

Not to be cited without
permission of the authors¹

DFO Atlantic Fisheries
Research Document 96/04

Ne pas citer sans
autorisation des auteurs¹

MPO Pêches de l'Atlantique
Document de recherche 96/04

**Review of the American eel elver fisheries
in Scotia-Fundy area, Maritimes Region**

by

B.M. Jessop
Biological Sciences Branch
Department of Fisheries and Oceans
P.O. Box 550
Halifax, Nova Scotia
B3J 2S7

¹This series documents the scientific basis for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the secretariat.

¹La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte atlantique du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

Abstract

The fishery for American eel (*Anguilla rostrata*) elvers in Scotia-Fundy Region has, since its inception in 1989, increased the number of experimental licenses has increased to seven, with each license operating within separate, defined geographic areas, and increased catches from 26 kg to 3.2 tonnes, worth an estimated 1.6-2.2 million dollars.

Elver catches (presumed to reflect elver abundance) varied geographically and between years. In 1995, elver catches were highest along the lower Bay of Fundy and South Shores of Nova Scotia, moderately high along the lower Bay of Fundy (southwest) shore of New Brunswick and scarce along the Eastern Shore of Nova Scotia. In 1994, elver catches were higher in southwest New Brunswick than along the Fundy and South Shores of Nova Scotia. Elvers first arrive in April but most elver catch occurs during May. The higher proportion of May elver catch occurring in southwest New Brunswick relative to the lower Bay of Fundy shore of Nova Scotia reflects the counterclockwise movement of elvers through the Bay of Fundy in response to residual currents.

Refinements to the existing management plan are being considered for 1996 with the objective of promoting full geographic coverage by the fishery and providing for native and aquaculture requirements.

Résumé

Depuis les débuts, en 1989, de la pêche des civelles d'anguille d'Amérique (*Anguilla rostrata*) dans la région de Scotia-Fundy, le nombre de permis de pêche expérimentale est passé à sept, ces permis étant exploités chacun dans des zones géographiques distinctes, et les prises sont passées de 26 kg à 3,2 tonnes, d'une valeur approximative de 1,6 à 2,2 millions de dollars.

Les prises (censées refléter l'abondance des civelles) ont varié selon le lieu géographique et l'année. En 1995, elles étaient les plus élevées le long des rives néo-écossaises de la partie inférieure de la baie de Fundy et de la côte sud de la Nouvelle-Ecosse, moyennement élevées le long de la côte néo-brunswickoise (sud-ouest) de la partie inférieure de la baie de Fundy et rares le long de la côte est de la Nouvelle-Ecosse. En 1994, elles étaient plus élevées dans le sud-ouest du Nouveau-Brunswick que le long de la côte sud de la Nouvelle-Ecosse et des rives néo-écossaises de la baie de Fundy. Les civelles commencent à arriver en avril, mais c'est en mai qu'ont lieu la plupart des captures. La plus forte proportion de prises de civelles en mai dans le sud-ouest du Nouveau-Brunswick comparativement à la côte néo-écossaise de la partie inférieure de la baie de Fundy reflète la migration antihoraire des civelles dans la baie de Fundy pour contrer les courants résiduels.

On envisage d'améliorer le plan de gestion actuel en 1996, en vue d'étendre la pêche dans toute la région et de répondre aux besoins des Autochtones et des aquiculteurs.

Introduction

No fundamental changes have occurred in or to the fishery for American eel elvers (*Anguilla rostrata*) in the Bay of and Atlantic coastal areas of Nova Scotia (formerly the Scotia-Fundy Region) since the review by Jessop (1995). That review provides the necessary background information on eel biology and a biological and economic justification for an elver fishery. The high interest in the development and progress of this fishery and the ongoing development of management policy justifies an update on the status of this fishery which will be provided by this report.

Elver Fishery

Active fishing for elvers during 1995 remained confined to the former Scotia-Fundy Region, although the former Gulf Region (both regions have recently been amalgamated into a single Maritime Region) issued an experimental permit for test fishing in the Miramichi River estuary. The Gulf Region fishery was unsuccessful largely due to a restriction on where the fishing could occur. Catches of elvers in Scotia-Fundy Region more than doubled from 1,574 kg in 1994 to 3,238 kg in 1995 (Table 1). About 72 kg (2.2%) of the elver catch was used for aquaculture in New Brunswick. Most (5 of 7) fishers did not achieve their quota of 1,000 kg (except 5 kg for one new licensee fishing for aquaculture) in 1995 for reasons ranging from operational difficulties to lower elver availability in some areas. Two fishers achieved their initial quota and were granted extensions of up to 300 kg; neither extension was fully met.

