A Summary of a Whelk (*Buccinum undatum*) Test Fishery in the Tusket Island Area of Southwest Nova Scotia with a Review of Biological Characteristics Relevant to the Development of this Resource

By

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Abstract

Preliminary data on whelks from the Lobster Bay area (Tusket Island) of south-west Nova Scotia indicate that the size distribution and meat yield are markedly different from that reported for the Gulf of St. Lawrence. The maximum shell height (71 mm) in the Tusket Island sample was 20 mm smaller than that reported in the literature for the New Brunswick north coast. The shell weight is considerably greater than those reported for a 60 mm sized whelk from the Gulf or the New Brunswick side of the Bay of Fundy, and may result from selection pressure imposed by the large resident lobster population. The regression equations show that in the Tusket Shoal area, a 15 g foot weight would only be found in an animal of approximately 80 mm shell height. This weight has been offered as a minimum mass for marketing. The size of the whelks in the Tusket Island area are thus too small for established markets.

Females are significantly larger than males and are heavier than males in total weight for a given size. This difference is due to a heavier shell and heavier soft parts, but not to a heavier foot (meat).

Several aspects of the biology of this species warrant a conservative management approach. Their distribution appears to be highly contagious, at least during the October trial fishing experiment. Whelks appear to form small, locally adapted stocks, and local management zones may provide a unit consistent with the nature of the resource. The resource may not be large enough to support a sustainable directed fishery, and this species may be more efficiently harvested as a by-catch of the lobster fishery. Lobster by-catch will be a concern in most areas, especially if modified lobster traps are used.

RÉSUMÉ

Des données préliminaires sur les buccins de la région de la baie Lobster (île Tusket) du sud-ouest de la Nouvelle-Écosse indiquent que la répartition des tailles et le rendement en chairs sont nettement différents par rapport au golfe du Saint-Laurent. La hauteur maximum de la coquille (71 mm) des buccins échantillonnés dans l'île Tusket était de 20 mm inférieure à celle signalée dans des études publiées sur les buccins de la côte nord du Nouveau-Brunswick. Par contre, le poids de la coquille était nettement plus élevé que celui de buccins de 60 mm du golfe du Saint-Laurent et du littoral néo-brunswickois de la baie de Fundy, le résultat peut-être d'une pression de sélection naturelle exercée par la forte population résidente de homards. Les équations de régression révèlent que, dans le secteur du banc Tusket, un pied de 15 g ne sera retrouvé que sur un buccin d'environ 80 mm. Ce poids étant considéré comme la masse minimum pour la commercialisation, les buccins de l'île Tusket sont donc trop petits pour être vendus sur les marchés établis.

Les femelles sont nettement plus grosses que les mâles, leur poids total à une taille donnée étant plus élevé. Une coquille plus épaisse et des parties molles plus lourdes expliquent cette différence, et non un pied plus pesant.

Plusieurs aspects de la biologie de cette espèce justifient une gestion prudente. Sa répartition semble être fortement discrète, au moins pendant la pêche expérimentale effectuée en octobre. Les buccins semblant former de petits stocks adaptés aux conditions locales, des zones de gestion locale pourraient être crées comme unités qui tiendraient compte de la nature de la ressource. N'étant peut-être pas assez abondante pour alimenter une pêche dirigée durable, l'espèce serait probablement récoltée plus efficacement comme prise accessoire de la pêche du homard. Par contre, les prises accessoires de homard seront une source de préoccupations dans la plupart des régions, surtout si des casiers à homard modifiés sont utilisés.

Introduction

Interest from fishermen and processors in Nova Scotia toward a directed whelk fishery has recently been renewed. The whelk, *Buccinum undatum*, is considered to be a non-traditional species in Nova Scotia. As such, an "exploratory" fishery will be undertaken during which a reasonable scientific basis for management is to be established, prior to progressing to a commercial stage. Exploratory license holders will be required to work closely with Science Branch in order to meet the objectives of the license.

Preliminary drafts of a whelk management plan have been circulated, however, critical data necessary to establish a minimum allowable size are unavailable. This document presents information on the biology of *Buccinum undatum* and discusses features which are important to the management of this resource.

Buccinum undatum

General Biology

The most common species of *Buccinum* is *B. undatum*, locally referred to as the Buckie, Waved Whelk, Rough Whelk or Common Whelk (Fig. 1). It has a shell which can be up to 15 cm long (Flight 1988) and is the species which is often caught in lobster traps. The flesh of the foot is a mottled black and white. *Buccinum* lives to depths of 180 m as well as in shallow waters. Larger animals are found in deeper water. The lower lethal salinity limit is in the range of 18 ‰ (Staaland 1972). Whelks spend much of their time partially buried in the sediment or quiescent on the surface when not feeding or mating (Himmelman 1988).

Buccinum undatum

Figure 1. Illustration of the Waved Whelk. Size range to 15 cm.

Buccinum is a carnivore, and captures its prey with its foot. The whelk will grip a bivalve (mussel, clam, oyster) with the foot, pulling the two valves apart or wedging them with the edge of the shell or siphonal canal (thicker part of shell near the base) as the animal becomes weak. To accomplish the wedging the gastropod may first partially pull open the valves or break the edge of the bivalve shell with its own shell, which is quite thick. The gape in the prey shell permits the whelk to insert its proboscis, and feed (Himmelman 1988). It does not drill a hole in the shell as is commonly believed (e.g. Anonymous). *Buccinum* is known to be a scavenger and will feed readily on dead fish, hence its attraction to bait in lobster traps. The bait may impart flavour to the meat, impacting negatively on the market price.

Whelks feeding on bivalve molluscs are susceptible to the accumulation of phycotoxins (PSP, DSP, etc.) which occur in their prey (Caddy and Chandler 1968, Medcof 1972). PSP has been found in the meats and digestive glands from whelks captured in the Bay of Fundy (Cadegan

1974). Medcof (1972) reports on deaths in Quebec attributed to the consumption of PSP in whelks. Inspection Branch (DFO-Halifax, G. Burns) is currently testing PSP and toxicity of whelks from Nova Scotian waters, and this information will be used to decide whether whelks should be included in seasonal closures for PSP in different areas. Whelks are known to eliminate toxins readily if fed non-toxic food, and so depuration maybe a solution to fishing in contaminated areas (Caddy and Chandler 1968).

