

P. McCART¹

*Fisheries Research Board of Canada
Biological Station, Nanaimo, B.C.*

Digging Behaviour of
Oncorhynchus nerka
Spawning in Streams at
Babine Lake, British Columbia

ABSTRACT

Female *Oncorhynchus nerka*, sockeye and kokanee spawning in streams prepare a nest in the gravel by repeated digging. After the spawning act, the eggs deposited in the nest are covered by repeated digging at its edges. Pre- and post-spawning digging differ in a number of ways: in the frequency of digging, the number of flexures per dig, the direction in which the female turns, the orientation of the female to the current and the decreased tendency to alternate sides while digging. Except that kokanee have a higher rate of flexure, the digging of female sockeye and kokanee is similar.

Male sockeye and kokanee also dig. Male digging is less vigorous than that of females and is not always closely oriented to the nest. Situations in which male digging commonly occurs are described. It is suggested that male digging is a displacement activity.

INTRODUCTION

Female *Oncorhynchus nerka* spawning in streams prepare a nest in the gravel by repeated digging. After the spawning act, eggs deposited in the nest are covered by repeated digging at its edges. Female digging is one of the most easily observed of the behaviour patterns associated with the spawning of this species and has been described, usually in general terms, on a number of occasions. Schultz and students (1935) described the digging behaviour of female kokanee, the freshwater form of the species. Kuznetsov (1928) and Mathisen (1962) described the digging behaviour of the sockeye, the anadromous form. One purpose of this paper is to present a more detailed description of female digging behaviour than is presently available for *O. nerka*. In particular, digging during nest preparation is compared with digging during covering. Data for both sockeye and kokanee are presented.

Male *O. nerka* also dig, though much less frequently than females. Such digging has been noted by Kuznetsov (1928), Schultz and students (1935) and McAfee (1960) but has not been described. In this paper, the digging of male sockeye and kokanee is compared with that of females and some suggestions are made concerning its significance.

1 Present Address: Department of Biology, University of Saskatchewan Regina Campus, Regina, Saskatchewan.

MATERIALS AND METHODS

Data reported here were collected over several years during the course of other investigations. Most of the observations were made at Four Mile Creek, a small tributary of Babine Lake, during July and August 1965 and 1966. Unless specifically indicated, data can be presumed to have been gathered there. Some additional observations were made at other small creeks tributary to Babine Lake: at Gullwing Creek (Six Mile Creek) in 1965 and 1966 and at Sockeye and Pierre Creeks in 1967. Each of these streams is described by Brett (1952). Four Mile Creek is described in more detail by Hanson and Smith (1967). The four streams have spawning populations of both sockeye and kokanee. The two forms are easily distinguished by size: spawning kokanee range from about 200 mm. to 280 mm. fork length, spawning sockeye from 310 mm. to 700 mm. (Hanson and Smith, 1967 and author's data).

Most observations were made at a distance of less than 3 meters, from the stream bank or from platforms (Four Mile Creek only) overlooking favourable observation areas. Observations were of two kinds:

- 1) Detailed observations during which all the classifiable activities of individual fish were recorded for known time periods, generally 5 minutes.
- 2) General observations during which only activities of special interest were recorded. Such observations were made at each of the four creeks.

Only data relevant to digging behaviour is presented in this paper.

Some digging activities were photographed on 16 mm cinefilm. Data derived from these films are indicated in the text.

DIGGING BEHAVIOUR OF FEMALES

DIGGING BEHAVIOUR DURING PREPARATION OF THE SPAWNING NEST

Sockeye and kokanee spawning in streams characteristically prepare an excavation in the bottom gravel to receive the eggs deposited during spawning acts. There is some confusion in the literature about the terminology to be applied to these excavations. I use the term *nest* for the depression in the gravel which the female prepares to receive the eggs, *redd* for the total area which the female disturbs in preparing, spawning in, and covering a series of nests.

With some exceptions, the nest is prepared entirely by the female. Though females are usually joined by one or more males soon after construction of the nest begins, the presence of males is not prerequisite. In 1965 and 1966 when low water levels in Gullwing Creek restricted the movements of the less-agile males, several female sockeye were seen lying alone over completed nests. Three female sockeye panned alone in Four Mile Creek in 1966 dug normally for one or two days then ceased almost all activity and lay quiescent on the bottom, downstream of the finished nest. Female kokanee also prepare nests in the absence of males. On August 18, 1966 3 of 31 female kokanee observed actively preparing nests in Four Mile Creek were unaccompanied by males. At Gullwing Creek, August 17, 1966, 14 of the 38 active female kokanee observed were unaccompanied.

Females construct the nest by repeatedly digging over a selected area. Between digs the female usually positions herself downstream of the nest. Before digging, she may move across the bottom of the nest several times, pectoral, pelvic and anal fins extended, apparently checking the disposition of the gravel. This activity, feeling or testing, has been described for a number of nest-building salmonids (Breder and Rosen, 1966).