Catches (Table 1) cannot be presented by geographic area, e.g., southwest New Brunswick, upper Bay of Fundy N.B. and N.S., lower Bay of Fundy N.S., south shore N.S., etc. because the Access to Information Act prevents public release of catch data that may be linked to individual fishers. The following discussion avoids presentation of detailed catch or other data where fisher identification might occur but reported observations may be based on such detailed analysis.

Market prices for elvers fluctuate substantially between years and throughout the fishing season. In 1995, reported (L. Flagg, Maine Department of Marine Resources, personal communication) prices for elvers paid by U.S. buyers (most Canadian elver catches are sold to U.S. buyers or at comparable market prices) averaged about \$685 Canadian/kg and ranged between about \$240 and \$1000/kg while a Canadian fisher reported average prices of \$500 Canadian/kg. At average prices, the 1995 elver fishery grossed between \$1.6 and \$2.2 million dollars.

The increased fishing activity in recent years and the expansion of the fishery to several new areas has begun to produce information sufficient for basic analysis of seasonal and regional patterns of elver catch. It is assumed that, given sufficient fishing effort in each fishing area throughout the period of elver arrival, catches will reflect elver abundance.

Prior to 1995, the largest annual elver catches occurred in the lower part of the Bay of Fundy on both the New Brunswick and Nova Scotia sides. Catches were largest from the south-western New Brunswick side of the Bay of Fundy, but the fishing effort (no effort statistics are available) is believed to have been greatest there also. In 1994, significant fishing effort began in the Nova Scotia portion of the upper Bay of Fundy and along the South Shore of Nova Scotia's Atlantic coast. In 1995, an exploratory fishery began in Guysborough County on the Eastern Shore area of Atlantic coastal Nova Scotia. According to observations and reported catches by the elver fishers, the abundance of elvers arriving in different geographic areas in 1995 differed from that in 1994, with a decreased abundance of elvers in Southwest New Brunswick, few elvers along the Eastern Shore of Nova Scotia, and greater

abundance along the Nova Scotia shore of the lower Bay of Fundy and the South Shore of Nova Scotia. These observations imply annual variability in the geographic distribution of elver abundance (fishing effort is believed to have been roughly similar in each area between years). Annual variations in elver abundance in an index river may reflect conditions only in a limited geographic area. Several appropriately distributed index rivers may be required to draw inferences from a wide geographic area.

Estimates of fishing effort in 1995 were obtained from several elver fishers to assist interpretation of the catch data (Table 2). The estimates of fishing effort were obtained several months after the end of the fishing season on a "best remembrance" basis since only daily catches from each river had originally been requested. Consequently, the effort data are of somewhat uncertain and variable accuracy. Catch per unit effort (CPUE) differed among areas ($F_{3,39} = 3.42$, $P < 0.03$; CPUE values logarithmically transformed) with the CPUE for the South Shore of Nova Scotia being lower than that from the other areas. It is believed that the effort reported from the South Shore area is overestimated and that CPUE was basically similar in all areas. Given this condition, one might conclude that regional catches depend simply on the effort expended. The fishers would reject this interpretation because the actual effort expended fishing depends, in a feedback loop, on the quantities of elvers available. Thus, if no elvers are present after an initial survey of the river on a given night, no further time is spent there and another river may be visited or fishing suspended. The similar CPUEs among areas may imply that, when elvers are present, their catchability by dip-net is similar among regions. Differences in catches among areas thus reflect differences in elver abundance among areas.