The reproductive cycle of *Buccinum* is well documented (e.g. Martel et al. 1986a, Martel et al. 1986b, Gendron 1992). In mid-May the whelks aggregate for copulation, often migrating shoreward. A female may mate with more than one male, and is able to store sperm for up to eight weeks. Egg laying begins soon after copulation and may extend to the end of August. On average, a female will lay 340,000 eggs per egg mass and the number of egg masses laid per female is unknown (Martel et al. 1986a). Martel et al. (1986b) observed only 60% to 80% of the females of a size which suggests they should be sexually mature, reproducing each year. Feeding by females may be reduced during the egg laying period (Lanteigne and Davidson 1992). Preferred egg laying areas are the irregular surfaces and faces of boulders and the stipes of kelp. Egg masses are vulnerable to predation by sea urchins and to loss through detachment due to storm activity (Martel et al. 1986). Embryos develop in the egg cases and hatch after 5 to 8 months, in the late autumn to late winter (c.f. Martel et al. 1986). Only 1% of the eggs hatch, with approximately 3700 hatchlings emerging from a single egg mass (Martel et al. 1986a). There is no planktonic larval phase, implying that dispersal is limited (Gendron 1992, Lanteigne and Davidson 1992). The female begins gonad development immediately after egg laying. Large whelks commonly show no sign of sexual maturity (Gendron 1992), however reproductive senility may be the result of parasitic castration.

Whelks are preyed upon by cod, dogfish, crabs, starfish and lobsters (Thomas and Himmelman 1988). The escape response of whelks to starfish is well documented (cf. Thomas and Himmelman 1988) and involves a rapid twisting action of the foot followed by escape. As with other species (e.g. scallop) this response is triggered by saponins released by the starfish, and can be induced in the lab with starfish extract.

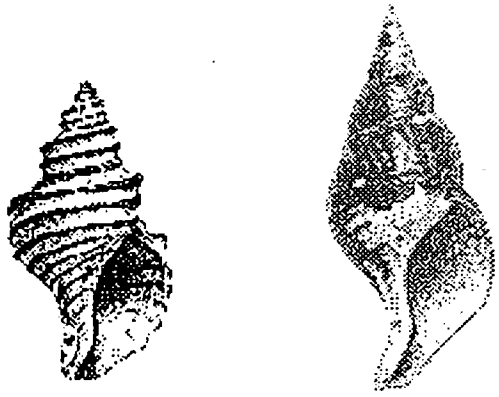
Whelks can be aged by counting annuli on the operculum (Santarelli and Gros 1985). On the northern coast of Quebec, males reach sexual maturity at 5-6 yr and sizes of 49 to 76 mm. Females mature later and at a larger size (above 7 years and 60 to 81 mm shell height) (Gendron 1992).

Neptunea and *Colus* By-catch

Neptunea is closely related to *Buccinum*, being members of the same taxonomic Family. *Neptunea decemcostata*, the ten-ridged whelk, is found at shallower depths (subtidal to about 70 m) and is also sometimes caught in lobster traps (Fig. 2). In some areas, *Neptunea* is more common than *Buccinum*. *Neptunea* produces toxins that cause severe illness in man if eaten. The toxins are found in the salivary (or "buccal") glands. The main toxic substance in the glands of *Neptunea decemcostata* is tetramine, but histamine, choline and choline esters have also been identified (G. Burns, Inspection Branch, DFO-Halifax, pers. comm.). The salivary glands of one species of *Buccinum* (*B. leucostoma*) were found to be toxic to humans. However, *B. undatum* is not toxic. All whelk species contain strong proteases (protein digesting enzymes) in their digestive glands.

Colus stimpsoni (Fig. 2) is also found with *Buccinum*. The toxicity of this species is not known. The harvest of both *Neptunea* and *Colus* is prohibited.

Other species caught in whelk traps include the sea urchin, hermit crab, lobster, sculpin, snow crab, ocean pout, sea cucumber and monkfish, with ocean pout being particularly troublesome (Appendix 1; unpublished DFO Scotia-Fundy Region Central Registry document 2901, John Mac Innes, PO Box 113, Mabou, N.S.).



Neptunea decemcostata *Colus stimpsoni*

Figure 2. Common whelk species found with the Waved Whelk.

Buccinum Fisheries in Quebec and Atlantic Canada

Buccinum undatum supports small local fisheries in the Gulf of St. Lawrence and off Newfoundland. The oldest fishery is in Quebec, where landings have ranged from 5 to 1300 mt fresh weight per year since 1949. In recent years, landings have been stable at 700 mt (1991-1993) (Gendron 1992, Lambert and Gendron 1994). In Quebec, this fishery is considered a "complementary fishery" and open only to inshore fishermen (Anonymous 1990). The majority of the landings are in Zones 5 and 6 along the north coast (Lambert and Gendron 1994). Commercial catches of whelk on the east coast of New Brunswick are comparatively poor (Lanteigne and Davidson 1992) as were those in Newfoundland (Flight 1988). In both these areas, the fishery was viewed as a supplementary fishery, as in the Quebec Region. Whelks supply a domestic bait market for groundfish in Atlantic Canada (Anonymous). *Buccinum undatum* supports a commercial fishery in England and northern Europe where it is a valued food item (Anonymous).

A survey of whelks on the Nova Scotia side of the Bay of Fundy was carried out in 1973 by the Nova Scotia Department of Fisheries. In general, the results were not promising, with the exception of the Annapolis Basin catches (Cadegan 1974). A variety of traps, pots and nets, as well as bait have been tested and descriptions of these are available (e.g. Cadegan 1974, unpublished DFO Scotia-Fundy Region Central Registry document 2901, John Mac Innes, PO Box 113, Mabou, N.S.).

