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Justification for, and status of, American eel elver fisheries in Scotia-Fundy Region

by

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Abstract

North America contributes less than 1% to the total world production of eels (Anguillidae) for human consumption. Elvers of the native species have been fished by many coastal nations of Europe (Anguilla anguilla) since the early 1900s, by Japan (A. japonica) since the 1920s, and in various U.S. Atlantic coastal states (A. rostrata) since the 1970s to provide a base for eel culture. In recent years, as the demand for elvers for aquaculture has increased in Japan and Europe and the supply of elvers of local origin has declined, the demand for elvers from North America has increased.

A review of the available evidence on the biology of the American eel and other eel species (many fundamental questions remain) supports the fishing of elvers and other life stages to the extent that the spawning stock is not overexploited. The analysis also indicated economic advantages to fishing elvers, given the current price structure for elvers and larger eels. Although American eels are a panmictic species (a single spawning stock exists, composed of eels from all areas of the species geographic range) and ideally should be managed on a species-wide basis by international agreement rather than by political jurisdiction, conservatively-based management of each life stage of the eel (elver, yellow, silver) on a regional basis is a necessary prerequisite.

Since 1989, the development of elver fisheries in the Scotia-Fundy Region of Nova Scotia and New Brunswick has been encouraged, under tightly controlled conditions, as an opportunity to utilize this stage of the eel resource. The number of potential licences for fishing elvers is tightly limited, each license covers a specific geographic area, no fishing for elvers is permitted in streams where fisheries exist for larger eels, an overall catch quota is set for each license, catch limits are set for each fishable stream, and a record of daily fishing activity is required. The total elver harvest has increased from 26 kg in 1989 to almost 1.6 t in 1994, with greatest catch in New Brunswick.

Résumé

La part de l'Amérique du Nord dans la production mondiale d'anguilles (*Anguillidae)* destinées à la consommation humaine correspond à moins de 1 %. Les civelles d'espèce indigène sont pêchées par de nombreux pays côtiers d'Europe (*Anguilla anguilla*) depuis les années 1900, par le Japon (*A. japonica)* depuis les années 1920 et par divers États de la côte atlantique des É.-U. (*A. rostrata)* depuis la décennie 1970, pour alimenter l'anguilliculture. Ces dernières années, la demande de civelles d'Amérique du Nord a augmenté en raison des besoins accrus des anguilliculteurs du Japon et d'Europe, et de la baisse de l'offre locale.

Quoique de nombreuses questions fondamentales subsistent, une étude des données dont on dispose sur la biologie de l'anguille d'Amérique et d'autres espèces d'anguille milite en faveur de la pêche de ce poisson à l'état de civelle et à d'autres stades de son cycle biologique, puisque le stock reproducteur n'est pas surexploité. Cette étude fait aussi ressortir les avantages économiques d'une telle pêche, étant donné l'échelle des prix actuels de la civelle et des anguilles plus grosses. Bien que l'anguille d'Amérique soit une espèce panmictique (il n'en existe qu'un seul stock reproducteur, composé d'anguilles provenant de toutes les parties de l'aire de distribution géographique de l'espèce) et qu'idéalement il faudrait la gérer de façon globale, au moyen d'ententes internationales plutôt que selon les zones de compétence politique, une gestion régionale - axée sur la conservation - de l'anguille à chaque stade de son cycle biologique (civelle, anguille jaune, anguille argentée) est une condition préalable nécessaire.

Depuis 1989, on encourage le développement de la pêche de la civelle dans les parties de la Nouvelle-Écosse et du Nouveau-Brunswick qui composent la région de Scotia-Fundy, cela dans des conditions strictes, afin de permettre aux intéressés d'exploiter l'anguille à ce stade de son évolution. Les permis alloués à la pêche de la civelle, dont le nombre est très restreint, portent sur une région géographique donnée; de plus, la pêche de la civelle est interdite dans les cours d'eau où on pêche de plus grosses anguilles, les permis sont assortis d'un quota déterminé, des limites de prises sont établies pour chaque cours d'eau exploité et un relevé des activités de pêche quotidiennes doit être fourni. La récolte totale de civelles est passée de 26 kg en 1989 à près de 1,6 t en 1994, les captures les plus importantes provenant du Nouveau-Brunswick.

