

Paper 7

Fishing Behaviour of Alaska Brown Bear

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INTRODUCTION

Each summer 60 to 80 brown bears (*Ursus arctos*) congregate at McNeil River Falls, located 320 km southwest of Anchorage on the Alaska Peninsula, to fish for migrating chum salmon *Oncorhynchus keta*. The falls impede upstream movement making salmon vulnerable to bears. As many as 25 bears may fish simultaneously, many only a few metres apart. Many bears stay at the falls over 30 days each summer and return yearly. Because we can observe so many bears throughout a fishing season and during subsequent seasons, McNeil Falls provides an excellent opportunity to study prey-catching behaviour and its development in a natural situation.

The purpose of our study was to describe brown bear fishing behaviour, its development, and its relation to environmental and social factors. This paper describes fishing behaviour and its relation to salmon abundance. Elsewhere in this volume (Paper 4) Egbert and Stokes report on other factors influencing fishing success, notably time of day and status of the bears.

METHODS

During 1972 and 1973, we spent 25 consecutive days each summer watching the bears fishing. Observations were for five hours daily between 1400 and 2200 hours (Alaska Standard Time) from a cave 10 m from the river.

We observed 16 bears regularly in 1972 and 14 of the same 16 in 1973. They ranged in age from 3.5 to 22 years. Individuals were recognized by ear tags, scars, facial and body characteristics, and behaviour.

To measure salmon abundance we counted the number of times a fish broke the surface of a large, deep pool near the cave in a two-minute period each half hour. The average of the half-hour counts for each day provided an index of relative salmon abundance. This index compared closely with the rate of catching fish by bears and the number of fish observed in the pool.

We used a super-8mm ciné camera and a 35 mm still camera to record behaviour for later analysis.

RESULTS

Fishing for salmon at McNeil River is a cultural tradition among bears. Many of the same bears return year after year, and females bring their young to maintain the tradition. Some bears appeared only for brief visits but most fishing was by bears that returned regularly each summer. Bears had a wide choice of specific fishing locations. A suitable location had to be where salmon could be caught profitably. The omnivorous bears could always return to eating plants should fishing not be sufficiently profitable.



Fig. 1 Bears fishing at McNeil Falls.

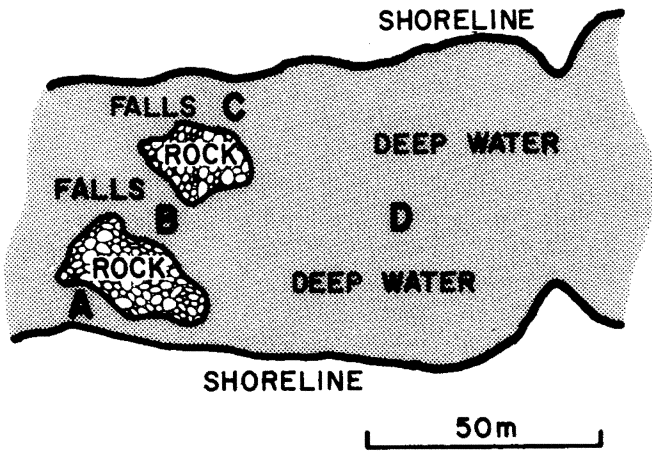


Fig. 2 Map of McNeil Falls showing points of salmon movement.

Choice of Fishing Location

The topography of the falls greatly affected salmon availability and, in turn, preference for fishing area. The falls consist of large rock slabs flanked by bare rock shorelines, creating rapids and pools of varying depth (Fig. 1). In one deep pool (D in Fig. 2), salmon congregated before ascending the falls. At high water level, they could ascend at points A, B, and C. At low water most salmon moved upriver through the deep rapids at C. Bears preferred to fish

at point C because the shore provided good fishing locations at all water levels. Fish were especially vulnerable wherever they momentarily halted in their upstream movement: at the head of eddies along shore; in shallow pools half-way up the falls; and wherever their upward struggle was halted by the force of the current. They were virtually secure as they milled about by the hundreds in the deep pools below the falls.

A bear's size influenced its selection of fishing location. Some fished regularly by standing waist-deep in rushing water that would have swept humans and smaller bears off their feet. Bears usually left a fishing location to eat the fish, the more subordinate ones going up the banks into the adjacent alders where they were free from disturbance.

Social status also influenced the fishing area selected. Large adult males, who topped the social hierarchy, used the preferred locations near point C, as did a few large adult females, but usually only when large males were absent. Lower status bears used the remaining areas of the falls.

We recorded 50 fishing locations, of which 14 were used frequently. Individual bears often used from one to three locations. Although social status divided fishing areas, individuals preferred certain locations within an area. For example, one large subadult male generally had free access to several locations within a small area of the falls without being threatened by other bears. But he continually used only one of those locations.