In all years, most catches (66-88%) occurred in May in all areas (Table 3). The high monthly variability in catch reflects the historical development of the elver fishery and seasonal variability in elver abundance. Elvers first arrive in late April or early May, depending upon the area, peak in May, and decline to negligible commercial quantities in, or before, early June. Small quantities of elvers may continue to enter streams, e.g., East River, Sheet Harbour, through July (Jessop, unpublished data). The proportion of catches occurring in May was consistently highest in the lower Bay of Fundy, New Brunswick (88%), then decreased in a clockwise fashion through the upper Bay of Fundy, N.B. (82%), upper Bay of Fundy, N.S. (78%), and lower Bay of Fundy, N.S. (63%). Elver catch proportions were similar (63%) during May in the lower Bay of Fundy and South Shore areas of Nova Scotia. The pattern and speed of coastal water currents and rising spring freshwater temperatures may play major roles in the coastal distribution and entrance of elvers to rivers. The arrival of elvers throughout the Bay of Fundy progressed in counterclockwise fashion from the lower Bay of Fundy, Nova Scotia, to Southwest New Brunswick consistent with the counterclockwise pattern (and probably velocity) of residual water currents in the Bay of Fundy (Greenburg 1984). American shad (*Alosa sapidissima*) migrate in a similar manner through the Bay of Fundy (Dadswell et al. 1983). Increasing river water temperatures may provide the first cue for elvers to enter rivers (Martin 1995) and river temperatures usually warm sooner along the south shore and lower Fundy shore of Nova Scotia than elsewhere in the Maritimes. Early elver arrivals to the lower Bay of Fundy may progress around the Bay until water temperatures rise sufficiently to cue river entrance.

Management Regulations

Refinements continue to be made to existing management principles and regulations (G. Stevens, Resource Management Branch, personal communication). Seven experimental elver fishing licenses presently exist for different geographic areas of the Scotia-Fundy Region, five of which permit commercial

sale, while two prohibit direct sale and are to be used for aquaculture. Four areas are not covered by experimental licenses - Shelburne/Yarmouth Counties, Halifax County from Dartmouth to the Guysborough County line, Cape Breton Island, and a small sector of Minas Basin shore from Cape Chignecto to Debert River.

Experimental licenses are issued for a specific purpose, have no guarantee of renewal, and may contain a variety of restrictions, such as specification of the rivers permitted to be fished, catch quota, permissible gear, weekly closed fishing period, and bycatch release provisions. A regular license, once issued, is annually renewable upon application and is restricted only by the provisions allowable under the Canada Fishery Regulations (General and Maritime). Present policy prohibits issuance of an experimental elver license for the Shelburne/Yarmouth County area because all rivers have existing fisheries for adult eels. Consideration is being given to issuing licenses for the remaining unlicensed areas in 1996.

Each commercial fishery license and one aquaculture license has arbitrarily, but with rough biological justification, been allocated a catch quota of 1,000 kg (one aquaculture license was issued a trial 5 kg quota), with consideration given to an extension of 300 kg if the initial quota is achieved. Catch quotas usually limit exploitation to biologically and managerially acceptable levels. Exploitation rates of 40-60% are often viewed as acceptable but the issue is moot when population size cannot or has not been measured. Elver recruitment to a river is usually unknown as is the population of large eels in, or the spawning escapement of silver eels from, any river. Insufficient information exists to set biologically meaningful catch quotas for elvers or larger eels. A quota set on an arbitrary but best judgement basis seems preferable to no quota, as for yellow and silver eels, although stage (elver, yellow, silver eel) and area (estuarine, freshwater) of exploitation (but not degree of exploitation) is irrelevant for eels.

It might be argued that the elver fishery quota should be proportional to the fishing area, on the assumption that elver abundance is proportional to the drainage area or discharge of a river or series of rivers in the licensed fishing area. Evidence presented above suggests that the assumption is false that annual elver recruitment is of similar density or abundance over wide geographic areas and among years. Drainage areas for the Scotia-Fundy portions of New Brunswick total about 65,400 km² and for mainland Nova Scotia (excluding Cape Breton) total about 37,800 km² (Maritime Resource Mapping Service, Amherst, N.S.). Elver fishing is licensed for about 17% and 32%, respectively, of the total drainage area in the Scotia-Fundy portions of New Brunswick and mainland Nova Scotia, for combined elver fishing area of 23% of the total drainage area. Individual fishers exploit an average of 57% (range 24-100%) of the total drainage area in their licensed territory. It is, I believe, premature to adjust an arbitrary catch quota on the basis of fishing area, particularly when changes to elver fishery quotas are likely to have minimal effect relative to the potential (many licenses for large eel fisheries are unused and existing gear allowances are often unfished) for fishing effort to increase greatly in the fishery for larger eels. Adjustments to the exploitation rates for eels in a river or geographic area should consider all life stages and the economics of each fishery.