Introduction

Annual world production and consumption of eels, Anguilla spp., has averaged 100,000-120,000 tonnes (t) in recent years (Anon. 1987; Heinsbroek 1991; Gousset 1992). About 70-80% of world production occurs in Japan and Taiwan and is consumed in Japan. Europe produces and consumes the remaining 20-30% of world production. About 15% of European production is cultured. North American production contributes less than 1% to the world total, much of which is exported, primarily to Europe.

Regional markets in Europe and Japan prefer the local species of eel (Anguilla anguilla and A. japonica, respectively), although imports of American eels (A. rostrata) to Europe and Japan and A. anguilla to Japan occur where demand exceeds local species supply. High demand for eels and declining catches in Europe have increased interest in the culture of European eels (Heinsbroek 1991). Intensive culture of European eels has had variable success and the number of farms and quantity of production has declined in recent years (EIFAC 1993).

Eel culture uses wild-caught elvers as seedstock and competes with the use of elvers as a food delicacy in some areas, e.g., the Basque region of Spain. European elvers have been fished since the early 1900s; abundance has declined since the 1940s in Sweden (Hagström and Wickström 1990) and through the 1980s and early 1990s in Atlantic coastal Europe (Moriarty 1990, 1992; EIFAC 1993). For example, annual elver catches in the Severn River estuary of England once averaged 50-70 t (Bristol Channel Fisheries Ltd, promotional brochure) but have declined to less than 10 t (EIFAC 1993). Recent record low catches have increased European interest in importing elvers from North America. Elver fisheries began during the 1920s in Japan. Declines in Japanese glass eel (unpigmented elvers) abundance during the late 1960s led to imports of European and American elvers during the 1970s and early 1980s but these imports have since declined to very low levels because culture of European and American eels in Japan has generally been unsatisfactory (Gousset 1992). In Japan, about 50-65 t of glass eels are required annually to produce 40,000 t of marketable A. japonica (Gousset 1992).

Eel Life History

American and European eels spawn in the southwestern Sargasso Sea during late winter and early spring (January-April). Spawning areas of both species overlap greatly and occur in or south of the Subtropical Convergence Zone, which is a narrow latitudinal zone of thermal density fronts where water temperatures and density rapidly change (McCleave et al. 1987; McCleave 1993). After hatching, the Florida Current and Gulf Stream carry the willow-leaf-shaped leptocephali larvae north and eastward. Within a year, American eel larvae detrain from the Gulf Stream, presumably via oceanographic processes of eddy diffusion and intrusions of Sargasso Sea water onto the continental slope. McCleave et al. (1987) hypothesize that American eel leptocephali are developmentally ready at this time to metamorphose into glass eels when they encounter the sea bottom during their diel vertical migrations. European eels are hypothesized to have a later and longer window of time for metamorphosis to account for the greater travel distance to Europe. Upon metamorphosis, the leptocephalus becomes a glass eel (unpigmented elver). Glass eels switch from a diel rhythm to a tidal rhythm of vertical migration and use selective tidal stream transport to reach the shore and move up the estuaries of rivers (McCleave and Kleckner 1982). Glass eels in near-shore and instream areas progressively become pigmented and grow into small eels. Most pigmented elvers enter freshwater streams and progressively move upstream into headwater areas if access is possible, but some remain in estuarine and marine conditions. In Scotia-Fundy Region, glass eel arrival varies slightly with geography - in the lower Bay of Fundy, glass eels first arrive in estuaries at water temperatures of 5-7 °C, usually between late April and mid-May (Groom 1975), whereas along the Atlantic coast of Nova Scotia, elvers typically first arrive between early and late May (Hutchison 1981; Jessop, personal observation). Run peaks may occur 1-2 weeks after first arrival, at water temperatures exceeding 10 °C. By June, most elvers have become pigmented to some degree. In some areas, small numbers of elvers may continue arriving until late July and even August (Sheldon, 1974; Jessop, personal observation). When not engaged in seasonal migration, yellow eels have a relatively small home range, typically with areas about 1-2 ha (LaBar and Facey 1983; Bozeman et al. 1985; Ford and Mercer 1986). After a variable period of time, which may range from perhaps five to twenty or more years in Atlantic Canada depending on growing conditions (Gray and Andrews 1971; Jessop 1987), juvenile (yellow) eels begin sexual maturation, become silver eels, and migrate to sea to complete their adult life cycle by spawning and ultimately dying in the Sargasso

Sea. The eel stock of the rivers in Scotia-Fundy Region is primarily female (> 96% of eels sexually identified; Jessop 1987; Ingraham 1992).