As the dig begins, the female moves slowly upstream, feeling the substrate, then turns

Symposium on Salmon and Trout in Streams

jack-kokanee mating observed at Four Mile Creek. The spawning behaviour of the female kokanee seemed to be inhibited by the presence of her much larger mate and he did not court her in the normal manner.

If a thwarting of the sexual drive is associated with male digging we might expect males, which have little opportunity to associate with and court females, do dig more frequently than dominant males. For kokanee at least this does not appear to be so (Fig. 2). Dominant and accessory male kokanee dug with the same frequency.

In some instances, male digging appears to function as an alternative behaviour pattern in attack-flee conflict situations. These are situations in which male are approached by intruding males. In such situations, male digging is apparently irrelevant and as such accords with Tinbergen's (1952) definition of a displacement activity. Wickett (1959), who observed male pink salmon digging in the presence of intruding males, also suggested that this was displacement behaviour.

ACKNOWLEDGEMENTS

Many people were involved in the field studies during which these data were collected. The author especially wishes to thank D. Workman and B. Andersen for their help. F.C. Withler read and criticized the manuscript. Margaret Dean drew the figure illustrating movements during digging.

LITERATURE CITED

- BELDING, D.L. 1934. The spawning habits of the Atlantic salmon. *Trans. Am. Fish Soc.*, 64: 211-216.
- BREder, C.M. Jr., and D.E. ROSEN. 1966. Modes of reproduction in fishes. American Museum of Natural History, National History Press, Garden City, 941 p.
- BRETT, J.R. 1952. Skeena River sockeye escapement and distribution. *J. Fish. Res. Bd. Canada*, 8(7): 453-468.
- BRIGGS, J.C. 1953. The behaviour and reproduction of salmonid fishes in a small coastal stream. *Fish. Bull. Calif. Dept. Fish and Game*, No. 94, 62 p.
- FABRICUS, E., and K.J. GUSTAFSON. 1954. Further aquarium observations on the spawning behavior of the char, *Salmo alpinus* L. *Ann. Rept. Inst. Freshwater Res.*, Drottningholm, 35: 58-104.
- HANSON, ARTHUR J. and HOWARD D. SMITH. 1967. Mate selection in a population of sockeye salmon (*Oncorhynchus nerka*) of mixed age groups. *J. Fish. Res. Bd. Canada*, 24(9): 1955-1977.
- HINDE, R.A. 1966. *Animal Behaviour. A synthesis of ethology and comparative psychology*. 534 p. McGraw-Hill, New York.
- JONES, J.W., and G.M. KING. 1949. Experimental observations on the spawning behaviour of the Atlantic salmon (*Salmo salar* Linn.). *Proc. Zool. Soc. London*, 119, pt. 1, 33-48.
- KENDALL, W.C., and W.A. DENCE. 1929. The fishes of the Cranberry Lake region. *Roosevelt Wildl. Bull.*, Roosevelt Wildl. Forest Exp. Sta., 5(2): 219-309. *Bull. New York State Coll. Forestry Syracuse Univ.*, 2(1a).
- KUZNETSOV, I.I. 1928. Some observations on spawning of the Amur and Kamchatka salmon. *Izvestiya Tikhookeanskoi Nauchno -Prom. Stantsii*, 2(3): 1-195. (FRBC Translation Series No. 22).
- McAFFEE, W.R. 1960. Redds of the red salmon, *Oncorhynchus nerka*, in three streams of the Alaska Peninsula. M.S. Thesis, School of Natural Resources, Univ. of Michigan. 39 p.
- MATHISEN, O.A. 1962. The affect of altered sex ratios on the spawning of red salmon. *In studies of Alaska red salmon*, 1: 137-245. Univ. of Washington, College of Fisheries, Contr. No. 109.
- NEEDHAM, P.R., and A.C. TAFT. 1934. Observations on the spawning of steelhead trout. *Trans. Am. Fish. Soc.*, 64: 332-338.
- SCHULTZ, L.P., and students. 1935. The breeding activities of the little redfish, a landlocked form of the sockeye salmon, *Oncorhynchus nerka*. *Jour. Pan-Pacific Res. Inst. Honolulu*, 10(1): 67-77. *In Mid-Pacific Mag.* 48(1).
- SHERIDAN, W.L. 1960. Frequency of digging movements of female pink salmon before and after egg deposition. *Animal Behaviour*, 8(3-4): 228-230.
- SMITH, Osgood R. 1941. The spawning habits of cutthroat and eastern brook trouts. *J. Wildl. Mgmt.*, 5(4): 461-471.

H. R. MacMILLAN LECTURES IN
FISHERIES

Symposium on
Salmon and Trout
in Streams

A SYMPOSIUM HELD AT
THE UNIVERSITY OF BRITISH COLUMBIA
FEBRUARY 22 to 24, 1968

Edited by T. G. Northcote

INSTITUTE OF FISHERIES
THE UNIVERSITY OF BRITISH COLUMBIA
VANCOUVER

1969