

The Contribution of Inadequate Fines to the Collapse of the Sea-egg Fishery of Barbados

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ABSTRACT

A small but important fishery for the white sea-egg (*Tripneustes ventricosus*) has existed in Barbados for well over a century. Around the mid-1980s the sea-egg fishery of Barbados collapsed, despite over a century of continuous management through legislative control. Throughout this period of management, the imposition of fines was the principle punitive measure taken against offenders of the relevant legislation. Using a variety of reference material ranging from press reports to scientific studies, this paper presents a retrospective comparative analysis of the potential revenue derived from sea-egg fishing and coinciding fines. It is suggested that the maximum legislated fines in effect during the years just prior to the collapse of the fishery were too low to act as effective deterrents to illegal fishing when compared with the profitability of harvesting sea-eggs at the time. Increased profits from the fishery in addition to inadequate fines together may have encouraged both increased fishing intensity and imprudent fishing practices, both of which contributed to the collapse of the fishery.

KEY WORDS: Fines, management measures, sea-eggs.

INTRODUCTION

The Fishery

Sea-eggs are harvested for their roe, which is considered a nutritious and tasty delicacy. Barbados, St. Lucia, and Martinique are the only Caribbean islands where sea-eggs are harvested intensively (Smith and Berkes 1991). Archeological evidence indicates that sea-eggs were harvested in Barbados from pre-historic times, by the island's Amerindian inhabitants and then by the British settlers of the island (Hughes 1750).

The most productive sea-egg fishing grounds were concentrated along the southeast and northwest coasts of the island. However, sea-eggs were also located at several other sites around the island, and although fishers tended to fish in areas that they new best, they would travel to any site where the animals were found if the need arose. Traditionally sea-eggs were transported to shore where the shells were broken open and the roe scooped out with spoons. The roe was collected and washed in pails of water. It was then packed into cleaned intact "half shells", also known as husks. Leaves of the sea grape (*Coccoloba uvifera*) were shaped into

cones, filled with roe and used to cover the "half shells" (Brown 1942, Hickey 1982, Scheibling and Mladenov 1987). It is estimated that, on average, the roe of 15 sea-eggs were required to fill one half shell (Scheibling and Mladenov 1987). From the mid-1980's, sea-egg roe was also sold in plastic ice cream cartons. This latter packaging method rapidly increased in popularity and eventually all but completely replaced the older methods (Nation newspaper, 1991-09-26).

The arrival of the annual sea-egg fishing season was timely, as it came when the season for flying fish and the large pelagic fish, such as dolphin (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*), was over. In addition, the beginning of the season coincided with the last weeks of school children's summer holidays. Hundreds of Barbadians, men, women and children, became involved in some aspect of the fishery. In 1948 the industry was described as employing "almost every available fisherman and their families" (Wiles 1949). In 1949, the sea-egg fishery was estimated to net approximately \$30,000 per annum (Wiles 1949) making it the second most economically valuable local fishery at the time. Unfortunately the details of how the economic worth of the fishery was calculated were not outlined. In a letter written to the Director of Agriculture in 1950, Wiles stated that the sea-egg fishery comprised 75% of the total island's fisheries during the months of September and October (the pelagic off-season). Wiles went on to emphasize the importance of the fishery to fishermen by stating that: "fishermen of all classes, as well as boat-owners depend on this industry for a livelihood".

Review of Management Legislation

The social and economic importance of the sea-egg fishery to Barbados is evidenced by the fact that it was the first single species fishery in the island to be brought under legal control. The first laws governing the fishery were embodied in the Sea-egg Preservation Act of 1879. In the official announcement of the Sea-egg Preservation Act, printed in the Official Gazette of July 21, 1879, the Colonial Secretary, Mr. Walter Huey-Hutchinson stated that the object of the Act was "to preserve a cheap and popular article of food by preventing reckless and wasteful fishing for sea-egg at all seasons of the year" and that "the provisions of the Act will be strictly enforced and the police and rural constables have received instructions accordingly" (O.G. July 21, 1879, Vol. XIII, pg. 1339). The rationale stated for the enactment of the Sea-egg Preservation Act suggests that even in 1879, it was thought that Barbadian sea-egg stocks were in need of protection from overexploitation.