Eel Population Structure

American and European eels are genetically distinct species (McCleave et al. 1987) although hybrids have been found (Avise et al. 1990). Both species are panmictic, i.e., have a single spawning site and random mixing of the gene pool at each spawning (Avise et al. 1986, 1990; Williams and Koehn 1984). Given that larval distribution of each species is essentially random because ocean currents are highly variable, no link has been identified between the river origin of any adult eel and the elvers that enter a river, i.e., no stock-recruit relation for the eel stock (management unit) of any river. At high stock abundance, many commercially-fished marine species do not seem to have a stock-recruit relation (Gulland 1983) but, at sufficiently low abundance, a relation develops and recruitment declines with continued overfishing (Hilborn and Walters 1992). American and European eels may have a stock-recruit relation at low stock abundance but data sufficient to test this hypothesis are unavailable. The nature of any relation between spawning eel abundance and elver recruitment to a geographic area is unknown. Nor is there knowledge of the relation between the number of elvers entering coastal areas and the number of spawners produced. Panmixia requires that recruitment variability of the American eel be interpreted at the level of the whole species (Castonguay et al. 1994a). Eggs, larvae, and, to a lesser extent, young marine fishes experience high rates of natural mortality due to predation and adverse environmental conditions and it is likely that similar high mortalities occur to eel eggs, larvae, and elvers. The nature (linear or non-linear) of the relation between abundance of various life stages is also unknown.

A variety of environmental and human-influenced factors can affect eel survival and growth during marine and freshwater life phases. Factors that might reduce elver/eel stocks include freshwater habitat changes that prevent access to or degrade rearing habitat, an excessive level of commercial harvest, and changes in marine oceanic conditions that reduce spawning success or the distribution of elvers to rivers. Some of these factors have been assessed in relation to the declining stock of American eels in the St. Lawrence River and Gulf with the conclusion that eel life history is too complex to unequivocally determine a cause (Castonguay et al. 1994a). Castonguay et al. (1994b) speculate that the decline through the 1980s of elver recruitment to Europe and to the Gulf of St. Lawrence was due to changes in oceanic conditions, specifically a more northerly position and slower current speed of the Gulf Stream. Recruitment of American eel elvers to rivers south of the Gulf of St. Lawrence appears unaffected. Uncertainty exists as to how much the extensive elver harvesting in European rivers has contributed to subsequent decline in elver recruitment because of the lack of synchrony between the decline and the long history of elver harvesting (Moriarty 1990), the intensive fisheries for yellow and silver eels, the progressive loss and degradation of habitat due to dams and weirs without fish passage, and to water pollution (Tesch 1977; EIFAC 1993).

Obstruction to upstream migration of elvers and small eels may unnecessarily reduce production of adult eels in many Scotia-Fundy streams. No specific guidelines exist to ensure adequate passage of elvers or eels (of any size) through fishways, highway stream culverts, or any other potential obstruction to upstream passage. Movement past natural and man-made obstructions, e.g., fishways and culverts may be prevented by high current flow and vertical waterfalls of even a few cm (Porcher 1992; Legault 1993). The weak swimming ability of elvers and small eels prevents successful use of most fishways, which are designed for strong swimming fishes such as Atlantic salmon. Average swimming speed and peak speed increases with eel size; elvers of about 50-70 mm length have peak swimming speeds of 0.6-0.9 $m \cdot s^{-1}$ and cannot handle water velocities exceeding 0.3-0.5 $m \cdot s^{-1}$ (Porcher 1992; Barbin and Krueger 1994). The movement of eels upriver is greatly slowed and reduced in number if only larger, older eels can pass the typical pool-and-weir fishway and culvert. Fishways may have inter-pool water velocities of 1.6-1.8 $m \cdot s^{-1}$ and a vertical drop between pools of 0.3 m (V. Conrad, Department of Fisheries and Oceans, Halifax, Nova Scotia; personal communication). The ability of eels to bypass obstructions by climbing over nearby wet surfaces may be more illusory than real, with few eels actually succeeding under most conditions. Production of adult eels in Scotia-Fundy Region could be much increased by attention to the specific requirements of eels for upstream passage at fishways, road culverts, and other obstructions. The progressive development of watersheds over time may inadvertently reduce eel habitat to the degree that movement upriver is delayed or prevented. No provisions are made for downstream passage of eels (primarily late summer-autumn migrating silver eels) at hydroelectric dams, with consequent high potential mortality of eels during turbine passage.

