IRISH FISHERIES INVESTIGATIONS

SERIES A (Freshwater)

No. 22 (1981)

An Roinn Iascaigh agus Foraoiseachta
(Department of Fisheries and Forestry)

DUBLIN:
PUBLISHED BY THE STATIONERY OFFICE

TO BE PURCHASED FROM THE
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DUBLIN.

Price: 45p.

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M. F. O'Grady

SOME DIRECT GILLNET SELECTIVITY TESTS FOR BROWN TROUT POPULATIONS

Some direct gillnet selectivity tests for brown trout *Salmo trutta* L. populations

by

M. F. O'Grady

Central Fisheries Board, Balnagowan House, Mobhi Boreen, Glasnevin, Dublin 9.

Received 1st March, 1981.

ABSTRACT

Direct gillnet selectivity tests for introduced brown trout populations in three Irish lakes are outlined. The net gangs and netting procedure utilised are described. Data indicate that the gear used was capable of capturing a random cross-section of a trout stock in the length frequency range 19.8 to 47.7 centimetres.

INTRODUCTION

Little quantitative data has been collected in Ireland on the structure and density of lake brown trout *Salmo trutta* L. populations. The author undertook such a project in 1975. To achieve the aims of the programme, a suitable procedure for obtaining a random cross-section of lake trout populations had to be developed.

Fishery development work carried out by the Inland Fisheries Trust in Irish lakes had indicated that braided nylon gillnets were highly efficient gear for catching trout. These nets are known to be highly selective gear (Hamley, 1975 and Pope et al, 1975). Thus, if they were to be utilised to obtain a random cross-section of a lake trout stock, it was essential that information be obtained with regard to their selectivity. Otherwise, samples might be biased for particular length frequency groups. The results of a number of direct gillnet selectivity tests are described here.

MATERIALS AND METHODS

These experiments were designed to establish whether or not equal lengths of gillnet, every half inch (12.7 mm) mesh size from 2 to 5 inches (50 to 127 mm), were capable of capturing a broad random cross-section of a trout population. All references to mesh sizes are to stretched mesh measurements.

For convenience, these nets were arranged in gangs for fishing purposes. Each gang was identical, containing one net of each mesh size (Table 1).

A broad length frequency range of trout were stocked in three lakes. All of these fish were measured prior to their introduction. It was hoped that a comparison of the numbers of trout stocked and subsequently recaptured with these gillnets, within discrete length frequency groups, would indicate whether or not this gear was capable of capturing a random cross-section of a trout population.

The nets utilised conformed to the net type defined as a gillnet. "Gillnets are one-wall nets held in the vertical plane between floats on a floating line and sinkers on a lead line" (Von Brandt, 1974).

The alteration of net colour (Parrish, 1969 and Jester, 1979) twine size (Hansen, 1974), material (Hamley, 1975) and net construction (Von Brandt, 1974) can all effect the efficiency of gill nets. These parameters were standardised for the gear used in this study (Table 1). Hanging coefficients were altered for each net size to ensure that all mesh patterns would be approximately diamond shaped and thus would fish with equal efficiency.

Variation within individual mesh sizes was calculated for each net size utilised. Ten nets of each size were examined, with thirty meshes chosen at random being measured in each net. Mesh measurements were made by eye on a rule. Data indicate negligible variation from the manufacturer's specified size in each case (Table 2). The actual nets used to estimate variance within mesh sizes had been utilised in pike cropping operations for two years and were subject to more stress than the gear used in this exercise. Thus, negligible variance, within mesh sizes, was assumed for the present study.

Any nets which were torn during the course of a survey were replaced immediately to ensure continuity of effort.

A series of direct selectivity tests was carried out using fish farm trout to establish the selectivity pattern of a range of nets and to determine the upper and lower selection limits for the net gang. Attempts made to broaden the lower end of this range by using 3 cm meshed nets were unsuccessful. This mesh size proved totally inefficient in capturing trout.

The trout utilised were stocked in one of three small lakes, Lough Inchiquin (113 hectares; R 27 90), Lough O'Flyn (130 ha; M 58 80) and Pallas Lake (13.4 ha, N 27 19). Introduced fish were always scattered in small numbers all over the fishery. Immediately after stocking, the lake was netted randomly with the experimental net gangs.

