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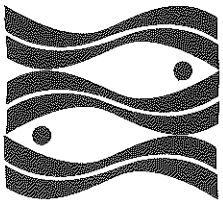

# IRISH FISHERIES INVESTIGATIONS

**M. F. O'Grady**

Ecological changes over 21 years caused by drainage of a salmonid stream, the Trimblestown River

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## Roinn na Mara
## (Department of the Marine)

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# Ecological changes caused by drainage of Trimblestown River

by

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## ABSTRACT

A site on the Trimblestown River (Boyne Catchment) studied by McCarthy (1977 and 1983), pre- and post-drainage (1968 to 1974), was re-examined by the author in 1989. Changes in the nature of the stream bed, in-stream and bank flora and fish stocks over the entire period (1968 to 1989) are reviewed. Data indicate a general ecological recovery of the site 17 years after drainage works.

## INTRODUCTION

The Trimblestown river was subjected to an arterial drainage scheme in 1972. Over the period 1968 to 1974 McCarthy (1977 and 1983) carried out a detailed ecological survey of a section of this channel at Clonleasan Bridge to establish the status quo pre-drainage and to measure change in the channel following the drainage scheme.

In 1989, fifteen years after McCarthy's study was completed, the author carried out a similar study in the same area of the river. The purpose of this exercise was to establish the extent to which the ecology of the channel had reverted to its pre-drainage state with particular reference to fish stocks.

McCarthy's studies (1977 and 1983) included observations on the physical nature of the river bed, the aquatic and marginal flora, the aquatic invertebrate fauna and fish stocks. The present study covered all of these areas with the exception of the invertebrate faunal regime.

The Trimblestown River is one of thirteen major tributaries in the Boyne catchment (Fig. 1). It was drained in 1972 by the Office of Public Works as a part of a major scheme which involved draining most channels in the Boyne catchment upstream of Navan. The drainage scheme commenced in 1969 and was completed in 1985.

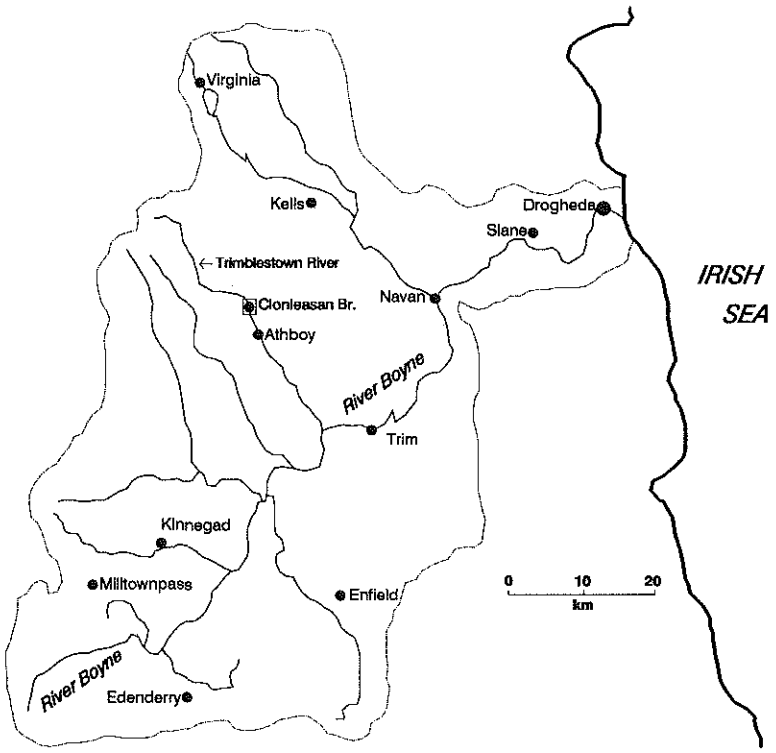



**Figure 1. The Trimblestown River and its position in the Boyne catchment.**

Since 1983 a major biological survey of drained areas in the catchment has been in progress. The objective of this exercise was to define the status quo of fisheries within the catchment post-drainage and, thereafter, to design fishery rehabilitation programmes for specific areas with limited salmonid stocks. This survey was carried out by the Central Fisheries Board. Fisheries rehabilitation programmes were designed by a team of staff from the Fisheries Boards (Central and Eastern), the Department of the Marine and the

Office of Public Works. Both the biological survey and rehabilitation programmes have been funded by the Office of Public Works.