Other types of environmental degradation, e.g., acid precipitation and organochloride pollution might also affect eel survival and growth in freshwater, with ultimate effects on harvest and spawning stock size. About one-half of Nova Scotia (south-western and Atlantic coastal areas) has a geology prone to severe acidification ($pH <5.4$) of surface waters via acid precipitation (Watt et al. 1983); the geology of much of New Brunswick is less affected by acid precipitation. American eels are more tolerant of low pH than are many other species, e.g., salmonids, although densities and growth rates may be adversely affected by direct mortalities or declining abundance of prey as productivity declines at low pH. Comparisons of American eel survival and growth under different pH conditions are unavailable. Chemical contamination of eels seems insufficient to produce mortality. Polychlorinated hydrocarbons and pesticides were either undetectable or just above detection limits in American eels from the upper Saint John River, an area of high agricultural use of pesticides and herbicides (Prouse and Uthe 1994).

Justification for an Elver Fishery

The panmictic nature of American and European eel life histories requires coherent stock management on a continental-scale (EIFAC 1993), particularly when exploitation of elver and adult life stages is high. In the absence of continental scale management, local fishery managers must act prudently on a regional and local scale. In the Maritime provinces and Scotia-Fundy Region, exploitation of yellow eels may be sufficiently high in some rivers that signs of overfishing may appear, e.g., sustained decrease in size and quantity of eels caught. Overfishing of an eel stock in a river or lake becomes excessive when it is no longer economically viable; it is not an issue of threat to existence of the stock due to the unique life history of the eel. An unknown, but likely significant, portion of the regional eel stock is unfished or only lightly fished because the small size of many rivers makes fishing uneconomic.

The absence of any link between the eel stock of a river and the recruitment of elvers to it, and the large, widespread, and long-established European fisheries for elvers (notwithstanding the recent declines in European elver abundance) are evidence that a properly managed, moderate-scale fishery for elvers can exist in Scotia-Fundy Region without significant negative effects on regional fisheries for adult eels. The natural mortality rate of elvers during their first year in freshwater (or estuary) is unknown but is likely high, as for the early life stages of most fishes. Mortality rates of 40-60% are common for glass eels cultured over 6-12 months (Heinsbroek 1991); mortality rates of wild fishes usually exceed those of cultured fishes. Elvers caught in a fishery are a part of the overall mortality, not necessarily an addition to it; that is, most elvers caught in a fishery would likely die of other causes if not harvested. Only when all sources of mortality, including the adult eel fishery, become excessive is there a threat to stock abundance. The elver exploitation rate permissible with minor or no detectable effect on adult eel abundance is unknown, but elver exploitation rates of less than 25-30% may have minor effect relative to a high natural mortality rate. The exploitation rate for adult eels allowable over the geographic distribution of the species that is sufficient to maintain a spawning stock capable of producing some critical level of continent-wide elver distribution is also unknown. Natural mortality rates for larger American eels are also unknown. Whether elvers or larger yellow or silver eels are exploited is biologically immaterial (both are pre-spawning stages) as long as catch rates for each life stage are kept within limits that will not produce overfishing of the spawning stock. Determination of these limits will be difficult, perhaps impossible, and may only be evident after overharvesting has occurred. This does not imply that rational, conservative limits cannot be set based on existing knowledge.

Economics may be the deciding criterion, given no biologically best (from a stock perspective) stage at which to harvest eels. The economic justification for harvesting elvers rather than larger (yellow, silver) eels was evaluated under the following conditions: 6,500 elvers/kg, a mean eel size of 250 g (4/kg) and 10 years of age at capture (growth rate 25 $g \cdot yr^{-1}$; Jessop 1987), an elver survival rate during the first (arrival) year ranging from 0.4 to 0.7 (high elver survival rates are unlikely and may be lower than assumed here), and an annual eel survival rate increasing (in increments of 0.5, under the assumption that annual eel survival rate increases with age) ranging from 0.4 to 0.6 in year 2 to a maximum of 0.8 in annual increments of 0.05, then remaining constant, over a 10 year lifespan before harvest (total elver-eel mortality rates from 0.43 to 0.68), elver prices ranging from \$100-\$300/kg, and eel prices ranging from \$2.75-\$3.85/kg (a large increase in price for elvers is more likely than for eels). Under Scenario 1, which assumes a lower initial survival rate (higher mortality rate) for eels, profits were highest catching elvers rather than larger eels. Thus, even at the highest elver survival rate (0.70) and a total elver-eel mortality rate of 0.52 over a 10 year lifespan, harvesting elvers yielded \$15,385 at the lowest elver price of \$100/kg as compared with \$5,462 for eels at the highest eel price of \$3.85/kg (Table 1). The elver and eel mortality rate assumptions are most critical to the outcome of the model; increased survival rates for either/both elvers and larger eels and higher growth rates for larger eels are necessary to make eel fishing more economically beneficial than elver fishing. Under Scenario 2, an increased initial survival rate (decreased mortality rate) resulted in changing advantage for elvers versus eels, depending upon the specific mortality rates and price/kg for elvers and eels. If it is assumed that the average price/kg for elvers is more likely to equal or exceed $200/kg than the average price/kg for eels is to reach $3.85/kg, then fishing for elvers is equally, or more, economically profitable than fishing for eels.