The netting procedure recommended by Pope et al. (1975) was adopted. The various nets, one of each mesh size, were arranged randomly within each gang. The lead ropes on adjacent nets were not joined. Thus, gaps were left between nets to alleviate the problem of leading. Half of the sets were fished on the bottom and half were operated as floating gangs. The former group were always placed in water exceeding two metres in depth to avoid tangling large numbers of trout. Gangs were set each afternoon and lifted the following morning to be reset in different locations. A lake was netted in this fashion for four successive days. A total of 38 (Inchiquin) 35, (O'Flyn) and 27 (Pallas) net gang samples were taken. The exercise was carried out in a short time span because stocked fish tend to congregate and shoal by size. If the netting operation was delayed until such time as shoaling occurred, catches might be biased.

Pope et al. (1975) has described the ways in which a mesh can hold a fish.

(1) Wedging—A fish is held tight by a mesh around the body.

(2) Gilling—A fish has entered a mesh and cannot back out because the mesh is caught behind the gill cover.

(3) Tangling—An individual has not necessarily penetrated a mesh but is caught in the net by teeth, maxillaries or other projections.

In the course of this study a fourth category was noted. Some trout were caught in a single mesh around the face, well behind the maxillary bones. These individuals probably entered the net with great force, enough to wedge them in position around the face.

The majority of trout (97%) caught during this study were either gilled, wedged or caught around the face. Individuals caught by tangling were ignored for selection purposes because such fish were not representative of the selectivity of the mesh sizes in which they were captured.

The samples captured were all measured individually to the nearest millimetre (fork length) and the number and sizes of trout caught in each mesh size was noted.

The question of net saturation, which can create problems (Pope et al. 1975), never arose in this study because the nets were serviced daily and the maximum number of individuals captured in any one net was thirty one.

RESULTS

The ratios of numbers stocked to numbers recaptured in the gillnet gangs were compared for each individual study. As the purpose of this exercise was to establish whether or not the range of nets utilised could capture a random cross-section of a trout stock, the individual numbers, length frequency range and mode of capture of fish in individual mesh sizes are not presented.

Data from Pallas and Inchiquin lakes were used to establish the selectivity pattern for the overall net gang (Table 3).

The Pallas lake data suggest that there was no significant difference ($P > 0.05$) in the efficiency of the net gang in capturing trout, in 2 cm size groups, within the length frequency range 19.8 to 47.7 cm. Data from Lough Inchiquin support the Pallas Lake result. No significant difference ($P > 0.05$) was evident in the efficiency of the net gang in capturing trout in two discrete length frequency groups (20-30 and 35-42 cm). These results suggest that the net gang in question can capture a random length frequency cross-section of a trout population (19.8-47.7 cm).

Data from the Pallas Lake and Lough O'Flyn experiments were utilised to establish the lower selection limit for this net gang (Table 4). The trout caught in two inch (51 mm) nets were related to the numbers stocked for each half centimetre length frequency group.

The results of both experiments indicate that two inch (51 mm) mesh nets cannot capture trout with equal efficiency over the size range 18.8 to 21.2 cm ($P < 0.001$—Pallas Lake; $P < 0.05$—Lough O'Flyn). Data indicate no significant difference ($P > 0.05$) in the efficiency of two inch mesh nets in capturing fish in the size range 19.8 to 21.2 cm in both experiments, suggesting that this mesh size is efficient at capturing trout of 19.8 cm or greater in length. Smaller fish are caught only occasionally and form the left hand "tail" of the two inch mesh selectivity curve.

It is significant to note that the large trout (40-47.7cm) caught in five inch (127 mm) nets, in the Pallas and Inchiquin studies, were all wedged. This fact indicates that this mesh size was capable of "gilling" larger individuals. Fish caught subsequently, in the course of lake trout population studies, indicated that a five inch mesh will "gill" trout up to at least 60 cm long. Large mesh nets (5.5-7.0 inches, 140-178 mm), used by the development staff of the Inland Fisheries Trust to capture pike, rarely caught trout in the study areas. In addition, an examination of the spawning stocks in these lakes indicated that trout rarely exceed 55 cm in length. Thus, five inch nets can capture the largest trout present in these waters.

Changes in the condition or plumpness of fish can alter their selectivity to a particular set of gear (Farran, 1936). As this study deals with a fusiform species, one which is predominantly gilled or wedged, variation in the condition of individuals is likely to influence the selection of wedged trout by gill nets. The condition factor referred to here is the relationship described originally by Nall (1930) where:

$$\text{Condition Factor (K)} = \frac{\text{Weight (g)} \times 100}{(\text{Length (cm)})^3}$$

A K value of 1.0 signifies reasonable condition, with poor and well conditioned fish having lower and higher K values respectively. The smaller trout captured in any mesh size are wedged individuals. Thus, a large variation in K values for trout might alter the minimum size of trout captured in two inch nets.

