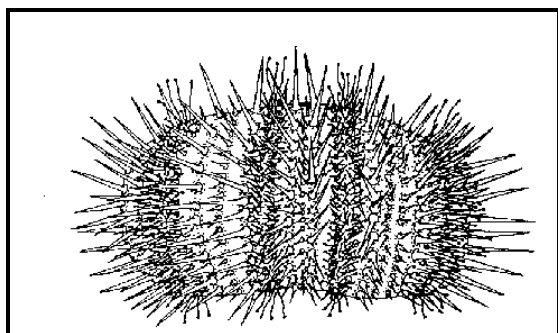




Nova Scotia Green Sea Urchins

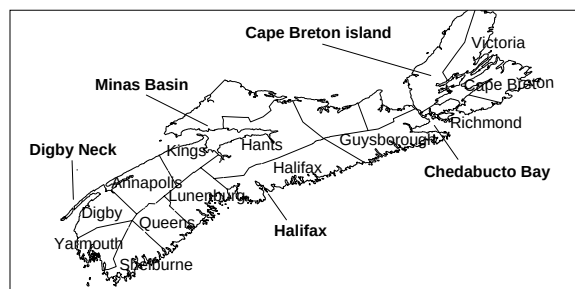
Background

The green sea urchin (*Strongylocentrotus droebachiensis*) is common to shallow rocky bottoms throughout Atlantic Canada. It matures at about 7 g and 25 mm shell diameter. Spawning occurs in early spring and the larvae are planktonic for 8-12 weeks before settling permanently to the bottom. It reaches commercial size in as little as 5 years if well fed, but may not reach this size in 15 years if the ration is poor. Its principal food is seaweeds, but attached bottom animals and decaying organic matter are also eaten. Urchins are found in highest concentration in feeding fronts bordering the deep edge of kelp beds. A variety of fish, crabs, and seabirds are predators.

The fishing area considered here is all the Nova Scotia shore exclusive of the Gulf of St. Lawrence. Most of the landings have come from Shelburne, Halifax, and Guysborough counties, but in 1999-00 Digby County became an important contributor.

Disease caused by a parasitic amoeba is the biggest threat to the stock.

Harvesting is by diver only. The fishery is also regulated by a minimum urchin size, a participation clause for exploratory licenses, and many fishing area restrictions. The marketable product is gonads and the market is almost entirely Japan.



Summary

- Landings were less than 100 t from 1989-90 to 1992-93, ranged from 1000-1300 t from 1994-95 to 1998-99, and fell to 900 t in 1999-00.
- Disease is the biggest threat to the sea urchin stock. Since 1995, it has eliminated 10 to 100 times the biomass the fishery has taken.
- The dive fishery is unlikely a threat to the biological sustainability of the urchin stock because of reproductive refuges in space, urchins below legal size, and urchins with poor quality gonads.
- A large resource in Cape Breton is largely unexploited; Guysborough and Shelburne counties have lost a significant portion of their stock to disease; Halifax, Lunenburg, and Queens counties have lost all their fishable stock to disease; the resource is probably small in Yarmouth, Annapolis, Kings, Hants, and Cumberland counties; Digby County landings are expanding, with the limits unknown.
- The resource in Guysborough and Shelburne counties has been underused. Because further loss from disease may occur, steps should be taken to increase utilization while ensuring access of fishers currently active.

- Unlike many fisheries, catch per unit effort is not a good index of stock size because restricted zones give fishers the freedom to plan for days of near uniform harvest.
- Most fisheries assessments and quotas are based on tonnes of fish. In this fishery, the focus has been on the fishing license and the fishing area needed to support a license.
- There are strong advantages to the restricted zone approach to management. However, correct sizing of zones remains an obstacle to achieving its full benefits.
- Better data are needed on landed weights, fishing locations, roe yields, urchin movement, catch history of selected beds, and factors controlling the spread of disease.

The Fishery

Management regime

This is a gonad fishery (although called a roe fishery, no distinction is made between ovaries and testes) with Japan as the ultimate market. Most of the best quality urchins are shipped by air to Japan for processing, and lesser quality (lower percentage yield and less valued color) are trucked to Maine for processing. About 20% of all qualities are processed in Nova Scotia.