The combination of social status and salmon availability effectively controlled where bears fished. The higher a bear's status the more easily could it explore different fishing areas. Once it had found a productive location, it could remain there until displaced by a higher ranking bear. This system was beneficial at McNeil Falls because it allowed division of the food resource and younger bears to gain proficiency at fishing.

Technique Use

Fishing involves three steps: orientation, approach, and capture, each with several forms (Table 1). Orientation components are self-explanatory. One of the several forms of approach, the lope, was a slow run; plunging was a quick movement into the water from an orientation position. In 'head under water' a bear appeared to be searching for fish, often moving its head back and forth. Since loping and 'head under water', when they occurred, preceded plunging, these components were subdivided making possible four-part techniques. For actual capture, a bear could use forepaws alone in which its forepaws pinned a fish to the bottom, then lowered the head to grasp the fish with the mouth (Fig. 3). In 'forepaws and mouth' capture bears used both paws and mouth simultaneously to capture fish. Bears used only their mouth in the

TABLE 1. BASIC COMPONENTS OF FISHING TECHNIQUE

Orientation	Approach	Capture
Sitting	Loping	Forepaws
Standing	Head under water	Forepaws and mouth
Walking	Plunging	Mouth
		1 forepaw
		1 forepaw and mouth

'mouth' capture. The last two capture components listed in Table 1 are similar to the first two except only one forepaw is used.

Any combination of the components in these three parts to fishing we call a technique. For example, the combination of standing-plunging-forepaws and mouth is one technique (Fig. 4, a and b).

Of 90 possible techniques, bears used 37 in 1972 and 43 in 1973. Individuals used from 9 to 28 techniques with old bears using fewer than young bears. We thought bears would use fewer techniques over the weeks as they learned the most efficient techniques. This was not so. Three techniques were used in about half of all attempts both years (Table 2). Bears changed technique very frequently, after a mean of 1.4 attempts both summers.

To some extent the technique used depended upon salmon abundance. Many infrequently used techniques were more efficient (fish caught per attempt) and were used more when salmon were abundant. For example, the 'walking-plunging-forepaws and mouth' technique increased in use from 3 percent in 1972, a poor salmon year, to 7 percent in 1973, a good salmon year. There was a corresponding increase in efficiency from .12 to .40 fish caught per attempt. This was a significant increase considering that the most preferred technique was used in only 20 percent of all attempts.

The varied topography of the falls and changes in salmon abundance and water level coupled with a bear's frequent change in location seemed mainly responsible for the steady use of many techniques and the high frequency of change in technique.



Fig. 3 A bear exhibiting the forepaws only component of capture. Note that the head is up during the plunge.

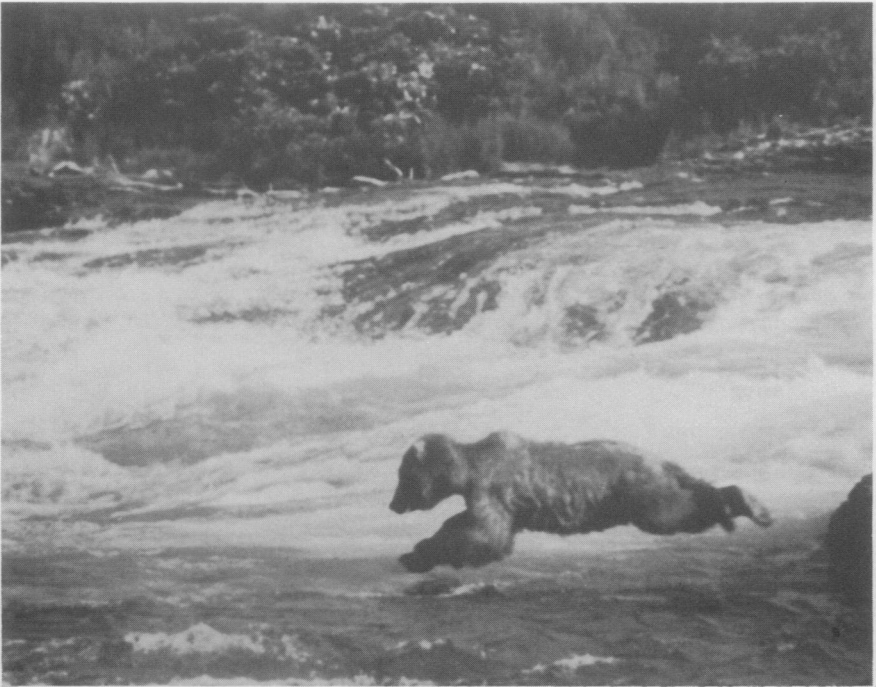
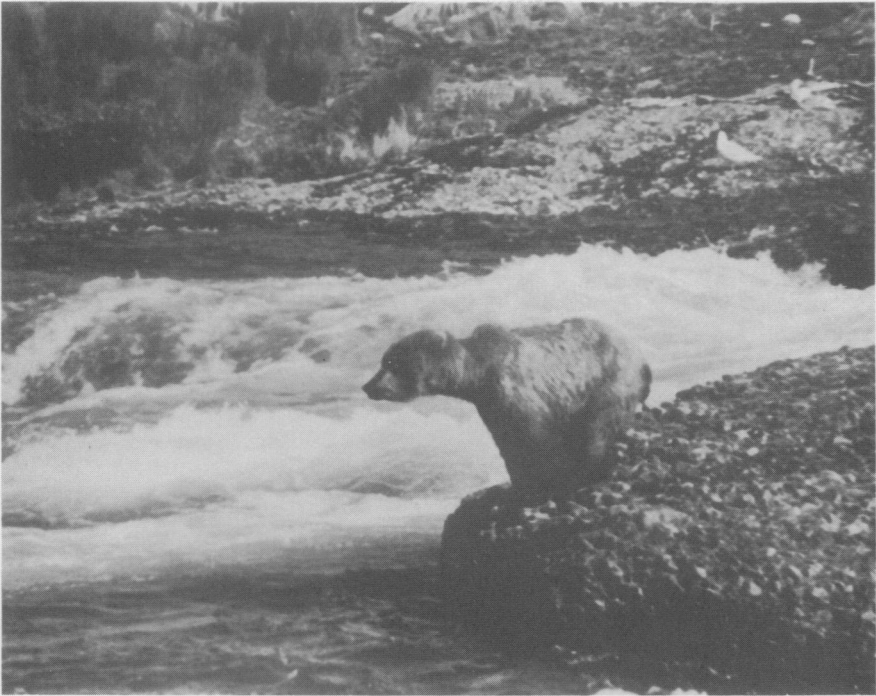