Test Fishing in Southwest Nova Scotia

A license to harvest the waved whelk, *Buccinum undatum*, was issued to Mr. Earl Jacquard and Mr. Gordon Boudreau on the 29th of September, 1995 (License No. 1995-314) for a usedperiod of one month. The whelk harvest was conducted to obtain samples for market testing. The fishing area was restricted to the Tusket Islands area in Lobster Bay (Fig. 3) in areas open to the harvesting of other shellfish species. The whelks were fished with modified lobster traps, i.e. with entrance heads knitted over to prevent the capture of large lobsters. Frozen herring was used

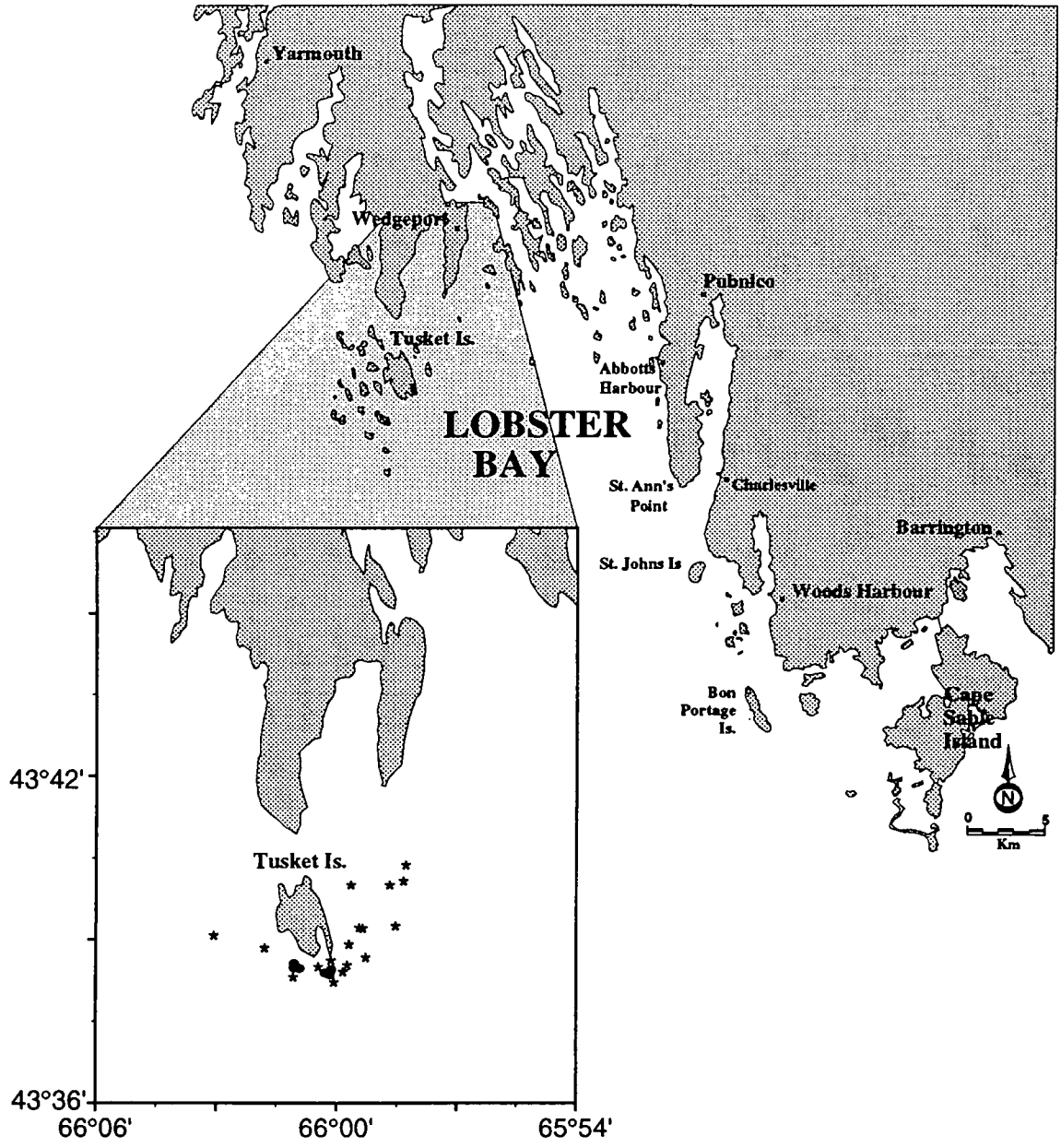


Figure 3. Location of test whelk fishery in the Tusket Island area. Solid circles indicate locations where more than 100 whelks were caught after one soak day (Appendix 2).

as bait, and was replaced at each trap haul. Four to 20 traps were fished from the vessel *Angela & Amy* and hauled after 1 to 3 days soak (Appendices 1, 2). The traps were placed in 5 to 8 fathoms of water, in areas known to contain whelks, as observed during the spring lobster fishery. Traps were placed in groups of 4 to 6 spaced approximately 100 feet apart. McQuinn et al. (1988) suggest that the area effectively fished by a whelk trap in the Gulf of St. Lawrence ranges from 18 to 278 m^2, varying with site and season. Groups were approximately a half mile apart around Big Tusket Island. Individual traps captured up to 43 animals per day, but many traps were empty (Appendix 1). The fishermen, who also fish lobster, state that the catch rate is much higher in the spring and that the size of the whelks at that time is similar to what they captured in October. Bottom temperature was recorded with a thermostat placed in one trap, and ranged from 12.5 to

14.2 °C. Small whelks were "eyeballed" for size and returned (less than about 45 mm). Catch data by size (154 animals) were provided for 20 traps with 1 day soak (Fig. 4). 191 specimens collected over several days of fishing (Appendix 2) were sent to the Department of Fisheries and Oceans for further study. Data collected by the fishermen is summarized in Appendices 1 and 2.

Whelks were provided to IMO Fisheries to establish a market price. However, the product was too small. [In 1992, local buyers stated that 15 g meats were the minimum acceptable size for marketing (unpublished DFO Scotia-Fundy Region Central Registry document 2901, John Mac Innes, PO Box 113, Mabou, N.S.), presumably in the United States, where the Quebec product was being marketed.] The Nova Scotia Department of Fisheries subsequently has identified a Korean market for the Tusket Shoal samples (Greg Roach, Nova Scotia Department of Fisheries, Halifax).