This is a diving fishery, with two categories of licenses – exploratory and full-time limited access. For both categories, the following license conditions apply:

Management control	Regulations
Fishing Effort	Diving only, 4 divers per boat
Seasons	None unless requested by fishers
Fishing Areas	Open - usually one county only Restricted - a few miles of coast, one license per area
Size	50 mm test diameter minimum
Catch reporting	Hail in 100 % of trips, catch monitored 20 % of trips
Minimum landings	No minimum for permanent licenses, 4 t/yr for exploratory licenses

Restricted zone regime

In the Nova Scotia urchin fishery the primary regulatory tool is the number of fishing licenses per geographic area of coastline. Initially, an assessment is made of how many licenses a section of coast might support and that number of licenses is issued. These licenses are restricted usually to a county to maintain dispersion of effort. They fish competitively within that area.

After meeting specified guidelines, fishers from competitive areas can apply for an individual restricted zone (one licensee per area). Setting zone boundaries usually requires a detailed survey of the yield potential. After a few years, the zone is again surveyed (audited) for degree of utilization. Zones are granted as an annual condition of license. Pros and cons of the restricted zones are:

Pros

- Fishers may implement a harvest plan without interference from others.
- Landed value is increased because of higher gonad yields and harvesting to market demand.
- Stock and habitat enhancement is possible and the problems of a competitive fishery (tragedy of the commons) are avoided.

- Fishers can manage the abundance of urchins and their food to create an optimum balance. When they do not, the resource is said to be undermanaged.
- Fishing effort is geographically distributed in relation to the resource abundance.
- The cost of fishing is decreased.
- Enforcement and assessment costs are reduced.

Con

- Start-up costs of establishing zones are high.
- Fishers may resist downsizing zones as well as responsibility to enhance stock and habitat.
- Consensus on an exact measure of optimum zone size is difficult to achieve.
- There is strong opposition to area-based access from those excluded from the fishery.
- The management agency and fishing industry must be persistent in defending the plan.

Under competitive, quota-based fisheries the stock size is measured in tonnes, the total allowable catch is calculated in tonnes, and tonnes are allocated among fishing enterprises. Under that regime, a great deal of money is spent by biologists monitoring and predicting recruitment to the fishery, by fishery managers and fishers allocating the potential yield among participants, and by police enforcing compliance. Also, individual fishers must share with others benefits from conserving a stock as well as costs from abusing it (the tragedy of the commons).

The restrictive zone regime is based on access to specific areas by individual fishers and is different from traditional, quota-based competitive fisheries. The system allows

individuals to manage their zones efficiently. In sum, the restricted zone regime has considerable advantages over quota management systems for sea urchins.

Licenses by county for 1999-2000 season

Competitive Zone				
County	Active	Inactive	Active	Inactive
Victoria	1	4	0	0
Cape Breton	2	5	1	0
Richmond	1	6	0	0
Guysborough	0	3	10	2
Halifax east	0	3	3	3
Halifax west	0	1	0	1
Lunenburg	0	2	0	0
Queens	0	1	0	0
Shelburne	0	0	7	1
Yarmouth	0	4	0	0
Digby	6	0	0	0
Totals	10	29	21	7

Includes full time and exploratory

Catch Data

Data sources for fishery monitoring are volunteer science logs, mandatory dock-side monitoring reports, and personal communication with fishers and buyers.

The Nova Scotia sea urchin fishery began in 1989 and remained at a low level, probably less than 100 t, until the 1993-94 season. A substantial increase in effort in 1995 followed a near doubling of price the previous season. Landings remained over 1000 t until the 1999-00 season when increases from exploiting new areas were less than losses from disease.