A fishery rehabilitation programme was carried out on the Trimblestown River in 1986. This involved the placement of some gravel beds in the channel, the construction of small weirs, the removal of some silt deposits and a tree planting programme. No rehabilitation works were carried out in the vicinity of Clonleasan Bridge, the section of the Trimblestown studied originally by McCarthy from 1968 to 1974 and re-examined by the author in 1989.

McCarthy found that this channel section, pre-drainage, had an extensive bank cover of trees and marginal aquatic plants, undercut banks and an in-stream flora and fauna whose composition was typical of many undisturbed Irish limestone streams (Plates 1 and 2). The fish stocks in this zone pre-drainage were dominated in both numerical and biomass terms by salmonids - 0+ and 1+ salmon with significant numbers of juvenile and some adult trout.

Two years after drainage the ecology was reviewed again. He found a situation very different from the pre-drainage status. All trees had been removed. There was a recovery in the marginal aquatic vegetation. Undercut banks were no longer present (Plates 1 and 2). The aquatic flora had changed with more silt-tolerant species being dominant (Table 1). The nature and density of fish stocks had also changed. Salmonids (trout and salmon) were present in significantly reduced numbers. Stoneloach and minnow had become the dominant species (Table 2).

## METHODS

The same channel area examined by McCarthy (1977 and 1983) from 1968 to 1974 was surveyed by the author. It encompassed a total channel length of 146 metres including sections both upstream and downstream of Clonleasan Bridge.

Photographs of the site were taken by the author, in January 1989, to allow visual comparison with shots taken by McCarthy in the pre-and immediate post-drainage period (1968, 1972 and 1973) (Plates 1 and 2).

The flora was surveyed on 24th January 1989 when, following mild weather, the aquatic plants had entered a spring growth phase. The nature and extent were calculated following McCarthy's (1977) methodology, classifying the plants as abundant, frequent and occasional.

Fish stock estimates were calculated by electro-fishing the section using the Zippin (1958) depletion technique. The entire channel length (146 m) was electro-fished three times. Stop nets were used to enclose the section and prevent the immigration or emigration of fish while electro-fishing was in progress. All salmonids captured were counted, measured, scaled and weighed prior to their release. All other fish species captured were counted. The smaller fish of all species were weighed in batches to allow calculation of a mean weight value for individual fish.

## RESULTS

### *Photographic evidence*

A photographic series illustrating the general ecological changes in this channel area pre-and post-drainage is presented (Plates 1 and 2). These illustrate the situation as it was pre-drainage, immediately post-drainage, two years later and seventeen years after drainage. The pre-drainage and present day photographs illustrate the extent to which the channel reverted to its pre-drainage status. A significant tree line had regnenerated along the banks. The tree canopy was still not as dense as that present pre-drainage. The tree-line present in 1989 was self regenerating - no post drainage planting programme was carried out here. The aquatic marginal vegetation was similar in 1989 in extent to that present in the pre-drainage era (downstream of the bridge). The excessive beds of silt evident in marginal areas after drainage works had been flushed.

### *The river banks and bed*

Investigations in 1989 indicated a restoration of the channel bed type to that described by McCarthy (1977) for the pre-drainage era - a substrate type varying from gravelled riffles to large stones to mud and silt. The extent of each substrate type was not quantified by McCarthy immediately pre- and post-drainage and consequently one can only say, in a qualitative sense, that the range of substrate types observed pre-drainage had been re-established in 1989.

McCarthy noted a change in mean channel width pre- and post-drainage from 6.1 m to 6.8 m. By 1989 the channel had reverted to its pre-drainage mean width of 6.1 m.

McCarthy recorded flows within the range 0.1 m to 1.0 m per second in the study are pre-drainage. In January, 1989, the author recorded values within the range 0.08 to 1.12 m per second in the same area in a low-flow situation, suggesting no major change in the hydraulic regime compared to the pre-drainage situation. The photographic evidence confirms this view (Plates 1 and 2).

