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Proceedings of a Workshop on Canadian Science and Management Strategies for Whelk

3–4 June 2008
Bedford Institute of Oceanography
Dartmouth, Nova Scotia

Compte rendu d'un atelier sur les stratégies canadiennes en matière d'étude scientifique et de gestion du buccin

Les 3–4 juin 2008
Institut océanographique de Bedford
Dartmouth (Nouvelle-Écosse)

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July 2009
***Revised: December 2010**

Juillet 2009
***Révisé : décembre 2010**

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

This workshop was not carried out as a formal Fisheries and Oceans Canada (DFO) Science Advisory process; however, it is being documented in the Canadian Science Advisory Secretariat's (CSAS) Proceedings series as it presents some topics of interest related to the advisory process.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

Le présent atelier n'a pas été tenu dans le cadre officiel du processus des avis scientifiques du ministère des Pêches et des Océans (MPO). Celui-ci est toutefois documenté dans la série des comptes rendus du Secrétariat canadien de consultation scientifique (SCCS), car il couvre certains sujets en lien avec le processus des avis.

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SUMMARY

The waved whelk (*Buccinum undatum*) is a gastropod mollusc that is found along the western Atlantic coast from New Jersey to Labrador, including the Gulf of St. Lawrence. Although waved whelk has supported directed fisheries off Québec and Newfoundland since at least the 1990s, a whelk fishery has yet to develop in the Scotia-Fundy portion of the Maritimes despite some preliminary test fishing activities. During the last few years, there has been renewed interest in launching an experimental fishery for whelk off Nova Scotia. In this regard, there is a need to develop an understanding of the information that exists to assist management, the approaches that could be used for management, and future information needs. These Proceedings document discussions held during 3–4 June 2008 on these issues.

SOMMAIRE

Le buccin (*Buccinum undatum*) est un gastropode présent le long de la côte ouest de l'Atlantique, depuis le New Jersey jusqu'au Labrador, y compris dans le golfe du Saint-Laurent. Bien que le buccin fasse l'objet d'une pêche dirigée au large du Québec et de Terre-Neuve depuis au moins les années 1990, ce n'est pas encore le cas dans le Secteur de Scotia-Fundy de la Région des Maritimes, malgré certaines activités de pêche d'essai préliminaires. Ces quelques dernières années, on s'est de nouveau intéressé au lancement d'une pêche expérimentale du buccin au large de la Nouvelle-Écosse. À cette fin, il est nécessaire de savoir de quelle information on dispose pour appuyer la gestion, quelles sont les approches qui pourraient être utilisées dans la gestion et quels seraient les besoins d'information futurs. Le présent compte rendu relate les discussions tenues les 3 et 4 juin 2008 à ce propos.

INTRODUCTION

The waved whelk (*Buccinum undatum*) is a gastropod mollusc that is found along the western Atlantic coast from New Jersey to Labrador, including the Gulf of St. Lawrence. Although waved whelk has supported directed fisheries off Québec and Newfoundland since at least the 1990s, a whelk fishery has yet to develop in the Scotia-Fundy portion of the Maritimes despite some preliminary test fishing activities. During the last few years, there has been renewed interest in launching an experimental fishery for whelk off Nova Scotia. In this regard, there is a need to develop an understanding of the information that exists to assist management, the approaches that could be used for management, and future information needs.

A workshop was therefore convened in the George Needler II Boardroom at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia, during 3–4 June 2008, to address the Terms of Reference (Appendix 1) which had been developed jointly by Department of Fisheries and Oceans (DFO) Fisheries and Aquaculture Management and Science branches. The Chair (Ross Claytor) opened the meeting by welcoming the participants (Appendix 2), which included experts from other parts of the Maritimes and Québec. He then reviewed the Terms of Reference, which included the workshop's context and objectives. He noted that the main product of the workshop was to be these Proceedings. The Agenda (Appendix 3) was then reviewed. The Chair noted that the first day was to be primarily devoted to presentations and discussion on whelk biology and fisheries, while the second day would be devoted to the science needs of potential management approaches and priorities. The Chair also noted that the agenda was deliberately designed to allow lots of time for discussion.

