fastened to a three-foot length of $1\frac{1}{2}$ inch heavy canvas webbing. To one end of this webbing strap is sewn a harness snap, and to the other end, a D-ring. It is this webbing loop, passed through the upper bights of the two sling ropes on the box, and its ends snapped together, which holds the box during the drop. When the box is thus secured to the shroud lines, the snap at the end of the static line is hooked into the ring affixed to the 'chute's apex, and everything is ready for the drop.

When the box is tossed out, the initial shock breaks, first the sling rope lashings, and then the cord holding the pack closed. The 'chute is drawn rapidly out of its pack and, when the whole hook up becomes taut, the final strain breaks the eight strand cord holding the 'chute's apex to the harness ring on the static line. The 'chute opens quickly, and the whole operation takes only a few seconds.

In our operations a Travelair was used, which carries pilot, Conservation Officer, and eight crates of beavers. The targets chosen are usually small, open meadows through which the selected streams run.

The best altitude for launching is between 500 and 800 feet. This height assures sufficient time for the 'chute to set the box down gently. Yet, it is low enough for accuracy in placing the box in the selected meadow, and to avoid trees or other obstacles in which the 'chute and box might become entangled.

Satisfactory experiments with dummy weights having been completed, one old male beaver, whom we fondly named "Geronimo," was dropped again and again on the flying field. Each time he scrambled out of the box, someone was on hand to pick him up. Poor fellow! He finally became resigned, and as soon as we approached him, would crawl back into his box ready to go aloft again. You may be sure that "Geronimo" had a priority reservation on the first ship into the hinterland, and that three young females went with him. Even there he stayed in the box for a long time after his harem was busy inspecting the new surroundings. However, his colony was later reported as very well established.

In the fall of 1948, 76 live beavers were dropped with only one casualty. On the first drops, light weight lashings were used on the sling ropes, and one of these broke before there was sufficient tension from the shroud lines to hold the box closed. One beaver worked his head through the small opening thus made for him, and managed to climb out onto the top of the box. Even so, had he stayed where he was, all would have gone well; but for some inexplicable reason, when the box was within 75 feet of the ground, he jumped or fell from the box.

Observations made late in 1949 showed all the airborne transplantings to be successful. Beavers had built dams, constructed houses, stored up food, and were well on their way to producing colonies.

The analysis of costs of this method of transplanting beavers showed a marked saving. The expense of transplanting four beavers is approximately as follows:

Cost of two boxes	$ 2.00
Cost of two cargo 'chutes	16.00
Flying time for 1 planting	12.00
Total	$30.00

This reasonable cost is reduced in practice because packers, game department men, ranchers, and Forest Service employees pick up and return some of the 'chutes. Enough are returned in good condition to lower the cost per transplant to less than $16.00. The savings in man hours, and in the mortality of animals, is quite evident. Sex ratios are maintained. The beavers are healthier, and in better condition to establish a colony.

FISH AND SHELLFISH MEASURING DEVICES

Leslie W. Scattergood
U. S. Fish and Wildlife Service, Boothbay Harbor, Maine

A great many investigators in the field of fishery biology are concerned with studies of marine or fresh-water populations of fish or shellfish and, consequently, much of their effort is devoted to acquiring a knowledge of the age, growth and racial characteristics of the species involved. Information on these problems is largely obtained from measurements of the various parts of the bodies of the organisms. Differences between the age, growth and morphological characters of various populations or races of a species are often small; therefore, it is usually necessary to employ relatively large masses of data to establish whether or not a significant dissimilarity exists. Because of the need for measuring large numbers of individuals, fishery biologists have devised a number of instruments which enable them to collect linear measurements in both an accurate and facile manner.

I have been prompted to discuss this matter of measuring fish and shellfish by the reading of an article by Hiatt and Hamre (1945) in which a description is given of a measuring device which has been used in an improved form by fisheries men both on this continent and in Europe for many years.

It is, of course, always difficult to determine the original inventor of any device. Many ingenious devices have no doubt been used for specific problems, but have never been described in the literature. As a rule, emphasis is placed on the results of the observations and experiments rather than on the exact means by which the data were measured.

Recently, how to measure the length of a fish has been thoroughly discussed by Ricker and Merriman (1945) and Hile (1948). These authors have listed eleven methods of measuring fish lengths. Of these eleven, three refer to total lengths measured from the anterior end of the fish (this point usually being the tip of the jaw) to the extreme points of various parts of the tail fin. The measuring of total length can be readily and accurately effected by a simple board with a "head stop" and a graduated rule. The method of recording on celluloid sheets the total lengths by perforations at the point of measurement, as mentioned by Buchanan-Wollaston (1928) and Thompson (1929) is advantageous when one is interested in securing length frequencies of the populations. The other eight measurements are "standard" lengths, which involve distances between the anterior end of the fish and various anatomical