Fig. 4 a and b. A bear exhibiting the standing-plunging-forepaws and mouth fishing technique.

TABLE 2. EFFICIENCY AND RELATIVE USE OF THREE MOST FREQUENT FISHING TECHNIQUES

	<u>Use*</u>		<u>Efficiency**</u>	
	1972	1973	1972	1973
Standing-plunging-forepaws/mouth	23	20	35	55
Standing-plunging-forepaws	19	8	9	11
Standing-mouth	10	18	25	44
Number of attempts	781	1178		
Salmon index			21	99

* Percent of all attempts.

** Fish caught per 100 attempts.

Fishing Efficiency and Fishing Success

The three most frequent techniques were also the most efficient (Table 2). Bears in general used those techniques which worked best for them. An exception was the 'standing-plunging-forepaws' technique in 1972. This high use of an inefficient technique was due to low salmon abundance. Bears were making many half-hearted attempts, using this technique on fish which were not close enough to be caught. Bears did not waste much energy at these low-return attempts, for there was little time or motion involved.

Technique efficiency improved with salmon abundance from 23 percent in 1972 to 42 percent in 1973 (Table 2). In fact, 56 percent of the variation in efficiency was related to salmon abundance (analysis by linear regression, $r^2 = .56$). Much of the remaining variation was due to high fishing efficiency the first week of each fishing season. Despite the scarcity of salmon at that time, the few bears present had little competition, so could select the most favourable fishing locations.

Fishing success (fish caught per hour of effort) also increased with salmon abundance. In 1972 bears caught 1.5 fish per hour, while in 1973 they caught 2.8. Seventy-three percent of the variation in success was attributed to salmon abundance (analysis by linear regression, $r^2 = .73$).

Changes in Fishing Locations

When fishing was poor a bear changed its location or its method of fishing. In 1972, bears changed to a new location after a mean of 3.4 attempts at one place, with a range of 1 to 33 attempts. In 1973, they changed location after a mean of 2.5 attempts, ranging from 1 to 25 attempts. This more frequent change in 1973 was related to high salmon abundance. With more salmon there were more attempts and at more locations. For example, if a bear were unsuccessful at one location its chase of the fish might carry it into another adjacent location. With so many salmon in 1973, the bear might immediately spot another fish and attempt to catch it from the new location. In 1972, bears were unlikely to see a second fish, so tended to return to their original location, where presumably they had worked out a suitable fishing strategy. Good

fishing was a second factor contributing to more frequent change of location. When a bear left a preferred location to eat its fish away from the falls, this let bears of lower status temporarily use these locations in addition to their regular more inefficient ones.