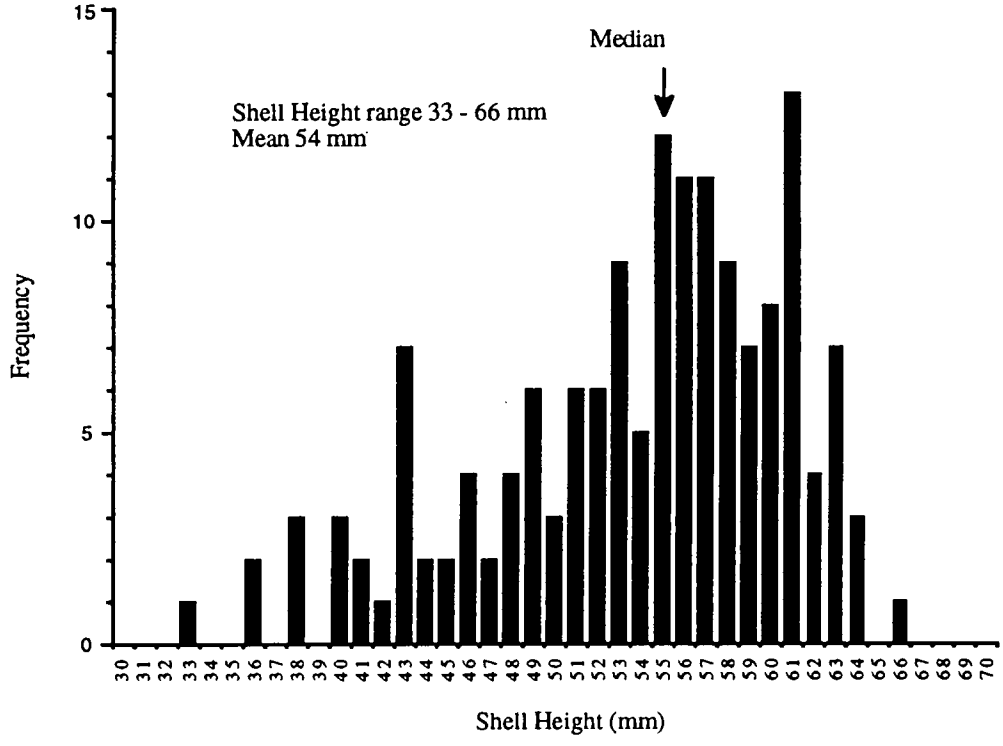


Figure 4. Shell height frequency distribution of the Waved Whelk captured from 20 trap hauls

Laboratory Studies

Ninety-eight whelks were processed immediately, and the remainder were stored frozen at -5° C for 2 months before being thawed and processed. The total shell height (mm) (see Fig. 5)

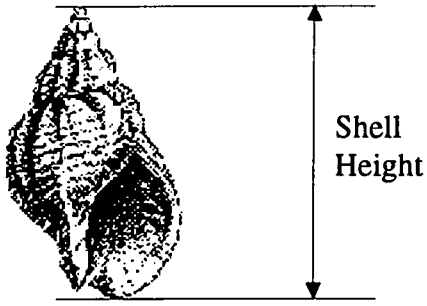


Figure 5. Shell height determination in the Waved Whelk.

and animal wet weight (g) were recorded, and the shell was cracked with a vice. The tissue (Fig. 6) was removed from the shell and the total tissue weight was recorded. The foot was then removed and weighed.

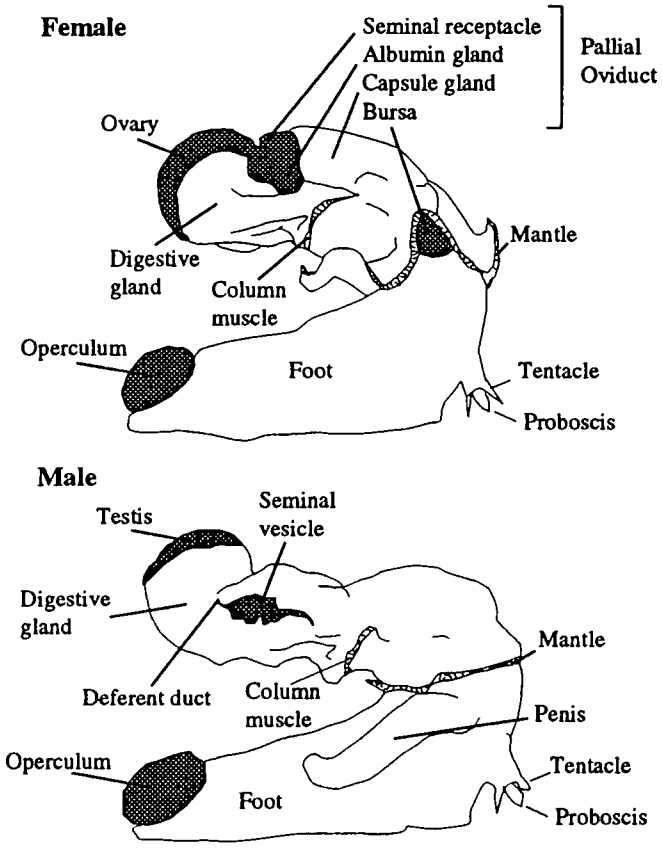


Figure 6. External anatomy of Waved Whelks (after Lanteigne and Davidson 1992).

The male sex was determined by the presence or absence of a penis (Fig. 6). If a penis was evident the penis length was measured. Males were considered sexually mature if their penis length/shell height ratios were larger than 0.5 (Lanteigne and Davidson 1992 , Martel et al. 1986a). Gonosomatic indices were not determined, as specimens were collected at the wrong time of the year (Gendron 1992). As a result, this report cannot provide information on size at sexual maturity of females. Summary statistics for these measurements are presented in Table 1.

The shell height range of animals in this sample was similar to that of the recorded catch sample (Fig. 4), although the latter captured more animals under 45 mm shell height (these were largely returned in the sample sent to the lab). The shell height range is smaller than that observed from 4190 whelks collected in the southern Gulf of St. Lawrence (34 to 99 mm, Lanteigne and Davidson 1992).

