

1948

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Recommended Citation

Harrison, Harry M. (1948) "Use by Fish of the Modified Denil Fishway In The Des Moines River," *Proceedings of the Iowa Academy of Science*, 55(1), 367-373.

Available at: <https://scholarworks.uni.edu/pias/vol55/iss1/54>

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Use by Fish of the Modified Denil Fishway In The Des Moines River

HARRY M. HARRISON

In December of 1937, the Iowa Conservation Commission entered into a cooperative agreement with the Iowa Institute of Hydraulic Research of the State University of Iowa for the investigation of fishways.* This agreement had for its purpose the development of a fishway, which could be practically installed at reasonable costs, and yet, provide efficient passage for fish over river barriers such as the hydro-electric dams that impound water in many Iowa streams.

In the course of the investigation, but under a set of special conditions, a modification of the Denil type fishway was determined far superior to the many other types studied. On the basis of these studies, the Iowa Conservation Commission adopted the Modified Denil Fishway as the type to be used in Iowa and installed the same at several dams along the Des Moines and Cedar Rivers.

It is the purpose of this paper to introduce into the literature the data collected on the use by fish of the Modified-denil Fishway under natural conditions in the Des Moines River for the years 1946 and 1947.

At present, four dams in the Des Moines River are fitted with the Modified-Denil fishway. These are: the Center Street Dam in Des Moines, the Iowa-Illinois Gas and Electric Co. dam at Fort Dodge, and the Iowa Public Service Dams at Humboldt and Rutland. The fishway at the Center Street Dam as yet has not been equipped with a trap, while the unit at Fort Dodge was not equipped with a functional trap until the spring of 1947. Hence, it follows that there are no data available for the Des Moines dam, while the only information for the fishway at Fort Dodge is for the year 1947.

Table 1 compares the physical features associated with the installation of each Denil fishway unit. Under field conditions it is not always economically feasible to install fishways in such locations on functioning dams so that optimum efficiency of the fishway can be expected. For example the high costs and construction difficulties that are encountered in locating a fish passage in the thread of the current or toward the center of the dam involve charges of such magnitude as to make the project prohibitive. In the case of the fishways reported upon in this paper, factors of engineering, construction and labor played an important part in the placement of the units with the result that each exhibits factors that cannot be considered particularly conducive to fish bent upon upstream migration. For instance, at Fort Dodge the entrance to the fishway is approximately 20 feet away from the foot of the Dam. At Humboldt the fishway is located on the shallow side of the river, and during

*A complete report of the Iowa Institute of Hydraulic Research Fishway Investigations is published in the Report of the State Conservation Commission for the Biennium Ending June 30, 1940.

dry periods there is an insufficient supply of water to make the unit operative. In addition, fish must pass through a hole in a concrete retaining wall to gain entrance to the ladder and, at Rutland fish must pass through a narrow and very shallow attraction channel before gaining entrance to the ladder. With the disturbance caused by fishermen, the Rutland fishway probably operates efficiently only at night.

Table I. Physical Features Associated With Each Denil Fishway Installed in Des Moines River.

	Ft. Dodge	Humboldt	Rutland
Height of dam.....	6 ft.	15 ft.	13 ft.
Length of dam.....	300 ft.	170 ft.	200 ft.
Construction	concrete	concrete	concrete
Maximum depth of water impounded	6 ft.	16 ft.	18 ft.
Average depth of impoundment	3 ft.	6 ft.	6 ft.
Normal average depth for 200 yds. below dam	1 ft.	2 ft.	4 ft.
Maximum fluctuation of water over dam.....	9 ft.	1 ft.	1 ft.
Maximum fluctuation below dam	15 ft.	8 ft.	7.6 ft.
Length of impoundment	1.5 mi.	4 mi.	4 mi.
Stream bed	Rock & Gravel	Rock	Rock
Fishway (number of lifts)	single	double	double
Length Fishway	24 ft.	Upper lift 26' lower lift 27'	Upper 27 ft. lower 18 ft.
Slope	1:4	Upper 1:6 lower 1:4	1:4
Attraction Channel	None	Hole in retaining wall	shallow narrow 20 ft. long

Yet, in spite of these adverse operating conditions a total of 10,443 fish weighing 12,241 lbs. made use of the three fishways in one year of record at Ft. Dodge and two years of record at Humboldt and Rutland. Table II lists the species of fish by number and weight using the three separate fishways during the time of this investigation.