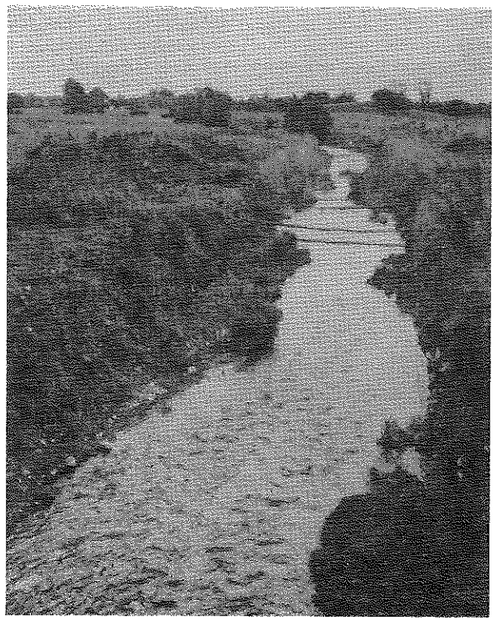
The only major physical difference was the height of the banks which remained circa 2.9 m higher on average in 1989 than they were in the pre-drainage era.





**1. Pre-drainage, autumn 1968**

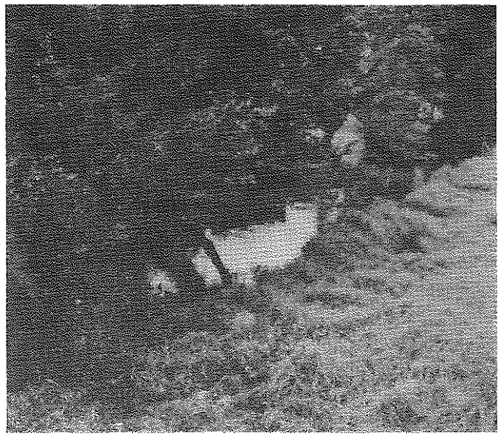
**2. Three months post-drainage, June 1972**



**3. Autumn 1973**

**4. November 1990**

**Plate 1. Trimblestown River looking downstream from Clonleasan Bridge (1, 2 and 3 reproduced from McCarthy, 1977).**



**1. Pre-drainage, autumn 1968**

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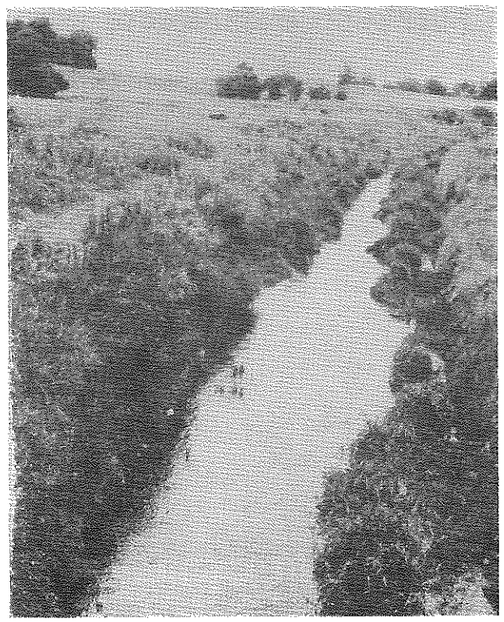
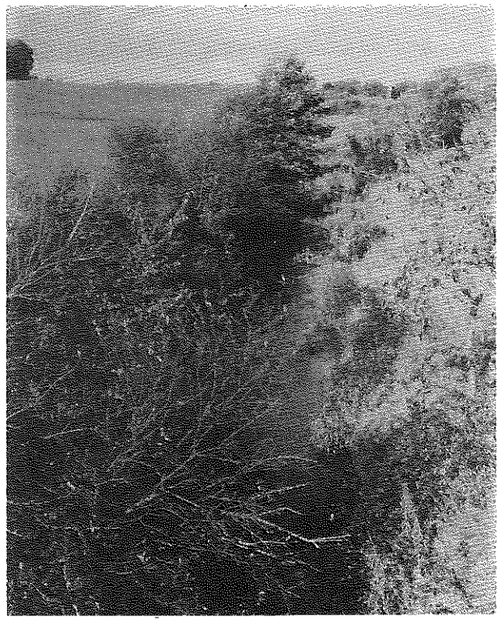


**3. Autumn 1973**



**4. November 1990**

**Plate 2. Trimblestown River looking upstream from Clonleasan Bridge (1, 2 and 3 reproduced from McCarthy, 1977).**





*Aquatic and marginal flora*

No significant difference was evident in the flora recorded by McCarthy for the pre-drainage period and that present in 1989 (Table 1). All of the species recorded as abundant in 1968 had reverted to the same status in 1989. In addition the silt-tolerant plants which were completely dominant in the two year period following drainage were absent in 1989 (Table 1).