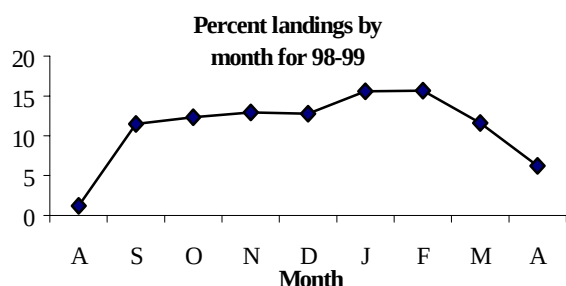
Most of the landings have come from Guysborough and Shelburne counties, but Digby County has supplied 19% and 43% in the 1998-99 and 1999-00 seasons. A large resource off the south coast of Cape Breton Island remains largely unexploited.

Landings (t) by area and season.

Area	Season					
	94-95	95-96	96-97	97-98	98-99	99-00 ¹
Digby	-	5	33	-	245	362
Western NS ²	466	312	317	263	351	136
Eastern NS ³	709	658	915	700	605	324
Cape Breton Island	34	46	60	61	98	80
Totals	1290	1021	1325	1024	1299	902

¹Preliminary²Halifax West to Shelburne³Halifax East to Guysborough

Monthly landings are almost evenly distributed from September through March.



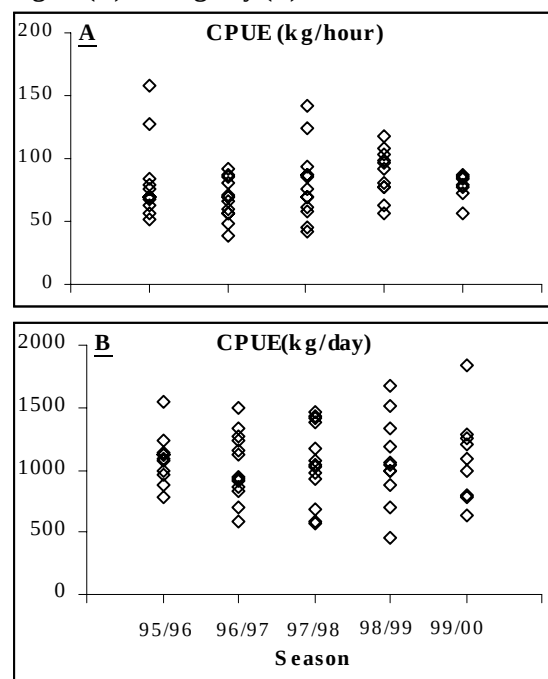
Although variable among years and locations, gonads usually reach acceptable size in mid-September and spawn in late March through April. Average gonad yields (as percentage of live weight) varied little from October-March and increased from the 1995-96 to the 1998-99 seasons, especially in western Nova Scotia.

Gonad yield (%) by month.

Month	Western N.S.		Eastern N.S.		Cape Breton	
	95-6	98-9	95-6	98-9	95-6	98-9
Sep	-	8.3	-	9.3	-	-
Oct	7.7	10.9	8.6	9.7	-	9.1
Nov	7.9	9.8	8.1	11.3	-	8.7
Dec	8.6	10.5	10.7	10.4	-	-
Jan	8.7	11.2	10.7	10.6	-	8.6
Feb	8.9	10.8	11.1	10.9	-	8.4
Mar	8.7	10.3	9.8	10.2	-	9.4
Apr	6.9	9.5	9.0	11.4	-	12.0

Resource Status

Catch per unit effort in kg/diver hr or kg/boat day, based on volunteer logs from 12 fishers with individual zones, has shown no trend over the past five seasons. Zones where biomass has been reduced by large amounts by disease showed little or no reduction in daily or hourly catch per unit effort. By fishing restricted zones (one fisher – one zone) without competing fishers, fishers are able to plan for a full day's harvest. Thus, catch per unit effort is not an index of stock size, but shows that the use of zones can increase the fishing efficiency.

Kg/hr (A) and kg/day (B) vs. season for 12 zones.

The dive fishery appears not to risk reproductive sustainability of the stock. Urchins with gonad size below market acceptability (minimum market acceptability varies from 5-10%), urchins too deep for divers to harvest, and urchins at too low density to harvest economically are all reproductive refuges. Urchins also have a refuge in size because they become sexually

mature at about 25 mm, far below the minimum commercial size of 50 mm.