All species of fish attaining a total length of six inches or more in life except the Hog molly *Hypentelium nigricans* living in the areas of the fishways made use of them. This use was roughly in proportion to the species composition and indicates that the denil fishway is not selective, at least with the larger kinds of fish.

The smaller fish, such as the minnows and darters made very little use of the fishways. The Rutland data gives the best information on the use of fishways by the smaller individuals. At this unit, it is impossible for the minnows to escape from the resting pool, while at Humboldt the little fish could gain freedom by ascending the second lift and pass through a one-half inch bar mesh screen that blocked the escape of the larger individuals. No record of minnows using the Fort Dodge Fishway exists. At this installation, small fish were free to move out between the slats of the basket trap immediately after ascending the ladder.

Maximum use of the fishways was in the spring and early summer months, and occurred simultaneously with an increase in stream stage. April 20th was earliest date that fish were found in the fishways while no fish were found there after July 24. The greatest use of the ladders occurred between June 18 and July 10, 1947, at the time of some of the most severe floods in Iowa History. McLeod and Nemenyi (1940) determined the period of greatest activity to come during the last two weeks in May and that 80% of the season's total run was completed by July 15.

In this study only very meager data was secured relative to the time of day that fish made the most use of the fishways. Because of heavy fishing pressure adjacent to the fishways and disturbances therewith, the heaviest movements up the ladders was probably late at night or very early in the mornings. Watchmen at the Rutland Hydro-electric plant informed the writer that upon several occasions carp were observed using the fishways shortly after daylight, but with the arrival of fishermen to the area all activity in the attraction channel ceased. Posting the area stopped fishing activities but invited an increased disturbance from curiosity seekers.

The records for the more important species utilizing the fishways have been compiled insofar as possible and are shown in Table III. Where information is too limited to reflect reliable trends or to leave doubt regarding the utility of the data the record is left blank. Additional studies may enable refinement of the table and may at the same time produce some changes.

DISCUSSION

In stream management, fishways may serve a dual purpose. Firstly, when equipped with head water traps, they may be used for rough fish removal, and secondly, they provide for passage of fish over river barriers.

Removal of the so-called rough or soft fish is a proved sound management practice for lakes. However, in the case of large streams an adequate technique for removing noxious fish in numbers sufficient to have an appreciable effect upon the over all population is yet to be devised. Even though the poundage of fish removed in the course of this investigation was far too small to profoundly affect a stream the size of the Des Moines River, it is felt that the Denil fishway holds promise of being an effectual device for removing soft

Table II. Species of Fish by Number and Weight Using Fishways During This Investigation.

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Species	Ft. Dodgs		Humboldt				Rutland			
	1947		1946		1947		1946		1947	
	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
Big-mouthed Buffalo	84	156	18	30	34	56	3	7	37	72
<i>Megastomatobus cyprinella</i>										
Quillback	1036	890	272	242	235	199	34	30	159	138
<i>Carpiodes</i> sp.										
Common Sucker	3	2	2	2	7	5	2	2	83	75
<i>Catostomus c. commersonii</i>										
Silver Mullet	11	11	1	1					2	3
<i>Moxostoma anisurum</i>										
Golden Mullet					1	1				
<i>Moxostoma erythrurum</i>										
Redhorse	75	62	36	30	57	50	52	48	54	48
<i>Moxostoma aureum</i>										
Carp	250	497	1609	1874	2251	2466	321	368	1861	1843
<i>Cyprinus carpio</i>										
Golden Shinner							1		2	
<i>Notemigonus crysoleucas auratus</i>										
Brassy Minnow			1						9	
<i>Hybognathus hankinsoni</i>										
Bluntnose Minnow									2	
<i>Hyborhynchus notatus</i>										
Fathead Minnow							1		42	
<i>Pimephales p. promelas</i>										
Common Shinner			1		2		1		89	
<i>Notropis cornutus frontalis</i>										
Channel Catfish	17	17	90	92	325	291	99	80	655	243
<i>Ictalurus lacustris punctatus</i>										
Black Bullhead			1222	127	239	31	3	25	96	18
<i>Ameiurus melas melas</i>										