PRESENTATIONS

Ecology of the Whelk *Buccinum undatum*: An Overview

Rémy Rochette

Presentation Highlights

The whelk *Buccinum undatum* is a boreal neogastropod of the Atlantic Ocean; in the western north Atlantic, it is found from New Jersey to Labrador. It is a relatively large and long-lived gastropod that attains up to approximately 11-12 cm in shell length and greater than 10 years of age. It is more active in colder water and tolerates salinities down to approximately 20 ppt (parts per thousand). It is found at depths of more than 100 m and on various types of substrates (boulders, cobbles, mud), but occurs in greatest densities on soft bottoms at 15-30 m depth.

B. undatum has a large muscular foot which it uses to crawl over the seafloor; it has been reported to crawl to baited traps at speeds of 7-15 cm/minute and from distances of 20-30 m. Detection and localization of food is likely largely via chemotaxis and a specialized organ in the whelk's mantle cavity, the osphradium. Although *B. undatum* is highly mobile, SCUBA surveys reveal that it spends much of its time stationary on the bottom or buried in the sediments, sometimes with only the siphon protruding. It is generally believed that adult dispersal is very limited, but better quantification of this parameter is desirable.

B. undatum appears to have a broad diet and varied means of acquiring food. It feeds on live and dead animal tissues using a long eversible proboscis which is an extension of its digestive system. Stomach content analyses and field observations suggest whelks acquire some of their food (e.g., polychaetes) via active predation, but circumstantial evidence (e.g., rarity of predation events, empty stomachs) suggests they may acquire much, if not most, of their food

by scavenging on the remains of dead or moribund animals. Also, whelks in some regions have been documented to approach predatory seastars when these are feeding, in order to steal some of their prey, feed on left-overs, or exploit benthic organisms exposed by the seastar's digging activity.

B. undatum has a number of predators, including seastars, arthropods (crabs and lobsters), and fishes (e.g., wolf eels), the relative importance of which varies geographically. It also has to contend with endo-parasites, particularly Platyhelminthe trematodes (flatworms). Many of these parasites (e.g., *Neophasis*) occupy and damage the whelks' visceral mass, including the digestive gland and gonads. These parasites, which are more prevalent in large sexually mature individuals, damage the gonads and sexual organs (e.g., atrophy of the male penis and destruction of the female palleal oviducte) and can ultimately castrate their host.

B. undatum is dioecious (separate sexes) and fertilization is internal. Females are thought to attract males using pheromones, and then males use their long penis to transfer sperm to their partner's bursa, from where it progresses to the seminal receptacle where fertilization occurs. Whelks are polygamous; females likely store sperm from many males in their bursa and males likely attempt to mate with numerous females. However, there exists virtually no information on critical reproductive processes such as mate choice, sexual selection, and sperm competition in whelks. Females lay their embryos inside capsules which they attach to hard structures such as rock and algal stipes, and the embryos undergo complete development (including a veliger larval stage) inside these capsules before emerging as miniature crawling whelks. Sexual maturation is relatively slow with maturity probably reached at 4-7 years of age depending on gender and location. Embryos take 3-8 months to develop, depending on local temperature and perhaps also food reserves and genetics. Larger females lay a greater number of capsules than smaller ones, but the number of embryos per capsule (approximately 2500-3000) seems independent of female size. Fewer than 1% of embryos likely survive in nature, mainly because many serve as nurse eggs for earlier-developing individuals and also because other animals, particularly urchins, prey upon them. In addition to loss of reproductive potential to parasitic castration, all females do not seem able to acquire sufficient resources to reproduce in any given year, and populations have also shown evidence of reproductive inactivity owing to senescence in both males and females. In the northern Gulf of St. Lawrence, copulation and egg laying occur in spring and summer and juveniles emerge from capsules in late autumn and winter; in Europe, copulation and egg laying occur in autumn. Adult whelks are reported to feed less during mating and egg laying.