The Pallas and O'Flyn selectivity tests indicated that two inch (51 mm) mesh nets were equally efficient at capturing trout over the size range 19.8 to 21.2 cm. Thus, it can be assumed that the range of condition factor values for the stocked fish in question did not affect selectivity (Table 5). Since these figures encompass the normal range of condition values it seems reasonable to assume that the lower selection limit of a two inch mesh net (19.8 cm) will only be altered in exceptional circumstances when condition factor values are exceptionally high or low. Subsequent lake trout survey data confirms this assumption because very few trout of less than 19.8 cm in length were captured.

DISCUSSION

A number of factors which often cause difficulty in interpreting selectivity data were avoided in these experiments.

Mature fish, particularly females undergo considerable seasonal fluctuations in condition. Thus, fluctuations could be expected in selection for wedged adult fish within the gang of nets (Ishida, 1967 and 1969). Since the species in question was fusiform and was either gilled or wedged, it was thought reasonable to assume that changes in condition would simply alter the overall selection curve by shifting it along its abscissa. Since the range of nets utilised was more than adequate to sample the length frequency range of the adult fish population, it was assumed that any changes in condition would not prevent the nets from sampling a random crossection of the population. Kipling (1959) has indicated that this in fact was the case with char *Salvelinus alpinus* (L.) populations.

Each experiment, from the initial planting of trout to the final netting samples, was completed in four days. Thus, all forms of natural mortality were limited and the introduced fish had little opportunity to emigrate or shoal by size. Predation on introduced fish stocks might alter the length frequency distribution of the group and bias selectivity patterns. The three lakes in question had very small pike (*Esox lucius* L.) stocks. No angling took place while the surveys were in progress.

When very large numbers of fish are removed during the course of a selectivity experiment it is often necessary to make daily allowances for the numbers which are still available to the nets (Hamley and Regier, 1973). The numbers of fish recaptured in this study, while adequate to assess the selectivity pattern, did not seriously deplete the numbers stocked (Tables 3 and 4).

The results of these direct gillnet selectivity tests suggest that equal lengths of gillnet every half inch mesh size, from 2 to 5 inches inclusive, can capture a random cross-section of a brown trout stock in the range 19.8 to 47.7 cms. Variation is evident in the ratio of numbers stocked to numbers recaptured for small length frequency groups. Ratio values ranging from 7.6 to 3.9 were recorded in the Pallas Lake study for 2 cm. groupings of fish. They suggest a possible decrease in the efficiency of the gear with increasing fish size. However, X^2 value for a comparison of the numbers stocked to the numbers recaptured indicates that their variation is not significant ($P > 0.05$).

The results of these experiments suggest that it might be possible to use the sampling gear tested to obtain a random cross-section of lake brown trout populations.

ACKNOWLEDGEMENTS

I wish to thank the Central Fisheries Board (formerly the Inland Fisheries Trust) for providing me with the facilities to carry out this project. Special thanks are due to the many development and fish farm staff members of the C.F.B. who assisted this programme. I am indebted to Mr. Peter Green for assistance in the collection of these data and to Dr. P. Fitzmaurice in the C.F.B. for reading this manuscript.

REFERENCES

Von Brandt, A. 1974. Enmeshing Nets: Gillnets and entangling nets. The Theory of their Efficiency. *E.I.F.A.C./74/1 Symp. 9,* 1-27.

Farran, G. P. 1936. On the mesh of herring drift nets in relation to the condition factor of the fish. *J. Cons. Int. Explor. Mer* 11, 43-52.

Hamley, J. M. 1975. Review of gillnet selectivity. *J. Fish. Res. Board Can.* 32, 1943-1969.

Hamley, J. M. & Regier, H. A. 1973. Direct estimates of gillnet selectivity to Walleye (*Stizostedion vitreum vitreum*). *J. Fish. Res. Board Can.* 30, 817-830.

Hansen, D. J. 1971. Evaluation of stocking Cutthroat Trout (*Salmo clarki*) in Munsel Lake, Oregon. *Trans. Am. Fish. Soc.* 100, 55-60.

Ishida, T. 1967. On the gillnet mesh selectivity curves for Pink Salmon, with special reference to the change of fatness. *Bull. Hokkaido Reg. Fish. Res. Lab.* 33, 9-12.

Ishida, T. 1969. The salmon gillnet mesh selectivity curve. *Int. North. Pac. Fish. Comm. Bull.* 26, 1-11.