Table 1. Whelk Descriptive Statistics

Combined Data

Variable	Mean	Std Dev	Minimum	Maximum	N
FOOT WT(g)	7.04	2.33	2.37	13.82	191
TISSUE WT(g)	12.14	3.46	5.24	21.26	191
SHELL WT(g)	26.89	5.00	14.55	41.70	191
PENIS LG(mm)	28.28	9.77	3	46	60
TOTAL WT(g)	39.03	7.73	20.02	58.84	191
SHELL HT(mm)	59.80	4.49	45	71	191

Males

Variable	Mean	Std Dev	Minimum	Maximum	N
FOOT WT(g)	6.40	2.11	2.76	11.40	60
TISSUE WT(g)	10.53	2.48	5.25	18.61	60
SHELL WT(g)	24.66	4.62	16.21	41.70	60
PENIS LG(mm)	28.28	9.77	3	46	60
TOTAL WT(g)	35.19	6.52	21.69	54.08	60
SHELL HT(mm)	58.17	4.07	50	70	60
MATURITY	.49	.17	.05	.82	60

Females

Variable	Mean	Std Dev	Minimum	Maximum	N
FOOT WT(g)	7.34	2.37	2.37	13.82	131
TISSUE WT(g)	12.88	3.60	5.24	21.26	131
SHELL WT(g)	27.90	4.85	14.55	41.25	131
TOTAL WT(g)	40.79	7.62	20.02	58.84	131
SHELL HT(mm)	60.54	4.49	45	71	131

Male whelks with a penis length/shell height of > 0.5 occur at shell heights from 50 to 65 mm (Fig. 7). This is consistent with the results of Lanteigne and Davidson (1992) who report that males reach sexual maturity at 50 to 60 mm, and Gendron (1992) who observed 50% of the males sexually mature at 49 mm. However, there were no males less than 50 mm in this sample and

sexual maturity may be achieved at a smaller size. The distribution of mature and immature males according to shell height shows that for any given size immature males are present (Fig. 7). Lanteigne and Davidson (1992) found similar ratios of mature to immature males to those reported here in the 50 to 65 mm range. In this sample, the mean penis length to shell height ratio was slightly less than 0.5 (Table 1).

Females dominated the sample 2.18:1 which is less than the 3.4:1 reported for the southern Gulf of St. Lawrence (Lanteigne and Davidson 1992). The distribution of males (mature and combined sample) and females by shell height is shown in figures 8 and 9. The females are generally more dominant over 60 mm shell height. The female whelks are significantly (P=0.00) larger than the male whelks in this sample. The median values for the female and male shell heights are 58 m and 61 mm respectively (Fig. 9).

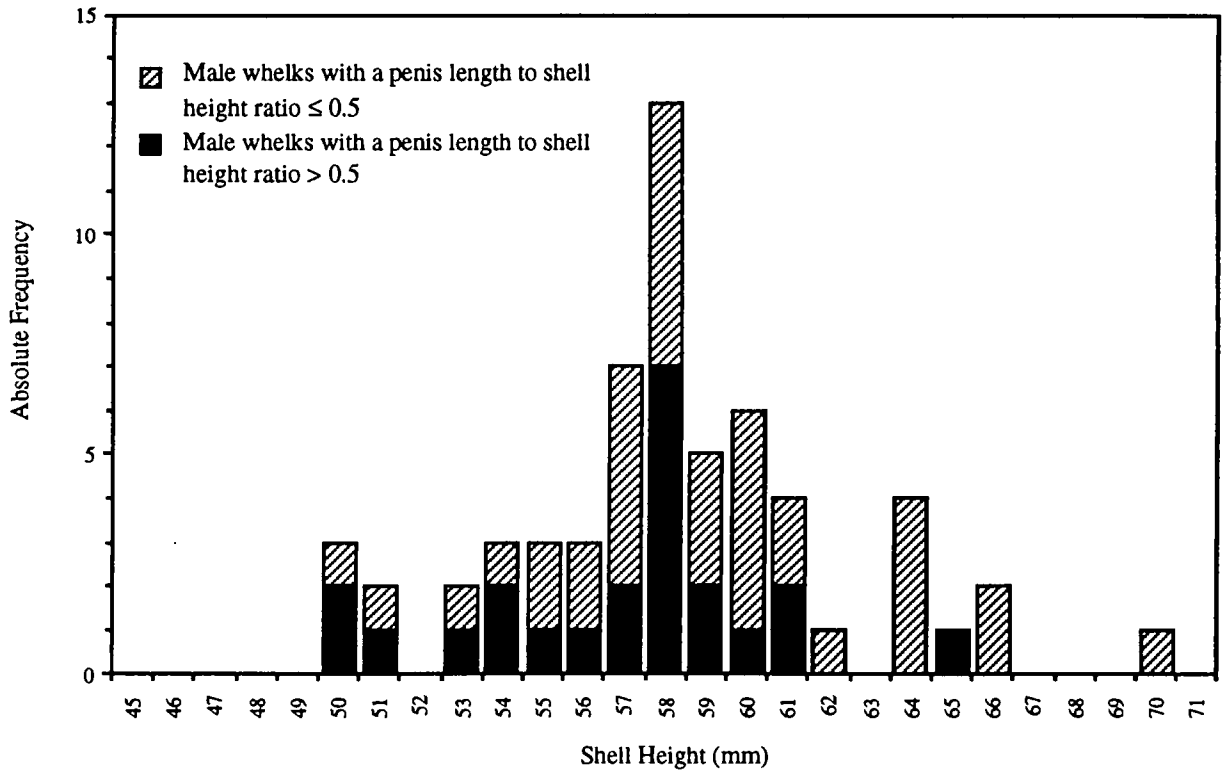


Figure 7. Proportion of immature and mature male whelks in the population sample.