Because of its marked mobility, seemingly high 'catchability' (attraction to baited traps), relatively slow reproduction (see above), and limited dispersal (both as adults and larvae), *B. undatum* is likely susceptible to localized over-exploitation, and indeed extirpation of historically abundant whelk populations has been documented in Europe. An additional consequence of the whelk's limited dispersal, particularly of the benthic larval stage, is that populations are likely isolated from one another over relatively short distances. Not surprisingly, *B. undatum* displays marked variation in different phenotypic traits such as size at sexual maturity, shell morphology, as well as feeding and anti-predator behaviours, over relatively short distances (tens to hundreds of kilometres). Unfortunately, very little is known about the population genetics of *B. undatum*. A recent study from Europe suggests weak, but significant, inter-population differentiation of neutral genetic markers over distances of tens to hundreds of kilometres. But more importantly, there is no quantitative information on the geographic scale at which whelk populations display genetically based differences in adaptive phenotypic attributes. Nevertheless, susceptibility to local extinctions and high potential for local adaptation suggest micromanagement of commercially exploited whelk populations may be desirable, for both economic and conservation purposes.

Discussion

Following the presentation, it was revealed that growth slows with age to a point whereby a maximum size appears to be reached. Further discussion of whelk predators identified lobster as a primary predator in the Bay of Fundy, while seastars seem more important in the Gulf of St. Lawrence.

Management of Whelk Fisheries in Québec
Bernard Sainte-Marie, Michel Giguère, and Sylvie Brulotte

Presentation Highlights

This presentation reviewed the biological basis and measures for management of whelk *Buccinum undatum* in the Québec Region, along with overall fishery statistics up to 2005. The Québec Region is divided into 15 fishing areas, and landings reached 2000 t in 2003 and declined to 1614 t in 2005, year of the last full assessment. Management of whelk is based on a minimum legal size of 70 mm shell height (SH), which is approximately the mean of SH_{50} of females and males across all fishing areas. The size of 70 mm SH may be reached at about 8 years of age based on laboratory and field tagging experiments. SH_{50} may be variable over the years within fishing areas. Additional management measures include licenses (264 in total, of which less than half have been active in recent years), a fixed number of traps, a fishing season lasting 5-6 months (sometime between April and November), and in some areas, there are preventive quotas. The status of the resource is assessed by fishery data (landings, effort as vessel trips, catch per unit effort (CPUE), and distribution of fishing effort) and whelk size distributions obtained by observers (dockside or in plant). Dedicated trawl or dredge surveys are conducted over limited areas to evaluate population status. Management measures aim to maintain CPUE and size structure constant with reference to baseline (early fishery) data. The landing of sublegal whelks is an issue in many fishing areas and preliminary work has investigated various trap designs to reduce their catch or at-sea sorting procedures to reduce their landings.

Discussion

A participant asked how quotas were established and it was revealed that they are based on past catch levels and designed to cap landings. Landings were reported to vary to some degree with price – the average price increased around 2000, and is approximately $1/kg (shell on) at present.

The rationale for zones was questioned and Sainte-Marie indicated that zones are arbitrary, although some natural barriers exist where deep channels occur. With respect to zoning, it was also indicated that in Québec Region, closed areas (permanent closures, not rotational) are being proposed for management of inshore invertebrate fisheries. However, such closures may be of limited utility for whelk given their low mobility.

Landing of sublegal size animals has been an issue in this fishery. There is no dockside monitoring of catch, but sampling occurs in plants. Some sorting of catch may occur onboard the vessel, although gears that minimize pre-recruit capture would be ideal. There does not appear to be any problem in bringing the animals up from depth, although injury and mortality can result from the animals being dropped on deck. There has been some work to develop a modified trap to allow small ones to escape. No attempt has been made to design a trap with selection at the entrance, although this may be a possibility.

Research has been conducted in this region to assess maturity and growth. It was noted that although size at maturity has been found to vary over the fishing area, it is impractical to have varying minimum legal size at small spatial scales, as whelk can be fished in one area and landed in another. Females tend to mature at larger sizes than males. Growth was reported to be minimal after maturity and added yield may take a long time at large sizes. Legal size may be reached after about 8 years, while whelk may live to 15-20 years of age. A question was posed regarding whether research and monitoring activities described were conducted by DFO or Industry. Sainte-Marie replied that trap development was done in collaboration with Industry, but other aspects (e.g., trawl survey) were undertaken using DFO funds.