Disease has proven to be the major threat to biological and economic sustainability. It killed more than 270,000 t of urchins in Nova Scotia in the early 1980s. It reappeared and has reduced the stock every year since 1995, first in Queens, Lunenburg, and western Halifax counties, then eastern Halifax, Shelburne and Guysborough counties. Incidence of disease is equally devastating over a wide range of urchin densities. Although a biomass survey was not conducted in the 1990s, the geographic extent of disease suggests a die-off of 50,000-100,000 t, 10 to 100 times the weight of urchins taken by the fishery.

Surveys were conducted to observe the extent of sea urchin feeding fronts. They were conducted from 1995-99, from Shelburne to Cape Breton counties inclusive, and included about 80 sea days. The surveys had one of four purposes: 1) to determine the potential for additional licenses, 2) to provide observations for negotiating the borders of restricted zones, 3) to audit compliance with the conditions of restricted zones, and 4) to estimate fishery yield per meter of urchin feeding front.

Survey observations included whether most of the urchins on the front were of harvestable size and whether urchins were present below the front to replace the ones harvested. Usually, only urchins near macroalgae have marketable gonads. Science log records show that the same feeding front has been harvested as many as six times in three years, suggesting the urchins form a slow moving belt from deep water to the edge of macroalgal beds.

In 1999, the length of feeding front was measured for 9 beds (12,900 m total length) for which good log records of harvest were

available for at least 3 years during 1995-1999. After omitting the first year of harvest for which we had records, because it may have been a virgin stock, we obtained a mean annual harvest of 5.4 kg/m and a range of 2.2-10.7 kg/m.

Victoria, Cape Breton, and Richmond counties: Significant mortality from disease has not been seen and a large stock, especially on the south coast of Cape Breton Island, remains nearly unexploited.

Guysborough County: In 1999, detailed surveys measured the lengths and locations of under-managed feeding fronts in 10 restricted zones. 268.5 km of undermanaged front were located, ranging from 2 to 65 km per zone. From previous surveys it is known that areas not included in zones contained additional harvestable resource. In the fall of 1999 mortality from disease occurred. However, the 1999-00 catch per day was similar to previous years and total landing were only down 30% from 1998-99. Given that sea urchins aggregate along fronts where fishing occurs, this infers that substantial resource remains. In addition, only half the coast was fished in 1999-00, and if these fished areas are representative of the unfished areas, this also implies there is a substantial resource.

Halifax, Lunenburg, and Queens counties: Mass mortalities from disease occurred in 1995, 1996, and 1999. Fishers report that there are now no harvestable concentrations of urchins in these counties. The 1999 audits of three zones in Halifax County located only 12 km of undermanaged front.

Shelburne County: Qualitative surveys in 1995, 1996 and 1997 revealed large underexploited areas. However, landings decreased 60% between 1998-99 and 1999-00. Fishers report this decrease was due to disease.

Yarmouth County: Over the past several years, six fishers have been given exploratory permits and DFO has conducted cursory surveys in the southern portion of the county. No commercial concentrations have yet been found.

Digby County: Fishers report moderate dieoff in Digby County in the autumn of 1999. Because of low water visibility our survey methods will not work in this area. No inexpensive method of determining the harvest potential is currently available.

Annapolis, Kings, Hants, and Cumberland counties: During the last two seasons, commercial quantities have been harvested near the Annapolis-Digby county line. Exploratory licenses have been granted for Minas Basin without successful harvests. DFO has conducted no surveys.

Counties where disease was observed.

County	Years urchin dieoff observed		
	Slight	Significant	Complete
Digby	1999		
Shelburne	1995-96	1997-99	
Queens		1995	1996
Lunenburg			1995
Halifax west			1995
Halifax east	1996	1997	1999
Guysborough		1999	
Richmond		None observed	
Cape Breton		" "	
Victoria		" "	

Outlook

There are no tools to predict the future of disease incidence. Based on experience through the 1980s and 90s, it is inferred that the disease will continue to expand in Shelburne and Guysborough counties. Much of the stock recovered from mass mortalities in the early 1980s, but has yet to start recovery from 1990s mortalities.

Compared to the disease the fishery is having a small impact on the resource.