Catch data accumulated from experimental fisheries is essential for assessing the potential elver yield of streams of various size and geographic location and the prospects for developing an economic, sustainable fishery. The abundance of elvers entering any river is unknown; it is presumed to be proportional to river size and may vary annually and regionally due to stock and environmental factors. The total annual return of elvers to the East River, Sheet Harbour (drainage area 526 km^2; mean May-June discharge 16 m^3·s^{-1}; Environment Canada 1991) between 1990 and 1994 has averaged 251,900 elvers (range 134,100-376,000) or about 48 kg in weight.

Run sizes to other rivers may be estimated by extrapolation from the East River data, assuming that the run size-river size relation is linear (unlikely), the availability of elvers from offshore is similar among geographic areas, and that the mean May-June discharge (or drainage area) is an appropriate indicator of elver attraction by a river. Elvers are attracted to streams by a preference for freshwater which contains the odours of decaying leaf detritus, aquatic plants, and migrating alewives and, less so, eel odour (Sorensen 1986; Tosi et al. 1990), which may vary among streams. Thus, the elver run to the Saint John River, New Brunswick (based on the area upriver of, and discharge at, the Mactaquac Dam, which underestimates values for the total drainage basin) can be estimated by linear extrapolation as 19.0 million (based on drainage area) to 24.8 million (based on discharge). Given 6,500 elvers/kg and a harvest efficiency of 25%, about 730-950 kg of elvers could be harvested from the Saint John River, if permitted. The drainage area (discharge is unavailable for many rivers) of rivers in the Scotia-Fundy Region totals about 94,800 km^2 which, by proportion, could have a total elver run of about 45.4 million elvers weighing 7.0 t. These quantities are small relative to the runs and harvests of elvers in European areas, where annual harvests of about 50-70 t were taken from the Severn River in England, over 100 t from the Loire River in France, and 2-3 t from the River Bann in Northern Ireland (Bristol Channel Fisheries Ltd., promotional brochure; Moriarty 1990), all of which are smaller than the Saint John River. Of course, the abundance of elvers arriving at a river need not be similar among species and continents but such wide disparity is unexpected. If the relation between river size and elver run size is nonlinear, the assumption of a linear relation could greatly underestimate run sizes of larger rivers. The East River may not be a good base from which to extrapolate elver returns for other Maritime province rivers: it has a low discharge, a discharge low for its drainage area, a moderately low pH, it may be less attractive to elvers than rivers with better environmental quality, and current patterns may bring fewer elvers to Atlantic coastal regions of Nova Scotia than to the lower Bay of Fundy. Annual elver harvests from rivers such as the Musquash (50 kg) and Magaguadavic (150 kg) of southwest New Brunswick presently approximate the projected total return based on drainage area (Musquash River 389 km^2; Magaguadavic River 1,812 km^2), yet dip net fisheries are naturally inefficient. Linear extrapolation of the catch-river basin area relation for the Musquash and Magaguadavic rivers provides an estimate of potential harvest of 3.2 t from the Saint John River, which may be more realistic than the 730-950 kg previously estimated. I conclude that insufficient data presently exists to reliably estimate the potential run of elvers to other Scotia-Fundy rivers. The run of elvers to the East River, Nova Scotia may be most useful as an index of annual variability in elver run size to Atlantic coastal streams of Nova Scotia and a source of data on the biological characteristics of elvers.