A participant inquired about the degree to which conflicts exist among fisheries in this region and Sainte-Marie indicated that there are potential conflicts between the fishery for whelk and those for species such as rock crab and spider crab. In addition, when the whelk fishery is conducted too early in spring or too late in fall, bycatch of juvenile snow crab can be high in traps. In this area, the fishing season overlaps with the whelk reproductive season and, as a result, there may be merit in adjusting the fishing season so that it does not conflict with spawning. However, such a shift in the fishing season is not popular with Industry.

Over the course of the discussion, it was noted that while 95% of landings are comprised of *B. undatum*, other similar-looking species occur, particularly in deeper waters of the northern Gulf of St. Lawrence. There has been some interest expressed in exploiting these deeper grounds.

An Overview of the Development of the Whelk Fishery in Newfoundland and Labrador
Larry Yetman and Don Stansbury

Presentation Highlights

The whelk fishery in Newfoundland and Labrador generates approximately $4M annually in revenue for fishers. Information presented highlighted a series of whelk fishing, processing, and marketing projects undertaken by DFO in partnership with Industry and the Provincial Department of Fisheries and Aquaculture, beginning in the 1970s to the present. Statistical data for more recent years indicating trends in catch and CPUE are also included. Management/conservation measures for this fishery are limited to effort control, fishing season, and minimum size requirements. Research and development is focused on gear selectivity and vessel based mechanical sorting systems to remove undersized animals from the catch. Information on population dynamics is lacking.

Discussion

Following the presentation, it was noted that while there is a limit of 500 traps per licence holder, there is no standard trap design specified except in NAFO (Northwest Atlantic Fisheries Organization) Division 3Ps, where most landings occur. While there is a minimum size limit of 63 mm, there is no efficient mechanism onboard for sorting the catch and, as a result, sorting on undersized animals is very coarse. There has been some discussion of whether a small whelk protocol (similar to groundfish fisheries) should be considered, whereby an area would be closed to fishing if a certain percentage of small whelks was encountered. At present, there is no observer coverage and no dockside monitoring.

Future developments anticipated for this fishery include use of standardized traps to better monitor changes in CPUE, experiments pertaining to gear selectivity, implementation of mechanized sorting devices onboard, and trials to assess survivorship of discards. While there

is no limit on the number of licences in the fishery at present, there have been suggestions that the fishery may be operating at capacity.

There was a question about how the Newfoundland whelk industry avoids conflict with the local scallop fishery and Yetman indicated that Industry members are expected to settle such issues amongst themselves, noting that mobile gear fishers must avoid fixed gear. When asked about bycatch, Yetman noted that bycatch is not a significant concern at present. Bycatch was monitored in the past by a technician deployed onboard whelk vessels, but no appreciable amount of bycatch was observed; wolfish and ocean pout were common bycatch species but not many others were encountered.

During the discussion, it was mentioned that NAFO Division 3NO is being considered as a new whelk fishing area and there was a question as to how this might be approached. For example, would this be considered a new fishery under the New Emerging Fisheries Policy? In addition, would this potential fishery involve existing licence holders or new ones? Yetman indicated that the answers to these questions are unknown at present.

Fisheries and Resource Assessment for Whelk in the Maritimes
Barry MacDonald and Ellen Kenchington

Presentation Highlights

An overview of work done in the 1990s by Dr. Ellen Kenchington on the waved whelk, *Buccinum undatum*, was presented. Included are results from a test fishery in the Tusket Island area of southwest Nova Scotia. The session contains biological information from 12 inshore areas along the Atlantic coast and Bay of Fundy and whelks collected from offshore on the Scotian Shelf. Highlighted are the morphological differences between the various populations and the sexes.

Discussion

A key result stemming from the research activities described was evidence for strong local adaptation in morphology. Whelk have no planktonic larval phase suggesting that dispersal is limited and, thus, small, locally adapted populations might be anticipated. It was noted that genetic differences have also been reported over large spatial scales using microsatellite loci (Weetman et al. 2006).

It was observed that in the studies described in this presentation (Cadegan 1974; Kenchington and Lundy 1996; Kenchington and Glass 1998), females appeared to be larger and more abundant than males. Discussion revealed that this may reflect differences in catchability as there is no evidence for skewed sex ratios in trawl surveys and growth rates appear similar between the sexes. It was also noted that sexual maturity data for females were lacking in these studies and may be worthy of further investigation. In this regard, standardized maturity staging protocols should be developed.