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Stone Cat			1							
<i>Noturus flavus</i>											
Northern Pike	2	5	4	10	5	15	3	7	16	43	
<i>Esox lucius</i>											
American Eel					1	4					
<i>Anguilla bos:oniensis</i>											
Smallmouthed Bass	2	3	2	2	2	4	2	4	11	13	
<i>Micropterus d dolomieu</i>											
Green Sunfish			20	.....	74	.....	3	.....	23	.....
<i>Lepomis humilis</i>											
Orange-spotted Sunfish			1	.....	11	.....	3	.....	58	.....
<i>Lepomis humilis</i>											
White Crappie			3	1	2	1	2	1	2	1	
<i>Pomixis annularis</i>											
Walleye			2	2	4	3			2	2	
<i>Stizostedion v. vitreum</i>											
Johnny Darter									1	.....
<i>Boleosoma n nigrum</i>											
Total fish using fishway	1280	1653	3285	2413	3246	3123	430	547	2202	2505	

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Table III. Species of Fish Using the Denil Fishway in the Largest Numbers in the Two Years of Observation Showing the Total Number and Range of Length of Each Species Using the Ladders Together With the Dates that Each Species was First and Last Taken From the Fishways As Well As the Dates of Main Use.

Species	Total Numbers	First taken	Last taken	Main Run	Total Length (inches)
Carp	6292	22 May	24 July	8 June- 16 July	10-20
Quillback	1736	20 April	24 July	1-16 July	8-13
Bullheads	1560	13 May	16 July	1- 3 July	3-5
Channell Catfish	1186	22 May	24 July	1-16 July	4-26
Buffalo	276	20 April	24 July	.....	12-18
Redhorse	274	20 April	24 July	15-31 May	8-13
Green Sunfish.....	120	20 April	22 July	1-15 June	2-3
Common Sucker	97	19 May	24 July	.....	8-12
Orange-spotted Sunfish	73	19 May	16 July	.....	1-2
Northern Pike.....	30	20 April	18 June	.....	14-30
Smallmouth Bass	19	20 April	21 June	.....	6-14
Silver Mullet	14	20 April	16 July	.....	8-12
White Crappie.....	9	19 May	3 July	.....	4-6
Walleye	14	19 May	22 July	.....	12-15

fish. Minor adjustments such as providing leads, deepening the attraction channel, or changing the location of the entrance of the fishway so that it opens at the foot of the dam on the units studied in this investigation, may result in increasing their efficiency many fold. A battery of several Denils placed side by side may prove much better than using single units. A factor certainly in favor of this method for removing rough fish lies in the fact that the Denil operates with a minimum of labor. The only labor needed being that required to empty the baskets traps.

In most cases, there is probably very little necessity in providing passage for fish over river barriers. However, there are at least several instances where free passage by fish to any part of the stream may be vital. Without discussing any of the ramifications, some of these may be listed as follows: (1) to provide upstream movement from feeder waters where dams block passage, (2) to provide for the upstream migration of fish that fall downstream during winter dormancy, and (3) to provide a downstream source of natural stocking where given reaches of stream may have been subjected to fish kills.

ACKNOWLEDGMENTS

The writer is particularly indebted to Mr. E. B. Speaker, Superintendent of Fisheries of Iowa Conservation Commission, who so

graciously made available his files and records on the development of the Modified Denil Fishway in Iowa, as well as to other members of the Conservation Commission for valuable assistance and comments toward this investigation.

IOWA STATE CONSERVATION COMMISSION,
DES MOINES, IOWA.

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