No floral maps of this channel area were constructed by McCarthy or the author. Therefore, any measurement of change can only be regarded as qualitative. However, the complete absence of all of the species which were dominant in the channel immediately after drainage and the recolonisation by the species present pre-drainage does indicate a restoration of the original flora at least in general terms.

*Fish populations*

Data on the fish population in the study area over the period 1968 (pre-drainage) to 1989 are presented in Table 2. No significant differences are evident in the 0+ trout, older trout and young (0+ and 1+) salmon for the pre-drainage (1968) and present day (1989) situation. The fish stocks in the channel would appear to have recovered completely in 1989 from the imbalances created by drainage.

The only significant difference in fish stock densities recorded pre-drainage and recently (1989) was in relation to the minnow population - significant numbers of this species were present in the channel in 1989 and none were found pre-drainage. However, the numbers present had not depressed the pre-drainage salmonid stock density values.

The structure of the trout sample measured by McCarthy at Clonleasan in September 1968, pre-drainage, appears to have been similar to that recorded by the author at this site in January, 1989. McCarthy (1983) found a mean length for the trout sample of 15.7 cm in 1968. The comparable figure recorded by the author in 1989 was 16.8 cm. McCarthy also noted a range of trout age groups at the site up to 4+. Length frequency data and scale analysis compiled by the author in 1989 indicate a similar situation (Fig. 2).

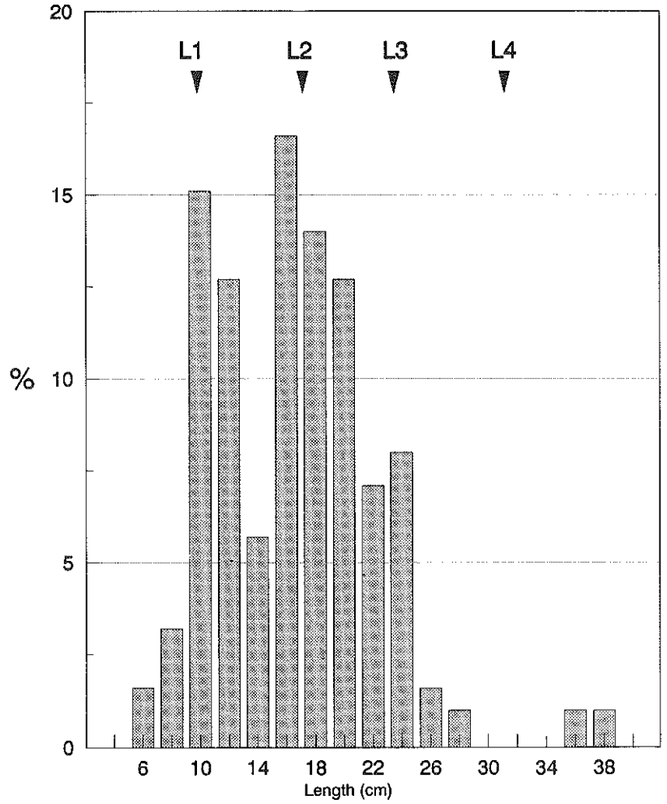



**Figure 2. Length frequency distribution of a sample of 87 brown trout from the Trimblestown River at Clonleasan Bridge on 19 January 1989. $L_1$ to $L_4$ are mean back-calculated lengths at ages 1 to 4.**

When the 1989 survey was being carried out a total of eight salmon redds were observed within this section of channel. The production from this number of redds would probably exceed the juvenile salmon carrying capacity of this zone.