It is noteworthy that in the latter part of the 19th century many still had the view that the ocean's resources were limitless and could never be fished out. T.H. Huxley, a noted zoologist of the time, conveyed this sentiment in his opening address to the International Fisheries Exhibition held in London in 1883 by stating that "...all the great sea fisheries are inexhaustible: that is to say that nothing we do seriously affects the numbers of fish" (King 1996). The Sea-egg Preservation Act of 1879 was therefore a prudent piece of legislation for its time and is probably one of the first pieces of fisheries management legislation in the world.

The main regulatory mechanism of the Sea-egg Preservation Act of 1879 was the establishment of an annual fishing closed season (April 1st to August 31st, inclusive). The first documented scientific study of the biology and ecology of Barbadian sea-eggs was published by Lewis (1958). The results of this study confirmed that the major spawning period of Barbadian sea-eggs coincided with the closed season prescribed in the 1879 act. Therefore, these laws that were probably based entirely on common knowledge were in principle appropriate for the conservation of sea eggs. The actions of these 19th century legislators to formulate the Sea-egg Preservation Act were in keeping with the spirit of article 7.5.1. of the 1995 FAO Code of Conduct for Responsible Fisheries, which encourages states to apply a precautionary approach to manage and preserve exploited aquatic resources even in the absence of adequate scientific information.

Persons caught harvesting, selling or in possession of sea-eggs during the closed season were subject to fines (forty shillings, maximum) or imprisonment (maximum of 1 month with hard labour) and having their catch confiscated. The act included a clause giving the Governor the power to alter the closed season by simply publishing a notice of the impending change in the Official Gazette.

In October 1899, there appeared to be renewed fears of a possible collapse of the sea-egg fishery, causing the representative for St. Philip, Mr. Lofty to present a bill in parliament seeking to extend the closed season for a period of two years (1900-1902) to give local stocks some time to recover. A parliamentary committee, under the chairmanship of the Attorney General, Mr. William Herbert Greaves was appointed to consider and report on the bill. The committee interviewed sea-egg fishers and concluded that the fishery had declined considerably and that sea-eggs were then scarce. The decline was attributed to "persistent breeches" of the Act. It was suggested that the annual closed season should be extended to the end of September and that enforcement should be improved (Official Gazette, June 21st 1900. Vol. XXXV).

The sea-egg fishing close season was then duly extended to September 30th for each of, at least, the next five years. In addition, an amendment to the Sea-egg Preservation Act was signed into law in July 1900. (O.G., July 20th 1900. Vol. XXXV). This amendment was obviously geared towards improving enforcement of the sea-egg laws by stipulating that Police magistrates should appoint rural constables, who were to be supplied with copies of the Act and to be instructed that: "they are required to use every effort in their power to secure the observance of the provisions of the Act".

In 1904 all of the fisheries laws in existence at the time were consolidated in the Fisheries Regulation Act, 1904. All of the clauses included in the amended Sea-egg Preservation Act were included in the new act. However, some new clauses were also added. Owners of boats or gear used in the illegal harvesting of sea-eggs during the closed season were made liable to punishment under the law and it was made illegal to "...willfully and wantonly destroy sea-eggs lying on any bank or shallows along the coast..." or to "...cleanse any sea-eggs and leave the shell or offal thereof on any bank or shallow on which sea-eggs lie". The system of fines was also

changed, whereby the charges of possession or sale of sea eggs during the closed season carried a lesser penalty (a maximum fine of £2) than the other offences (a maximum fine of £5 along with forfeiture of catch, vessels and gear used). Notably the threat of imprisonment was removed.

The Fisheries Regulation Act was amended three times before it was repealed in 1993. The first of these amendments, the Fisheries Regulation (Amendment) Act, 1960 was enacted in September 1960. The highest fines of (\$25 maximum) could be imposed for illegal harvesting, the wanton destruction of sea-eggs, disposal of shells and offal on sea egg grounds and on owners of vessels and gear used in illegal harvesting. A lesser maximum fine of \$10 could be imposed on persons selling and possessing sea-eggs out of season. The fines were again increased in 1977, in the Fisheries (Amendment) Act, 1977. The same categories were maintained, except a \$250 fine replaced the \$25 fine and a \$100 fine replaced the \$10 fine.