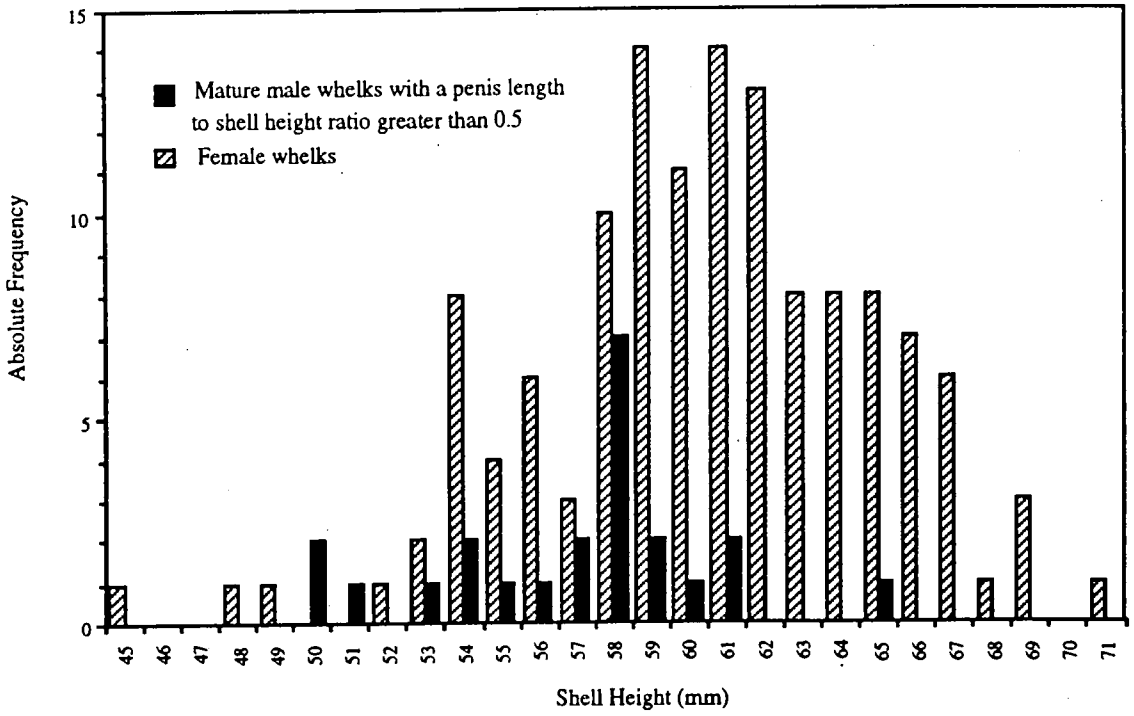


Figure 8. Shell height frequency distribution of mature male, and female Waved Whelks from Tusket Island Shoals.

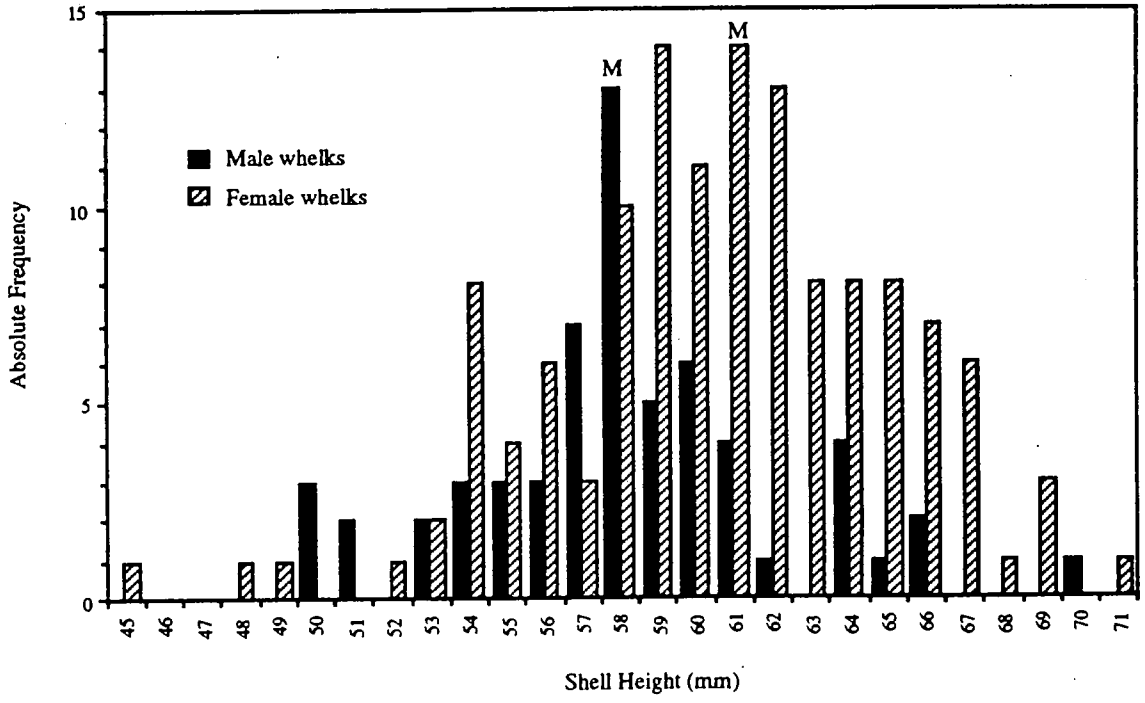


Figure 9. Shell height frequency distribution of male and female Waved Whelks from Tusket Island Shoals. "M" indicates the median value for each distribution.

Imposex?

Imposex (the imposition of male sex organs onto the female gonad system) has been defined as the development of male primary sexual characteristics in female gastropods, and is believed to be caused by exposure to tributyltin (TBT). TBT has been used in anti-fouling paints on ship hulls since the early 1970s, but has recently been banned for use on boats and small ships. Varying dose levels show varying responses. In extreme cases, the male organs block the oviduct and prevent release of eggs. The dog whelk, *Nucella lapillus*, is able to uptake TBT, however there currently is no health restriction on the harvest of whelks in TBT contaminated areas.