In September 1968 (pre-drainage) McCarthy found that the juvenile salmon population at Clonleasan was dominated by 1+ fish (87.7%) with the balance (12.3%) being 0+ individuals. In January 1989 the author found a dominance (82.2%) of 0+ salmon at this site with the balance (17.8%) being older fish. The difference in age structure recorded between 1968 and 1989 is most likely due to the seasonal difference in sampling dates.

The fencing of the right bank both upstream and downstream of Clonleasan Bridge immediately after drainage works (Plates 1 and 2) was probably of very considerable importance in allowing the regeneration of both a treeline and other bankside vegetation post-drainage. At some time since drainage works the left bank, downstream of Clonleasan Bridge was also fenced with positive consequences in relation to the bank cover regime. The complete absence of shrubs on the left hand bank upstream of Clonleasan Bridge (foreground) where no fence has been maintained and cattle have been allowed graze the banks, is very striking. The regeneration of a partial tree line further upstream on the same bank where a fence has been maintained is also significant.

## DISCUSSION

McCarthy's investigations (1977 and 1983) showed clearly that the study site on the Trimblestown, pre-drainage, was typical of many Irish limestone streams, a productive water with a capacity to support substantial numbers of juvenile salmonids and some adult trout. His data also show that arterial drainage, in the short term, can significantly alter the ecology of such channels and greatly reduce their capacity to support salmonid stocks. Similar results were recorded by J. Browne, (pers. comm.) for a number of other Boyne tributaries in the immediate (3-4 years) post-drainage period.

The present study indicates that seventeen years after drainage the salmonid carrying capacity of this zone has fully recovered. Qualitative data suggest that the pre-drainage physical in-stream and floral regime in the channel have also been restored.

The recovery of this section of the Trimblestown, 17 years after drainage, in terms of its ability to support salmonid stocks, is not surprising given that the hydraulic regime, substrate type, bank and in-stream floral colonies are now broadly similar to those observed by McCarthy (1977) in the pre-drainage era. Numerous studies in relation to factors limiting salmonid stocks in streams have identified bank and in-stream cover abundance (including undercut banks), a stony bed and the presence of a riffle/glide/pool sequence as being among the most critical factors (Lewis, 1969, Mundie 1974, Hunt 1976, Ward and Slaney 1981 and Wesche *et al* 1987). The restoration of these physical and ecological factors in the study area to their pre-drainage status must have played a key role in the restoration of salmonid stocks.

The single major difference (bank height) in the study area post-drainage does not appear to have affected the capacity of the channel to support salmonids.

The re-establishment of the pre-drainage fishery status in the study area was probably due to a number of factors:

McCarthy's (1977) studies indicate that immediately post-drainage some stones and gravels, although heavily silted at that time, were present on the stream bed. These photographs (Plates 1 and 2) of the site in the two-year post-drainage period illustrate the presence of considerable quantities of gravels and stones along the freshly drained banks. A lot of this material was probably scoured from the banks in subsequent years and deposited on the channel bed. Additional stony material may also have been washed down from upstream areas.

The crucial role played by bank fencing in allowing the regeneration of productive bankside ecology post-drainage is evident throughout the Boyne catchment (O'Grady, unpublished data). It must be stressed that throughout the Boyne, in the pre-drainage phase, many channel sections were not fenced and, where such lands were grazed, no shrubs were present in bankside areas - note the background area (right bank) downstream of Clonleasan Bridge in the pre-drainage phase (Plate 1).

The lengthy time lapse between the completion of McCarthy's studies in 1974, two years after drainage and the current study (1989) means that one cannot estimate the recovery rate of Trimblestown's salmonid carrying capacity with any accuracy. However, indirect evidence does suggest that the recovery of drained channels in the Boyne in terms of their ability to support significant salmonid stocks was relatively fast, (possibly a five to seven year recovery period). A major fishery survey of the Boyne catchment, completed in recent years (1983-1989), has shown that the Boyne catchment, post-drainage is probably capable of producing more salmon than it did in the pre-drainage phase. The creation of extensive new shallow fast-flowing areas in the Boyne itself by weir removal during works, and the exposure of additional gravel beds in tributaries by silt removal during works are among the major factors responsible for this phenomenon (O'Grady, 1990 and in press).