The Fisheries Regulation (Amendment) Act, 1989, enacted in January 1990, was the last amendment made to the Fisheries Regulation Act, 1904. This last amendment substantially increased the maximum penalties for contravening the Act. In addition to fines, a period of imprisonment could once again be imposed. For illegal harvesting and owning a vessel or gear used in illegal sea-egg harvesting, the maximum penalty was a fine of \$1000 or 12 months imprisonment. Interestingly, wanton destruction of sea-eggs and the disposal of shells and offal on sea-egg banks seemed to lose its importance and carried the same penalties as for selling and possession of sea-eggs during the closed season. For these offences the maximum penalty was a fine of \$500 or 6 months imprisonment. The 1989 Amendment Act also lengthened the annual closed season from January 1st to August 31st.

The clauses of the Sea Egg Preservation Act of 1879 and subsequently of the Fisheries Regulation Act of 1904 that gave government officials powers to alter the annual sea egg fishing close seasons by publishing a notice of the change in the Official Gazette, was often invoked during the first half of the 20th century (Table 1). It is note worthy that closed seasons were shortened on a number of occasions to allow persons to legally access the resource during times of hardship, for example during the two world wars.

Table 1. Annual legal closed seasons for the sea-egg fishery of Barbados (1879-2001). Laws are shown in bold.

Year	Legal closed season	Reference to relevant Law or Notice in the Official Gazette
1879 to 1899	1 April - 31 August	Sea-egg Preservation Act (1879-1)
1900 to 1903	1 April - 30 September	June 21, 1900, Vol.XXXV, No.55, pg.1291
1904	1 April - 30 September	August 29,1904, Vol.XXXIX, pg. 1525
1905	1 April - 30 September	July 24, 1905, Vol.XL, pg. 1323
1906 to 1907	1 April - 30 September	No specific reference to the sea-egg close season found for these years, assumed that the extended closed season (1900) still applies
1908	1 April - 8 September	September 7,1908, Vol.XLIII, pg. 1340
1909	1 April - 16 September	September 20, 1090, Vol. XLIV, No. 78, pg.1646
1910 to 1911	1 April - 31 August	Assumed to default to original period as no specific change gazetted
1912	1 April - 14 August	August 9, 1912, Vol. XLVII, No. 66, pg. 1387.
1913 to 1915	1 April - 31 August	Assumed to default to original period as no specific change gazetted
1916	1 April - 14 August	
1917	1 April - 31 July	July 30, 1917, Vol. Vol.LII, No.66, pg.1433
1918	1 April - 31 July	August 1,1918, Vol.LIII, pg. 1343
1919	1 April - 31 July	August 4,1919, Vol. LIV, No. 64, pg. 1029
1920	1 April - 31 July	July 26, 1920, Vol. LV, No. 60, Pg.785
1921	1 April - 31 July	August 1, 1921, Vol. LVI, No. 62, pg. 691
1922	1 April - 31 July	July 24, 1922, Vol. LVII, No. 59, pg. 829
1923	1 April - 31 July	July 30, 1923, Vol. LVIII, No. 61, Pg. 837
1924 to 1926	1 April - 31 August	Assumed to default to original period as no specific change gazetted
1927	1 April - 31 August	July 21, 1927, Vol. LXII, No. 58, pg. 879
1928	1 April - 31 August	July 19, 1928, Vol. LXIII, No. 58, p. pg. 821