Jester, D. B. 1977. Effects of colour, mesh size, fishing in seasonal concentrations and baiting on catch rates of fishes in gillnets. *Trans. Am. Fish. Soc.* 106, 43-56.

Kipling, C. 1959. The effect of gillnet selection on the estimation of weight-length relationships. *J. Cons. Perm. Int. Explor. Mer* 23, 51-63.

Nall, G. H. 1930. *The Life of the Sea Trout.* London, Seeley Service & Co.

Parrish, B. B. 1969. A review of some experimental studies of fish reaction to stationary and moving objects of relevance to fish capture processes. *F.A.O. Fish. Rep.* 62, 233-245.

Pope, J. A., Margetts, A. R., Hamley, J. M. & Akyuz, E. F. 1975. Manual of methods for fish stock assessment. Part III—Selectivity of Fishing Gear. *F.A.O. Fish. Tech. Pap.* 41, 1-65.

Table 1. Data on the nature and construction of each net gang used in the study.

	Stretched mesh size in inches, mm in parenthesis						
	2.0 (51)	2.5 (63)	3.0 (76)	3.5 (89)	4.0 (102)	4.5 (114)	5.0 (127)
Hanging coefficient	1:1.25	1:1.6	1:1.3	1:1.6	1:1.3	1:1.5	1:1.7
Net length in metres (hung)	27.5	27.5	27.5	27.5	27.5	27.5	27.5
Depth in metres (hung)	2	2	2	2	2	2	2
Twine size	1½ Z Nylon Netting Twine for all Mesh Sizes.						
Breaking strain	13 lb. for all mesh sizes.						
Colour	Green (Bridport Gundry Dye Code 24)						

Hanging Coefficient = Ratio of completed net to stretched length of webbing used in it.

Table 2. Maximum variance recorded in mesh size for gill nets which had been in service for two years.

Stretched mesh measurement in inches, mm in parentheses	No. of nets examined	Number of meshes measured per individual net	Mean $(\overline{X})$ mesh size of the individual net of each mesh size which departed most from the nominal size	
			$(\overline{X})$	S.E.
2 (51)	10	30	1.99	0.02
2.5 (63)	10	30	2.52	0.07
3.0 (76)	10	30	3.05	0.05
3.5 (89)	10	30	3.52	0.03
4.0 (102)	10	30	4.04	0.06
4.5 (114)	10	30	4.52	0.03
5.0 (127)	10	30	5.05	0.04

Table 3. X^2 tests and their significance for the relative numbers of trout stocked and recaptured by net gangs (2"—5") in the Pallas and Inchiquin experiments.

Fish size groups (cm)	N.F.S.	N.F.R.	R	X^2	Signif.
			Pallas experiment		
19.8—21.7	680	89	7.6		
21.8—23.7	465	64	7.3		
23.8—25.7	160	22	7.3		
25.8—27.7	49	8	6.1		
27.8—29.7	55	8	6.9		
29.8—31.7	40	6	6.7		
31.8—33.7	18	3	6.0	7.4	$P > 0.05$
33.8—35.7	75	13	5.8		N.S.
35.8—37.7	130	24	5.4		
37.8—39.7	144	24	6.0		
39.8—41.7	83	18	4.6		
41.8—43.7	27	7	3.9		
43.8—45.7	19	3	6.3		
45.8—47.7	8	2	4.0		
			Inchiquin experiment		
20.0—30.0	1,003	18	55.7	0.66	$P > 0.05$ N.S.
35.0—42.0	990	23	43.0		

N.F.S. = Number of fish stocked; N.F.R. = Number of fish recaptured; (R = Ratio of N.F.S. to N.F.R.); N.S. = No significant difference.

Table 4. Numbers of trout stocked and subsequently recaptured in two inch (51 mm) mesh nets in the Pallas and O'Flyn experiments.

Fish Size Group (cm)	Pallas Experiment		O'Flyn Experiment	
	N.F.S.	N.F.R.	N.F.S.	N.F.R.
18.8—19.2	202	6	24	0
19.3—19.7	204	2	22	0
19.8—20.2	160	20	21	2
20.3—20.7	236	24	22	4
20.8—21.2	197	18	19	4

Table 5. Data on the condition factor values of trout (19.8-21.1 cm) utilised in the Pallas Lake and Lough O'Flyn selectivity tests.

Selectivity Test	Condition Factors			Sample Size
	Max.	Min.	$\overline{X}$	
Pallas Lake	1.43	0.70	1.16	117
Lough O'Flyn	1.42	0.76	1.03	62

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