Imposex can be detected when animals possess both ovaries and penis. The penis homologue is often reduced in size. This phenomenon is not to be confused with the gonad reabsorption and penis atrophy associated with trematode parasitic infection (c.f. Gendron 1992). Under these circumstances only one sex is apparent. In our data set, three animals possessed both penis and female gonad. The penis length on these specimens measured 3 mm (no seminal vesicles), 4.1 mm (some evidence of seminal vesicles), and 5.3 mm. In contrast the mean penis length of the male population was 28 mm (Table 1). Unfortunately, full dissections were not completed as the rarity of the phenomenon was not appreciated at the time of sampling.

Imposex is found in populations of the dog whelk, *Nucella lapillus* where there is TBT contamination and whelk populations. Of 34 sites surveyed in Atlantic Canada, 13 sites had *Nucella* imposex (Nick Prouse, Jack Uthe, Habitat Science Division, DFO, Halifax). These sites were characterized by a high degree of boating activity. Unfortunately the Tusket Shoals area was not included in this study. Further collections of whelks should be screened for the presence of imposex.

Imposex in *Buccinum undatum* was reported for the first time in 1993 from samples collected from the French coast (Oehlmann et al. 1993) and subsequently from the arctic near Spitzbergen, Norway (Brick and Bolte 1994) and the North Sea (Ten Hallers-Tjabbes et al. 1994). In the North Sea study, the longest penis measured with the imposex condition was 18 mm. Whelks from their northern-most stations had either no imposex or only an infrequent and minor growth of penis homologues, 2 to 4 mm long. This description would describe the level of imposex observed in this study. This represents the first observation of this phenomenon in Atlantic Canada for this species.

Allometric Relationships

The allometric relationship between shell height (X) and the total wet weight, wet foot weight, shell weight and wet tissue weight (Y) were determined for the combined data, and for each sex. Functions of the form $Y=aX^b$ were fit using the Levenberg-Marquardt method for computing parameter estimates, using program NLR of the SPSS Release 4.0 software package (SPSS Inc. 1990). At each iteration, the estimates were evaluated against a set of control criteria. In these analyses, all iterations were stopped because the relative reduction between successive residual sums of squares was less than 1.000E-8. r^2 values were calculated as: one minus the residual sum of squares/corrected sum of squares. An analysis of the residual sums of squares was used to determine if fitting separate regressions by sex, to the same set of data, was a significant improvement over using a single model (Chen et al. 1992). The use of two models, one for each sex, was a significant improvement ($P>0.05$) over the use of a single model, with the exception of the regression of the wet foot weight against shell height. The resultant parameters (a, b) of the regression models are listed below (Table 2).

In this study, females tended to be heavier than males in total weight for a given size. This difference is due to a heavier shell and heavier soft parts, but not to a heavier foot. Females are also significantly larger than males (see above). Sexual dimorphism will influence the interpretation of data collected from samples where the sex ratio is unknown. Fortunately, the foot weight, which is the marketable product, does not appear to differ between sexes.

Table 2. Parameters of Regression Models for Meat Yield Determination in *B. undatum*

Regression Model: $Y=a\ (\text{Shell Height})^b$

Y (independent variable)	a (std. error)	b (std. error)	r^2	Weight (g) 60mm shell
Total Wet Weight (g)				
(Lanteigne & Davidson 1992, n=266)	0.000687 (-)	2.599 (-)	0.92	28.73
(Jalbert et al. 1989)	0.000219 (-)	2.86 (-)	-	26.67
This study (n=191, female bias 2.18:1)	0.003105 (0.0013)	2.3053 (0.1001)	0.75	39.02
male (n=60)	0.003597 (0.0025)	2.2596 (0.1727)	0.74	37.48
female (n=131)	0.004941 (0.0025)	2.1962 (0.1228)	0.73	39.72
Foot Wet Weight (g) This study	0.000093 (0.0001)	2.7430 (0.2603)	0.40	7.01
Tissue Wet Weight (g) This study	0.000083 (0.0001)	2.9035 (0.1899)	0.57	12.08
male	0.000322 (0.0004)	2.5559 (0.2816)	0.57	11.29
female	0.000119 (0.0002)	2.8222 (0.2444)	0.54	12.42
Shell Weight (g) This study				
male	0.004122 (0.0034)	2.1289 (0.2016)	0.66	25.15
female	0.011481 (0.0063)	1.8987 (0.1321)	0.64	27.30

All of the animals in this study are heavier than those of a similar shell height found in the Gulf of St. Lawrence (Lanteigne and Davidson 1992, Jalbert et al. 1989). The shell weight observed in this study for a 60 mm whelk is considerably heavier than those reported from the Gulf (Archipel de Mingan, 13.54 g) or the New Brunswick side of the Bay of Fundy (Kennebecasis Bay, 6.74 g, and Maces Bay, 22.06 g) (Thomas and Himmelman 1988). Salinity is not known to affect shell weight in whelks (Russel Hunter and Russel Hunter 1963) and Thomas and Himmelman (1988) propose that shell thickness is an adaptation to lobster predation. The high densities of lobsters in Lobster Bay may have provided selective pressure on shell thickness.

The regression equations show that in the Tusket Shoal area, the shell height of an animal with a 15 g foot weight is approximately 80 mm. This weight has been offered as a minimum mass for marketing.

Management Considerations

Several aspects of the biology of this species warrant a conservative management approach (Caddy 1989). The lack of a planktonic dispersal phase, and the relatively small range of adults (Himmelman 1988, McQuinn et al. 1988), suggest that the effective population size is small and local. Thomas and Himmelman (1988), followed by Gendron (1992), have further suggested that these local populations may be locally adapted to predators and parasites with substantial differences in size-at-maturity among populations. The test fishery data suggests that even within local populations, the whelks are contagiously distributed. Therefore, local management zones will be required for management to be consistent with the nature of the resource. In the longer term, it may prove appropriate to place the whelk fishery under zonal management, with each

licensee being confined to an individual zone. It should also be recognized that the resource may not be large enough to support a sustainable directed fishery, and that this species may be more efficiently harvested as a by-catch of the lobster fishery. However, a by-catch fishery would have to be regulated to account for population differentiation.