Year	Legal closed season	Reference to relevant Law or Notice in the Official Gazette
1929 to 1932	1 April - 31 August	Assumed to default to original period as no specific change gazetted
1933	1 April - 31 August	July 31, 1933, Vol. LXVIII, No. 61, pg. 1281
1934 to 1936	1 April - 31 August	Assumed to default to original period as no specific change gazetted
1937	1 April - 11 August	August 9, 1937, Vol. LXXII, pg. 1219
1938	1 April - 31 August	Assumed to default to original period as no specific change gazetted
1939	1 April - 23 August	August 28, 1939, Vol. LXXIV, pg. 1598
1940	1 April - 23 August	August 8, 1940, Vol. LXXV, pg. 1458
1941	1 April - 15 August	August 4, 1941, Vol. LXXVI, pg. 1031
1945 to 1950	1 April - 31 August	Assumed to default to original period as no specific change gazetted
1987 to 1989	1 September, 1987- 31 August 1989	August 20, 1987, Vol. CXXII, No. 73, pg. 854
1990 to 1993	1 January – 31 August	Fisheries Regulation (Amendment) Act, 1989-32
1993 to 1997	No Official Closed Season	Fisheries Act (1993/27) - No closed season defined
1998 to 2001	1 August, 1998 to 31 July, 2001	Fisheries (Management) Regulations, 1998, (S.I. No. 102, 27 July, 1998, Vol. CXXXIII, No. 61) Fisheries (Sea Eggs Closed Season) Notice, 1998 (S.I. No. 103, 27 July, 1998, Vol. CXXXIII, No. 61)

In 1993 the Fisheries Regulation Act of 1904 was repealed and replaced with the Fisheries Act, 1993. The format of the Fisheries Act was significantly different than that of the Fisheries Regulation Act. Laws related to the management of fisheries were made more general to cover all controlled fisheries and were not written for specific fisheries such as sea-eggs. The laws pertaining to the enforcement of the legislation embodied in the Fisheries Act were made more extensive. Enforcement of the Act was vested with a group of individuals entitled "authorized officers" and the law courts. Authorized officers included officers of the Fisheries Division, Customs, Police and the Coast Guard. The laws gave the authorized officers the power to stop and search fishing vessels and vehicles suspected of being used in contravening any of the laws included in the Act. Any fishing gear, vessel and cargo, or vehicle suspected as being used in the commission of an offence under the Act could be seized. Finally authorized officers had the power to arrest any person suspected to be committing an offence under the Act.

The Act also vested the Minister responsible for fisheries with the responsibility to make regulations relevant to the management of any fishery. These regulations could include, limiting fishing effort, setting maximum allowable catches, prohibiting any fishing method, controlling the use of SCUBA in fishing, prescribing closed seasons and closed areas and regulating the marketing and distribution of captured aquatic fauna. The Minister was also charged with the responsibility of prescribing measures for the protection of marine species such as sea-eggs.

The structure of the Fisheries Act of 1993 mandated that a closed season for sea-eggs had to be prescribed by the Minister. This was in fact not done until 1998. Consequently for the intervening five years the sea-egg fishery was effectively unregulated from a legal standpoint. In 1997, the Fisheries Division published a comprehensive Management Plan for all of the existing Barbadian Fisheries including that of the sea-eggs. The recommendations made to manage the sea-egg fishery were accepted by Government and put into law in August 1998, along with several other regulations related to other fisheries, in the form of the Fisheries (Management) Regulations, 1998. The maximum penalties for contravening any of the regulations were exceptionally stiff, a fine of \$50,000 and/or two years imprisonment.

The regulations specifically related to sea-eggs included banning the use of SCUBA equipment for harvesting sea-eggs. The Minister was also to prescribe a closed season for harvesting sea eggs and could designate closed areas as declared by a notice published in the Official Gazette. A companion Statutory Instrument that officially closed the sea-egg fishery for a period of three years was enacted simultaneously with the Fisheries (Management) Regulations. This three year long respite affords the over-fished sea-egg stocks a period in which to recover in numbers while government fashions a co-management arrangement for the fishery with sea-egg fishers. This is in keeping with the recommendations of Government's management plans for the sea-egg fishery (Fisheries Management Plan, 1995).

Despite continued management of the fishery since 1879, there were several occasions when it was feared that the fishery was in danger of collapsing. Government's response to these situations was usually through adjusting the legislation in some way. The causes of the potential collapses were usually attributed to illegal fishing during prescribed closed seasons. However, it was not until around the mid-1980s that it was officially recognized that the fishery had collapsed.

Public education leading to voluntary compliance is the best strategy of ensuring that regulations are obeyed. However, punitive measures must always be attached to any legislation to act as a deterrent to non-compliance. The fines should both fit the crime and be significant to the offender (King 1996). The premise used in this paper is that a fine will only be effective if it exceeds the profits that could be garnered by persons flouting the regulations. Using a variety of source material, including both published and unpublished reports on the fishery, Official Gazettes and newspapers, this paper attempts to offer a simple, economically based retrospective analysis of the profitability of sea-egg fishing in Barbados and the adequacy of impossible fines in managing this fishery.