The fact that Boyne salmon stock did not collapse temporarily after drainage works is probably due to both the relatively slow rate at which works were carried out (1969 to 1985) and the fact that the lower main channel from Navan and Drogheda (31.3 kms) which has a significant capacity to produce smolts was never drained. A five to seven year recovery rate is suggested because, despite the longevity of the





drainage programme, a longer period for individual drained channels would certainly have resulted in at least a temporary major reduction in salmon runs, particularly towards the end of the drainage scheme (1980 onwards). This did not occur (O'Grady, in press).

There is clear evidence to suggest that the recovery of the Trimblestown at Clonleasan, as illustrated by this study, represents the norm for many sections of the Boyne tributary catchment. Data to support this statement are presented and discussed in O'Grady (1990) and O'Grady (in press).

The only other published study to-date on the effects of drainage on stocks in an Irish salmonid stream is provided by Toner et al (1965). This research carried out on a tributary of the Moy, recorded a recovery of salmon fry stock densities two years after drainage works. This study was discontinued thereafter. In the author's opinion, any comparisons between events in the Moy and the Boyne, pre- and post-drainage are unlikely to be of value because of the very different nature of these catchments.

## ACKNOWLEDGEMENTS

I am most grateful to the Office of Public Works who funded this study. I would like to thank Dr. P. Fitzmaurice for his careful and constructive criticism of this paper. Special thanks are due to my colleague Mr. J. Caffrey who confirmed some of my plant identifications and to Messrs. J. Brown and R. Fluskey (Fisheries Research Centre) for personal communication. I would like to thank Inspector John Stapleton and Messrs. Paul Bourke and John Woodlock of the Eastern Regional Fisheries Board who assisted the author in carrying out electro-fishing operations.

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TABLE 1. The dominant aquatic plant genera observed in the Trimblestown upstream and downstream of Clonleasan Bridge in 1968, 1972 and 1989.

| Plant Species | Pre-Drainage (1968)* | Post Drainage (1972)* | Post-Drainage (1989) |
|---|---|---|---|
| Filamentous algae | (1) + | + | + |
| Fontinalis sp. | + | – | + |
| Rorippa sp. | + | – | + |
| Oenanthe sp. | + | – | + |
| Ranunculus sp. | + | – | + |
| Sparganium sp. | – | + | – |
| Phalaris sp. | – | + | – |
| Mentha sp. | – | + | – |
| Veronica sp. | – | + | – |
| Juncus sp. | – | + | – |
| Epilobium sp. | – | + | – |
| Equisetum sp. | – | + | – |
| Chara sp. | – | + | – |

(1) - Confined to marginal areas in 1968 and 1989.
(*) - From McCarthy (1977)

Table 2. Numbers and weight (g) per $m^2$ of fish at Clonleasan bridge sampled by McCarthy in 1968 and 1974 and by the author in 1989. 95% confidence limits in parentheses.

| **Fish Species** | **Pre-Drainage September 1968** | | **Post-Drainage May 1974** | | **January 1989** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Numbers** | **Weight** | **Numbers** | **Weight** | **Numbers** | | **Weight** | |
| Brown Trout 0+ | 0.26 | 0.94 | 0 | 0 | 0.17 | (0.27-0.08) | 0.8 | (1.01-0.62) |
| Brown Trout 1+ to 4+ | 0.22 | 12.95 | 0.015 | 2.0 | 0.26 | (0.31-0.21) | 13.2 | (1.01-0.62) |
| Salmon 0+ to 1+ | 0.18 | 2.64 | — | — | 0.13 | (0.2-0.065) | 2.1 | (2.9-1.57) |
| Eel | 0.02 | 1.7 | — | — | 0.004 | (0.006-0.001) | 0.38 | (0.51-0.20) |
| Gudgeon | 0 | — | 0.1 | 0 | 0 | | | |
| Minnow | 0 | — | 0.14 | 0.67 | 0.06 | (0.11-0.01) | 0.25 | (0.45-0.04) |
| Stoneloach | 0.01 | — | 0.16 | 0.5 | 0.012 | (0.018-0.007) | 0.027 | (0.036-0.016) |
| Stickleback | 0.016 | — | 0.004 | 0.5 | 0.02 | (0.031-0.008) | + | |
| Stream Lamprey | 0 | — | 0 | 0 | 1 | + | | |

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