Status of the Elver Fishery

Increased demand for elvers in Europe and Japan and the desire of Canadian freshwater fishers to diversify in response to declines in traditional fisheries led to granting the first experimental license in Scotia-Fundy Region in 1989. That license permitted elver fishing in southwestern New Brunswick and prohibited elver fishing in rivers and estuaries where fisheries for adult eels exist. Since then, three other licenses have been issued to fish in Nova Scotia and New Brunswick. Experimental licenses have also been requested to fish the eastern shore of Nova Scotia and the Scotia-Fundy portion of Cape Breton. Licences to fish elvers are issued under Section 52 of the Fishery (General) Regulations, of which Section 38(1) of the Maritime Provinces Fishery Regulations otherwise prohibits the catch and retention of eels less than 20 cm long in Nova Scotia and New Brunswick. A variety of provisions is attached to each license, including specific limitations as to the geographic area and rivers to be fished, the type of fishing gear permitted (generally dip net, but also including Sheldon and other types of elver traps, fyke nets, and elver trawls), numbers of each gear type other than dip net, provisions for live return of bycatch, an overall catch quota of, usually, one tonne with possible limits on the quantity from any specific river, and a requirement to maintain and submit at seasons end a record of daily fishing activity and catch.

The elver fishery in Scotia-Fundy Region has developed steadily for the past six years as fishers developed familiarity with proper fishing methods and gear, explored potential fishing sites, developed holding and shipping methods, and established markets for their catch. The total elver harvest has increased from 26 kg in 1989 to almost 1.6 t in 1994, with greatest annual production usually from New Brunswick (Table 2). Additional detail on the geographic and river distribution of catch has not been given because this would enable identification of landings by licensee and release of such data is prohibited by the Access to Information Act. Elver exploitation rates in any river are believed low because elver fishing techniques are relatively inefficient and not yet intensively applied.

Elver and small eel fisheries have intermittently occurred since the 1970s in several U.S. Atlantic coastal states, particularly Maine (Fahay 1978; Gousset 1992; L. Flagg, Maine Department of Marine Resources, Augusta, personal communication). Catch statistics for U.S. elver fisheries were not routinely kept by some states and are unavailable. The reported 1994 catch of elvers in Maine was 3.0 t, about 40% of which was taken from the coastal region between the New Hampshire border and the Kennebec River, 40% between the Kennebec and Penobscot rivers, and 20% between the Penobscot River and the Canadian border.

Summary and Conclusions

The biological information presented suggests that a properly managed fishery for American eel elvers in Scotia-Fundy Region will be biologically sustainable because it will have little impact on regional eel abundance and consequently on spawning stock size. Prohibition of elver fisheries where existing fisheries occur for adult eels will prevent conflict between modes of exploitation. A preliminary economic analysis indicates that harvesting elvers rather than larger eels may be economically advantageous. Catches from the elver fishery indicate that elver returns to smaller rivers are insufficient to support an elver fishery alone and the rivers fished must be grouped regionally to be economically viable. The potential number of elver licenses is limited; the number already issued and those few under consideration for unfished regions are perhaps sufficient to exploit the available resource.

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Table 1. Economic evaluation of elver versus eel harvest - the value at specified market prices of elvers and of eels surviving from those elvers, given the assumption of a harvest of 1,000,000 elvers, 6,500 elvers/kg, a lifespan of 10 years between elver and harvested eel, a harvest weight of 250 g/eel (4 eels/kg), and two scenarios for the pattern and rate of eel annual survival: Scenario 1 - initial eel survival rate 0.4; Scenario 2 - initial eel survival rate 0.6.

Value/kg	$100	$200	$300
Value ($) of 1,000,000 elvers	15,385	30,769	46,154

	Scenario 1				Scenario 2			
Elver survival rate (yr 1)	Number of eels (yr 10)	Total mortality (Z)	Eel price/kg		Number of eels (yr 10)	Total mortality (Z)	Eel price/kg	
			$2.75	$3.85			$2.75	$3.85
			Catch value ($)				Catch value ($)	
0.70	5,676	0.52	3,902	5,462	46,965	0.31	32,288	45,205
0.60	4,865	0.53	3,344	4,683	40,256	0.32	27,676	38,745
0.50	4,054	0.55	2,789	3,902	33,546	0.34	23,064	32,288
0.40	3,243	0.57	2,230	3,121	26,837	0.36	18,450	25,831

Table 2. Annual catches (kg) of American eel elvers in Scotia-Fundy Region, by province, 1989-1994.

Year	New Brunswick	Nova Scotia	Total
1989	0	26	26
1990	132	42	174
1991	65	0	65
1992	227	0	227
1993	534	156	690
1994	650	934	1,584