METHODS

Declining sea-egg abundances were reported at many popular fishing sites during the early 1980s. However, it was not until around 1983 that declines in abundance were observed on all coasts by some fishers (Scheibling and Mladenov 1987). Given that fishers were not necessarily site specific, they would tend to focus their efforts on sites that were productive. Therefore, for the purposes of this study, it was presumed that the critical point at which fishers could not take enough sea-eggs to make their normal profits was when the numbers of sea-eggs at all available sites had declined significantly. All fishers agreed that the east coast was the last bastion for local sea-egg stocks and that the significant decline in populations along this coast was observed in around 1983. Therefore, for the purposes of this economic study the point of collapse of the sea-egg fishery is taken as between 1983-1984, the first season that the decline had reached island-wide proportions.

No quantitative catch and effort data were found for the local sea-egg fishery. However, based on interviews with sea-egg fishers, conducted in 1986, Scheibling and Mladenov (1987) estimated that on a daily basis, fishermen sold between 30-150 sea-egg shells (mean = 78.7) prior to the mid-1980s collapse and between 2-24 shells (mean = 9.4) following the collapse. Using these mean catch sizes, estimates of mean daily revenue from sea-egg sales were calculated based on price data obtained from several sources, for the period 1973-1994 (Table 2), by multiplying the cost per shell by the respective mean catch size (78.7 for years before 1984 and 9.4 for years after 1984). From these calculations it was possible to estimate the revenue that a fisherman taking an average catch in a day would have made in each year.

Using the estimated mean daily revenue of a sea-egg fisherman in 1973 (\$78.70) as a basal value and the annual increase in mean wage rates as calculated by the Central Bank of Barbados using the Laspeyres Wage Rate Index for Barbados (CBB, 1995), it was possible by calculation, to estimate what a person earning that amount of money (\$78.70 per day) in 1973 would have earned in each successive year. The Laspeyres Wage Rate Index used by the Central Bank is an arithmetic mean of wages and salaries for hourly-paid skilled labourers in several employment sectors, using a 40-hour week as the basis for calculation. The values were weighted based on the percentage of the total employment provided by each sector, except where such data was unavailable when percentage contribution to GDP by the sector was used instead. The basal year used is 1980 (CBB 1995). For this study, the wages presented were calculated based on the means over all the sectors and therefore provides a general estimate based on most kinds of employment in Barbados. Simple linear plots were used to compare the rate and pattern of increase in potential earnings from sea-egg fishing over the years with the mean estimated wages earned by persons in other forms of employment. The hourly income for a fisheries assistant employed by Government has been included in some years to provide a benchmark for comparison of the calculated mean estimated wages with real wages.

Table 2. Retail prices reported for sea-egg half shells and information source. *Price converted per shell from price quote per 1 litre container by formula 4 shells=1 litre.

Year	Retail price (¢)	Reference source
1938	3	Report of the Royal West India Commission, 1939
1942	5	H. H. Brown, 1943
1945	8	Control of Prices (Defense) (Amendment) Order 1945 No. 15
1946	8	Control of Prices (Defense) (Amendment) Order 1946 No. 19
1947	8	Control of Prices (Defense) (Amendment) Order 1947 No. 39
1948	8	Control of Prices (Defense) (Amendment) Order 1948 No. 19
1949	8	Control of Prices (Defense) (Amendment) Order 1949 No. 17
1950	8	Control of Prices (Defense) (Amendment) Order 1950 No. 23
1952	12	Advocate Newspaper, 1952-09-02
1953	14	Advocate Newspaper, 1954-09-02
1954	16	Advocate Newspaper, 1955-09-02
1957	20	Advocate Newspaper, 1957-09-03
1960	25	Advocate Newspaper, 1960-09-02
1966	30	Advocate Newspaper, 1967-09-01
1967	30	Advocate Newspaper, 1967-09-01
1968	35	Advocate Newspaper, 1968-09-03
1973	100	Advocate Newspaper, 1974-09-04
1974	125	Advocate Newspaper, 1974-09-04
1978	175	Nation Newspaper, 1978-09-01
1979	200	Advocate Newspaper, 1979-09-11
1982	375	Nation Newspaper, 1982-09-03
1985	600	Scheibling and Mladenov, 1987
1986	625	Sunday Sun Newspaper, 1986-09-07
1989	800	Sunday Sun Newspaper, 1989-09-03
1990	1000	Advocate Newspaper, 1990-09-02
1991	1000	Advocate Newspaper, 1991-09-02
1993	1000	Nation Newspaper, 1993-09-02
1994	2000*	Saturday Sun Newspaper, 1994-11-18