Management Considerations

Biological

The precautionary approach to managing fisheries sets targets at less than maximum sustainable yield in deference to our incomplete understanding. An essential element of the approach is to set decision rules, e.g. if a stock reaches a preset level then a pre-arranged management measure is automatically applied. In this fishery decision rules for adjusting zone size and for capping landings with a TAC were recently set. The first was deferred indefinitely shortly before it was to be applied and in the second, landings apparently substantially exceeded the TAC. If decision rules are to be of any value, DFO and the fishing industry need to commit to their application and incorporate them into an IFMP.

Biological based catch quotas are not recommended. Biomass is very expensive to measure and the distance below feeding fronts that should be included is not known. Much of the biomass is of no commercial value because of low gonad yield. Also, survey results would change yearly with harvest and disease.

Halifax, Lunenburg, and Queens counties probably have no harvestable resource due to mass mortalities. The size of resource is probably small in Yarmouth, Annapolis, Kings, Hants, and Cumberland counties. More information could be obtained through exploratory fishing or surveys. Cape Breton Island has a sizable unexploited resource.

There are no known negative environmental impacts of the fishery. Diving might be the most environmentally benign (green) of any fishing method. There is very little bycatch of other species or undersized individuals of

the target species. A well-managed urchin fishing area has more macroalgal cover and production than it would otherwise have. Urchins are prey for a variety of species and may be important to some, e.g. cunners, wolffish, and eelpout.

Economic

By judicious scheduling of harvests, the resource can be taken at higher value from restricted zones than from competitively fished areas. Habitat enhancement can increase both the value per unit weight and volume of the harvest.

If zones are too large, the stock can be high-graded by the license holder while the unused portion is inaccessible to others. Large quantities of underused and fishable resource was lost to disease from 1995-99. Occasionally, zones have not been fished at all. To maintain individual zones, annual license conditions should include participation clauses.

License holders who have experienced devastation through disease in their zone, should be given the right of first refusal for access to under-exploited areas such as Cape Breton Island.

If zones cannot be suitably sized, then consideration should be given to reverting to competitive fishing.

Two methods of sizing zones are i) applying the rules developed for the 1999 zone audits; ii) allocating to a zone a total length of feeding front, including managed plus unmanaged front. The second allocation could be based on previous harvest history, the length that can be harvested in a season by a dive crew, or equal shares among licenses. The second option would require a more expensive survey than the first.

The available licenses in Cape Breton Island could be: cycled through many applicants until several are found who can successfully fish, or an increased number of temporary licenses could be added until the resource is fished down to where a better balance between urchins and their algal food supply is reached, or existing license holders from other areas could be given temporary access.

The resource in Guysborough and Shelburne counties has been underused. Because further loss from disease may occur, steps should be taken to increase utilization while ensuring access of fishers currently active.

Digby County has provided significant landings the past two seasons. The existing six license holders can be encouraged to explore further. In 1999, a TAC was set for two small but productive fishing areas at 70% of the previous years landings. This was a convenience for allocating the catch in equal ITQs, but had no biological basis.

Recommendations

The fishery is data poor in both biological and fishery information, and this impacts on the development of future management options. There is a need to improve information on the sustainability of the resource in harvested areas, the extent of the resource, and as well, develop a predictive capacity for the spread of disease and occurrence of die-offs. Specific requirements include:

- Improve accuracy of landed weights (including coding and verification) and fishing locations from the dock-side monitoring program.
- Increase industry participation in the DFO voluntary log program in order to obtain time series of harvests by bed within zones.

- Long term temperature data may be useful in addressing disease and growth issues.
- Measure the rate of urchin movement to and from feeding fronts.
- Delineation of refuges where the dynamics of urchin production might be investigated.
- Survey or conduct exploratory fishing on the east coast of Cape Breton Island and in the southern Bay of Fundy.
- Develop ability to forecast the occurrence and location of urchin die-offs from disease.

Reference

Miller, R.J., and Nolan, S.C. 2000. History and management of the Nova Scotian sea urchin fishery. DFO Canadian Stock Assessment Secretariat Res. Doc. 2000/109, 49p.

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