Eligibility criteria for new elver licenses are being developed within Fisheries Management Branch and may be implemented in a public call for new applications where competing applications have been made for licenses in some of the presently unlicensed areas. The new eligibility criteria will accommodate native fisheries, CORE eligible fishers, and requirements of the aquaculture industry. Other changes being considered include the conversion of some experimental fishing licenses to regular fishing licenses and implementation in 1996 of a formal log-book system to collect data on daily catch and fishing effort for each river fished.

Summary and Conclusions

The elver fishery in Scotia-Fundy Region has grown substantially in the past four years as fishers have refined their skills in catching and handling elvers and their knowledge of the elver runs to various rivers within their license area. The present annual doubling of catch is unlikely to continue much longer because fewer areas remain to be exploited and those areas may prove to be less productive than the best areas presently fished. The data from DFO research projects, e.g., at East River, Sheet Harbour, and the annual catch records of the fishery permit an improved understanding of the biological characteristics of elvers entering Scotia-Fundy Region rivers and the annual variability in elver abundance among geographic areas. Proposed regulatory changes will further stabilise the fishery.

References

- Dadswell, M. J., G. D. Melvin, and P. J. Williams. 1983. Effect of turbidity on the temporal and spatial utilization of the inner Bay of Fundy by American shad (*Alosa sapidissima*) (Pisces: Clupeidae) and its relationship to local fisheries. Can. J. Fish. Aquat. Sci. 40: 322-330.
- Greenburg, D. A. 1984. A review of the physical oceanography of the Bay of Fundy, p. 9-30. In Gordon, D.C. Jr. and Dadswell, M.J. Update on the marine environmental consequences of tidal power development in the upper reaches of the Bay of Fundy. Can. Tech. Rep. Fish. Aquat. Sci. No. 1256. 686 p.
- Jessop, B. M. 1995. Justification for, and status of American eel elver fisheries in Scotia-Fundy Region. DFO Atl. Fish. Res. Doc. 95/2. 10 p.
- Martin, M. H. 1995. The effects of temperature, river flow, and tidal cycles on the onset of glass eel and elver migration into fresh water in the American eel. J. Fish. Biol. 46: 891-902.

Table 1. Annual catch (kg) of American eel elvers in Scotia-Fundy area, by province, 1989-1995.

Year	New Brunswick	Nova Scotia	Total Catch	Fishery Quota
1989	0	26	26	2,000
1990	132	42	174	2,000
1991	65	0	65	2,000
1992	227	0	227	3,000
1993	534	179	713	4,000
1994	650	924	1,574	4,000
1995	549	2,689	3,238	6,005

Table 2. Catch and fishing effort by the dip-net fishery for American eel elvers in Scotia-Fundy area, 1995.

Area	Catch per hour		
	N ^a	Mean ^b	SD
Lower Bay of Fundy, N.B.	9	0.74	0.37
Lower Bay of Fundy, N.S.	7	0.61	0.26
South Shore, N.S.	9	0.33	0.30
Eastern Shore, N.S.	18	0.75	0.65

^aN is the number of daily catch and effort estimates.

^bThe mean determined from individual catch/effort (c/e) values does not equal the c/e value determined from total catch and effort because individual c/e values are not additive and are non-normally distributed.

Table 3. Monthly percentages of annual total catch of American eel elvers in geographic areas, in Scotia-Fundy area, 1990-1995.

Area	Month	N	Mean (%)	Range (%)
Lower Bay of Fundy, N.B.	April	5	1	0.1-4
	May	5	88	52-98
	June	5	11	2-44
Upper Bay of Fundy, N.B.	April	1	5	
	May	2	82	71-97
	June	2	13	3-19
Lower Bay of Fundy, N.S.	April	3	25	9-35
	May	5	63	33-66
	June	1	12	
South Shore, N.S.	April	2	36	19-43
	May	2	63	57-79
	June	1	1	