Terms of imprisonment were included as possible punishment for illegal harvesting of sea-eggs in some versions of the various relevant Acts. However, in reality breaking the regulations are misdemeanor offences and offenders would hardly have faced imprisonment. The imposition of fines was the most likely punishment for illegal sea-egg harvesting. As such, this study only focuses on the impact of the maximum imposable fines as deterrents to illegal sea-egg harvesting. For this analysis, simple linear graphs were used to compare the annual estimated revenues for mean sea-egg catches using the estimates of catch size and prices presented above for fishing periods of 1, 2 and 7 days, to the maximum fines

impossible for illegal sea-egg harvesting in force in the corresponding years.

RESULTS AND DISCUSSION

The plot of estimated revenue earned from sea-egg sales in Figure 1 illustrates that the revenue from sea-egg sales increased at roughly the same rate and pattern as ordinary wages between 1973 - 1979. However, from 1979 to 1982 the rate of increase in revenue from sea-egg sales substantially exceeded the rate of increase in mean ordinary wages. Note that although no price data could be found for the years 1980 and 1981 the increasing trend fits well with the apparently exponential trend in price increases occurring from around the early 1970s. From 1986, the revenue from sea-eggs fell dramatically, well below that of the predicted regular wages, and only increased again slightly in 1994. Over this period prices continued to rise but the decline in total revenue was driven by the presumed marked decline in catch sizes.

In essence, these graphs suggests that the profitability of sea-egg sales increased at a faster rate in the years leading up to the mid-1980s collapse than the rate of increase of regular mean wages. The high profitability of the fishery is further emphasized by comparison with the wages that a fisheries assistant, a junior technical government post, would have received in the same years. Given the low capital and operational costs incurred for harvesting and selling sea-eggs and the low level of skill needed to fish the animals, it is quite clear that the fishery at that time would have been very attractive from a financial perspective for anyone capable of free diving. Increased profitability would have encouraged increased fishing effort such as the length of fishing time, on the part of the harvesters. It would also be understandable why many non-professional fishers would have entered the fishery especially in this period of maximum profit making. This would have resulted in a marked increase in total fishing pressure, both in terms of the number of persons fishing and the fishing time per person. Such increased pressure could easily lead to over-exploitation of the resource.

It should be noted that one of the forces that may have driven the price of sea-eggs up in the first place was increasing scarcity of the resource. Signs of resource depletion in the early 1980s had been reported at the time (Hickey 1983, Scheibling and Mladenov 1987). However, in the case of the sea-egg fishery an increase in search time is theoretically all that would be required to gather a profitable catch from a stock that had only just started to decline in numbers. An increase in personal fishing effort costs nothing other than physical exertion to the fisher. It is only after the stock has collapsed and there are too few sea-eggs to be found that the fisher will not, despite his best efforts, be able to gather a profitable catch.