The second way to improve fishing success, changing the method of fishing, was also common. In both years bears changed technique after an average of 1.4 attempts. Undoubtedly many of these changes were matching of a technique to the particular situation in which successive salmon were seen. But other changes probably stemmed from the low rate of reinforcement from a particular technique.

DISCUSSION

A characteristic of bears at McNeil Falls was the constancy of their return throughout a season and from one season to the next. We rarely saw a newcomer establish itself permanently in the two years of intensive study. Those bears that did appear sporadically stayed so briefly we generally didn't learn them well enough to identify in later years. The high intolerance between bears probably discourages newcomers. Cubs brought to the river during the two or three years they stayed with their mother could work their way gradually into the hierarchy and into competitive fishing situations. In general, after weaning at 2.5 years of age, cubs moved about below the falls looking for scraps of discarded fish. Gradually they worked farther and farther into the central fishing locations, stealing fish from satiated larger bears and even doing a little fishing. Few bears entered the fishing circle at McNeil Falls until fully mature at six or more years of age.

This behaviour is in contrast to that at smaller streams. On the small tributaries leading into Becharov Lake farther south on the Alaska Peninsula, Derek Stonorov (pers. comm.) regularly observed younger bears fishing. On such streams bears could spread out over much greater distances to avoid competition, the lower-status bears going farther upstream where fishing was less good.

We observed fishing for red salmon *Oncorhynchus nerka* along nearby Mikfik Creek. Fish were available over most of the stream albeit in less abundance. On Mikfik Creek bears rarely staked out a fishing location; instead they fished for a few minutes only, then moved along the stream. Such streams with low fish abundance are not likely to generate the strong homing tradition seen in McNeil River bears. This sort of fishing situation would seem much easier for bears unable to withstand the heavy competition at McNeil River Falls.

Observations in other areas on how bears fish differ in part from ours. George Frame (pers. comm.) observed black bears *Ursus americanus* fishing in south-eastern Alaska. Black bears fished by plunging into the creek, running through the water, and leaping upon a fish and capturing it with their mouth. Since he does not give any orientation components, we cannot be sure how many techniques his bears actually used based on our classification system. Using our orientation components there would be at least four techniques. This is much less than our 37. Clark (1959) also describes only one technique for brown bears fishing at Karluk Lake, Alaska. These bears used the forepaws to pin the salmon to the bottom before grasping it with the mouth. Frame never observed this technique. Similarly, W. B. Sisson (pers. comm.) observed that brown bears fishing at Kodiak National Wildlife Refuge use only two techniques. In one creek where fish were emaciated, bears would capture

them with just the mouth. In other streams where fish were more lively, bears would herd fish toward shallow water and use their paws and body to capture fish. Sisson also noted that bears would slap the water to aid in herding fish, but he never saw a fish slapped out of the water. Bacon and Burghardt (this volume Paper 1) also noted that penned black bears would slap at prey. We never observed this behaviour at McNeil.

In all the above reports bears were fishing in shallow flat streams. This lack of varied topography, in contrast to McNeil Falls, could be the reason bears used far fewer and somewhat different techniques. Bears can chase fish in these shallow streams while at McNeil Falls they can seldom do this because of the deep water and the ease with which salmon can evade bears.

In all these studies bears have used the forepaws, although generally at one time or another in combination with the mouth. Eisenberg and Leyhausen (1972) consider capture with the forepaws more evolutionarily advanced than use of the mouth. This suggests that bears are not as advanced as the Felidae in which selection has favoured the use of forepaws to grasp prey. But cats rarely fish. If bears were to lose the ability to catch fish in the mouth, then they would not be able to capture salmon in the deep, fast-flowing water of McNeil Falls. Bears remain generalists, not only as omnivores, but as carnivores. The wide range of techniques they have available permits them to fish in a great variety of waters.

The rise in efficiency of capture from 23 percent to 42 percent between 1972 and 1973, was probably because bears made fewer wild attempts. In addition, the higher turnover of good fishing locations allowed more bears to use those places where salmon were most vulnerable. A third factor stemmed from the tendency of salmon to mill around for varying lengths of time in the deep water below the falls. At these times bears caught virtually no fish. When the fish did start upstream five or more bears might suddenly catch fish. When salmon were moving upstream in high numbers, more were forced close to shore or into other vulnerable locations, thus raising the efficiency of fishing.

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REFERENCES

- CLARK, W. K. 1959. Kodiak bear-red salmon relationships at Karluk Lake, Alaska. *Trans. N. Amer. Wildl. Conf.* **24**:337-345.
- EGBERT, A. L. and STOKES, A. W. 1976. The social behaviour of brown bears on an Alaskan salmon stream. This volume Paper 4.
- EISENBERG, J. F. and LEYHAUSEN, P. 1972. The phylogenesis of predatory behaviour in mammals. *Z. Tierpsychol.* **30**:59-93.