Within each local population, fishermen will be able to maximize yield by controlling minimum size and fishing intensity. In each local management zone, representative samples of the population should be collected for ageing in order to establish growth curves and natural mortality rates. These data can then be used to determine a minimum size which will optimize yield. At present, ageing data are not available for this species in this region.

In order to sustain local populations, both broodstock and egg laying habitat (kelp, boulders) must be protected. A minimum size regulation may be required to conserve broodstock. However, it is clear that this minimum size would have to be determined separately for each fishing area, matching variations in size-at-sexual-maturity of the females (Gendron 1992). At present we have no information on size-at-sexual-maturity for *Buccinum* along the Atlantic Coast of Nova Scotia. To get this information, samples would have to be collected in April and May before the beginning of reproductive activities (cf. Gendron 1992). There is no need for a maximum size limit, as large animals are believed to have low fecundity (Gendron 1992).

In the absence of data to recommend a minimum size regulation, it may be sufficient in 1996-97 to let the market regulate the size of the catch, provided that no efforts are made to develop a market for small whelks. In the Tusket Shoal area, the established U.S. market limit of a 15 g meat means that only very large animals (80 mm) are acceptable. Whelks of this size are extremely rare in that area, and could not support a fishery. However, new markets are being explored which may accept the smaller meats.

In the Quebec region, trap limits (100 per license), trap volume limits (max. external vol. < $0.3m^3$), area restrictions and license limits are defined in the licensing policy as effort controls (Anonymous 1990). Similar restrictions may be appropriate during the exploratory phase of a Scotia-Fundy fishery, to prevent over-development of the fishery before sufficient knowledge is gathered to permit effective conservation.

Seasonal closures due to PSP can be anticipated, and if coincident with the mating and egg laying period (May to August) may prove beneficial to recruitment.

Summary

For each local whelk management zone the following scientific data should be gathered prior to commercialization:

- resource abundance and size distribution by depth and location
- sex ratio of the population
- age distribution of the population prior to extensive fishing
- growth rate for males and females
- size-at-sexual-maturity for the females (samples required in April and May)
- allometric relationship between shell height and foot (meat) weight
- presence of imposex or parasitic infection in the population

In the absence of an exploratory fishery, whelks caught as by-catch during the lobster season will be collected in the spring of 1996 in order to gather information on the size distribution of whelks from a number of locations along the Atlantic coast of Nova Scotia. Samples will be collected in April and May in order to obtain information on the size-at-sexual maturity. Exploratory license holders will be required to provide samples from specified locations in order to estimate resource abundance and geographic distribution.

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Appendix 1. Summary of Individual Trap Catchs from the Test Whelk Fishing in the Tusket Shoal Area.

Date	Loran	Soak Days	Depth (ftm)	No. Whelks Caught	By-catch
05/10/95	12103 25420	1	4	25	-
			2	7	-
			2	0	-
			3	0	-
			3	1	62 mm female lobster
			3	40	-
	12115.7 25416.3	1	5.5	0	58 mm female lobster
			6	0	-
			6	0	55 mm male lobster
			6	0	-
	12120 25415	1	2.5	0	58 mm male lobster 59 mm female lobster
			2.5	0	54 mm female lobster
			2.5	0	-
			2.5	0	83 mm female lobster
	12124 25420	1	5	0	64 mm female lobster 57 mm male lobster 39 hermit crabs
			6.5	43	55 mm female lobster 60 mm female lobster 51 mm male lobster 55 mm male lobster 58 mm male lobster
			6.5	39	55 mm female lobster 62 mm male lobster 57 mm male lobster 10 hermit crabs
			6.7	0	27 hermit crabs 2 rock crabs (hole in head of trap)
			6.7	0	61 mm female lobster 59 mm male lobster 10 hermit crabs 1 rock crab (small hole in head)

Appendix 2. Summary of Catchs from the Test Whelk Fishing by Date in the Tusket Shoal Area.

Date	Loran	Traps Hauled	Soak Days	Depth (ftm)	No. Whelks Caught (Returned)	By-catch
09/10/95	12106.4 25419.1	5	3	5.5	12 (4)	4 lobsters 10 hermit crab 1 sculpine
	12119 25414.7	4	?	8	1 (0)	6 lobsters
	12121.9 25418.0	6	3	4	7 (1)	14 lobsters
	12120 25415.5	4	3	5.5	60 (6)	5 lobsters 10 hermit crab
10/10/95	12110.6 25416.3	5	1	7	1 (0)	1 hermit crab
	12120.9 25414.2	6	1	8	13 (1)	2 lobsters
	12123 25415.5	4	1	4	21 (2)	3 lobsters
	12119 25415.5	6	?	6.5	92 (4)	2 ocean perch 4 lobsters (hole in head)
	12113.2 25417	5	1	6	0 (0)	3 lobsters
11/10/95	12122 25416	8	?	6	136 (20)	8 lobsters
12/10/95	12122 25416	14	1	6-8	250 (20)	10 lobsters 11 hermit crab
	12 25	5	1	6	0 (0)	3 lobster
13/10/95	12116 25 416	7	1	6	77 (17)	5 lobsters
	12122 25416	12	1	6	570 (30)	9 lobsters 11 hermit crab
19/10/95	12120 25415.5	12	5	?	30 (6)	25 lobsters
	12113 25417	7	5	6	16 (7)	15 lobsters 9 hermit crabs
20/10/95	12113 25417	5	1	7	30 (5)	3 lobsters
	12120 25415.5	14	1	6	68 (21)	10 lobsters
21/10/95	12116 25415	4	1	7	0 (0)	1 lobster
		12	1	6	155 (17)	4 lobsters
23/10/95	12120 25415	14	2	6	340 (30)	12 lobsters 5 hermit crabs
	12116 25415	5	2	7.5	0 (0)	12 lobsters
24/10/95	12120 25415	14	1	6	210 (33)	15 lobsters sea perch
	12109 25420	5	1	5.5	0 (0)	6 lobsters
31/10/95	12105 25419	5	3	7	25 (15)	10 lobsters 12 hermit crab
	12118 25415	14	3	6.5	90 (25)	40 hermit crab 20 lobster 1 sculpine