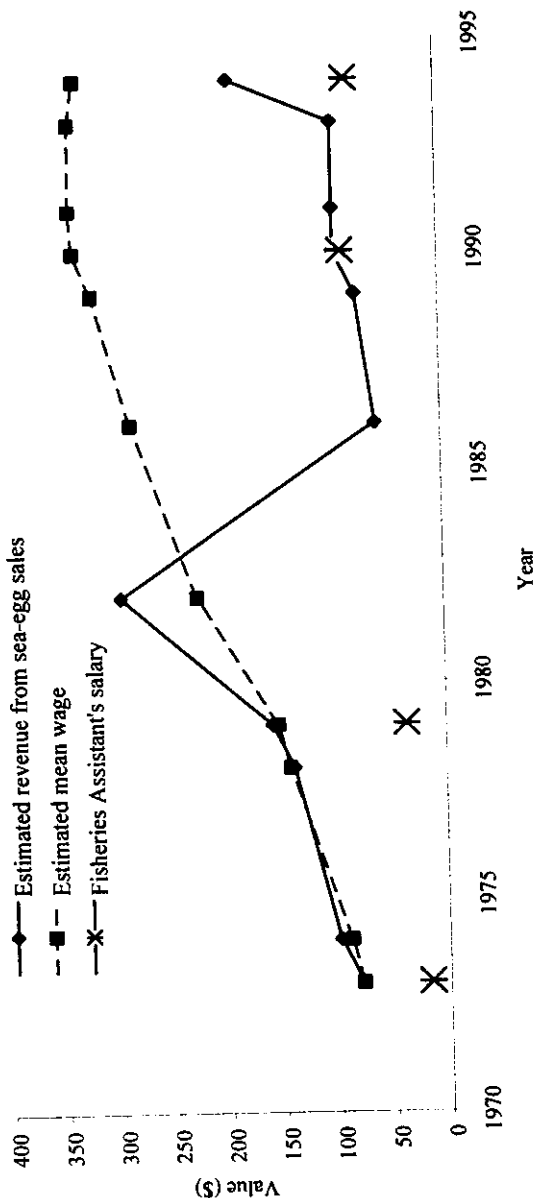


Figure 1. Estimated daily revenue from sea-egg sales compared with estimated mean daily wage, based on Laspeyres Wage Index for Barbados and with daily salary of a Fisheries Assistant, an example of a junior technical government post (1973 - 1994).

One economic mechanism to break the cycle of increasing fishing effort in response to increasing profitability and *vice versa* is to control the maximum retail price of the commodity. The rationale for such a measure is that opportunistic part-time fishers seeking quick financial rewards would be deterred from participating in the fishery, as they would not be able or inclined to spend the necessary time fishing to make the profits they desired. Only persons who truly relied on the income from sea-egg fishing would have continued to fish the resource and expend the time and energy needed to make their efforts financially worthwhile. However, this system would have resulted in increased financial hardship on full-time fishers, as while the money from the fishery only supplements the total earnings of part-time fishers, it represents the total or a much more substantial portion of the total earnings of the full-time fishers.

There are many other more sociologically sensitive methods of controlling the number of persons involved in a fishery that could have been used. One example is the use of a licensing system that only allowed true fishers to harvest the resource. High prices for the commodity may actually have assisted such a licensing system in protecting the stock, as fishers would not have needed to collect such large numbers of sea-eggs to earn a reasonable income. It is, therefore, recommended that such a licensing system be put in place as part of the management system of this fishery.

One of the potential negative impacts of out-of-season harvesting is the increased risk of taking animals during their spawning season, thus reducing the reproductive potential of the stock and consequently the size of the succeeding generation. The other negative impact is taking animals before their gonad volume has increased following spawning, resulting in lower yield and more animals being harvested to supply the demand for roe.

Mahon and Parker (1999) reported that many fishermen interviewed admitted to fishing sea-eggs illegally. Faced with the prospects of increased competition for the dwindling resource during the legal fishing season, many persons would have been tempted to harvest the animals before the season officially began to ensure that they were able to gather a sizeable and profitable catch. The additional "black market" price that out of season sea-eggs would have fetched would have further encouraged those willing to engage in premature harvesting. The reaction would of course be for even the most responsible fishers to engage in the practice, if for no other reason than financial survival. Many fishers suggested that they would not have engaged in out of season fishing if it were certain that others were not going to (Mahon and Parker 1999). The only real deterrent to curb such a trend would have been the threat of harsh punishment.

Figure 2 clearly indicates that the revenue derived from just two days of collecting an average size sea-egg catch exceeded the maximum fine that could be imposed in the years prior to the mid-1980s stock collapse, from as early as the 1960s. Essentially the fisher only needed to successfully illegally fish for two days to earn enough money from the activity to cover the fine. Past this point any additional fishing would have been pure profit. It is well accepted that government's policing of the sea-egg fishery has traditionally been poor. There are several reasons

for this, which will not be dealt with here. What is relevant to this discussion is that the chance of a fisher being caught and charged with illegal sea-egg fishing was small. With the very slim chances of getting caught and the low fines that were easily covered by two days of fishing, it is understandable why fishers would have found it tempting to engage in illegal fishing during this period. With a chance of earning as much as \$2,066 for one week of collecting an average number of sea-eggs in 1982, it is not surprising that people would have been encouraged to flout the law especially at this time. Therefore, it is suggested that the fines that could be imposed during the years prior to the stock collapse were totally inadequate as deterrents to illegal fishing.

The substantial fine of \$50,000 imposed by the Fisheries Management Regulations of 1998 for illegal fishing activities including those related to the sea fishery, marks a dramatic change in the policy of Barbadian governments regarding punishing offenders of fisheries' legislation. The basic tenet of setting the size of a fine is that the fine must match the weight of the crime. The significant increase in penalties attached to illegal fishing activities clearly demonstrates that the present government is of the view that the threats posed to fished resources, such as sea-eggs is much greater than in the past. However, the severity of the penalties may generate additional problems. For example, persons may be less willing to report offences if they are aware that in so doing they expose the perpetrators to such severe penalties (Dr. J. Horrocks pers. com.). In addition, to escape prosecution, offenders may be more inclined to offer bribes to persons that may potentially report on them and *vice versa* (Dr. D. Brown pers. com.). However, such a large fine should act as an effective deterrent to all but the most determined of poachers.

These historical economic analyses suggest that increased fishing effort driven by high profitability of the fishery and illegal harvesting, not effectively deterred by the system of fines in existence at the time, probably contributed significantly to the over-exploitation and eventual collapse of the Barbados sea-egg stocks. Local stocks have not yet recovered from the decline, and the future of the fishery remains bleak. However, it is hoped that the lessons learned from this experience will not be ignored and can be applied to successfully manage other easily accessible fisheries such as conchs and lobsters.

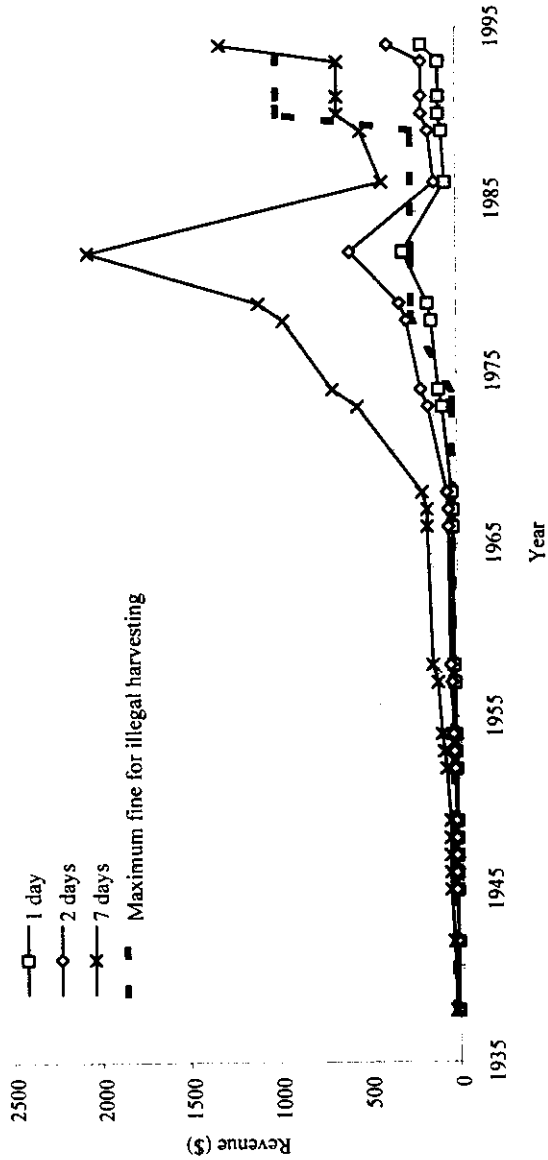


Figure 2. Comparison of estimated revenues from mean catches of sea-eggs for 1,2 and 7 days of fishing with maximum fines for illegal fishing (1993-1994). See text for methods of calculation.

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