Alan Dwyer noted that an experimental fishery for whelk also occurred in the fall of 1992 in the vicinity of Mabou Bay-St. Lawrence (Moffatt 1992). Landings were poor with no evidence for sustainable commercial fishery potential. However, whelk are more mobile at cooler temperatures and anecdotal evidence suggests that catch rates might have been better in spring, but no experimental fishing was conducted in this area during this time. Following Dwyer's description of this experimental fishing initiative, it was suggested that a database be established to compile and store data and literature pertaining to historical whelk fishing

activities within Maritimes Region. Such a database should be accessible to all research partners.

Experimental Fishing Activities for Whelk in the Maritimes
Tim Rawlings, Adam Mugridge, and Bruce Hatcher

Presentation Highlights

In 2006, the eastern Nova Scotian Whelk Harvester's Society (ENSWHS), the Department of Fisheries and Oceans, and Cape Breton University (CBU) developed an experimental fishing plan for the waved whelk, *Buccinum undatum*, following the guidelines of the New Emerging Fisheries Policy. This plan was designed to meet the needs of the fishers, to address fishery-related and biological/ecological questions, and to anticipate the requirements of a Stage I experimental licence. With financial assistance from the Nova Scotia Department of Fisheries and Aquaculture, combined with monetary contributions from ENSWHS and in-kind contributions from CBU, preliminary data important for the development of an ecologically and economically sustainable fishery for the waved whelk in eastern Nova Scotia was collected. Individual inshore licence holders were granted temporary scientific licences by DFO in the fall of 2006 and scientific fishing surveys were prepared and undertaken in 5 areas off eastern Nova Scotia. While the level of participation and fishing success varied in these 5 areas, the project was successful and the majority of the planned objectives were met.

Results demonstrated that cooperation among individual fishing licence holders can be achieved and that a collaborative scientific program involving Industry, academia, and government can also be successful. Licence-holders identified commercially harvestable populations of whelk in some, but not all, areas sampled. Additional fishing surveys are now needed to determine the commercial potential of whelk populations in other areas of eastern Nova Scotia. Although some problems were encountered with the coordination of data collection across a geographically dispersed sampling program, these shortcomings have now been addressed in anticipation of Stage I licensing of this experimental fishery. Preliminary analyses of frozen whelk sampled during scientific surveying in 2006 were successfully undertaken at CBU, expanding the University's capacity to conduct scientific research on fisheries-related organisms. Whelk were evaluated based on several criteria including shell length, tissue and foot weight, snail age, gender, and the onset of sexual maturity. Comparisons were also made with other published datasets on Nova Scotian whelk from other areas. Results supported these studies by further illustrating strong differences in population-level attributes of whelk at small geographic scales. Additional sampling and processing of sampled whelk will help to assess the fishery potential of this species in eastern Nova Scotia and to determine the procedures necessary to ensure an ecologically and economically sustainable fishery.

Discussion

Following the presentation, it was noted that while recent experimental activities have focused on inshore areas, an offshore experimental fishery is expected to occur in the near future. It has been proposed that the offshore fishery would use Newfoundland type traps as were used in inshore Nova Scotia during 2006.

Recent experimental fishing activities lend support to the notion of strong differences in whelk morphological attributes at small geographic scales. However, it was highlighted that while data from Scaterie Island were collected during fall 2006, most whelk data available for comparison (i.e., Kenchington and Glass 1998) were collected during the springs of 1996 and 1997. The potential impacts of seasonal differences in sampling on factors such as catch rate and catch

composition should be examined. In addition, it was suggested that environmental aspects be considered when comparing shell thickness among areas, as local predation levels may be important (e.g., whelks appear to have heavier shells in areas where lobsters are more abundant; Kenchington and Lundy 1996).

At present, ageing is being conducted by counting striae on the operculum which appear to correspond to annual rings. Ageing undertaken to date is consistent with the observation that after a certain size or age, growth may be minimal and only sufficient to offset shell wear.

Fishery Sustainability and Ecosystem Considerations
Tana Worcester

Presentation Highlights

A presentation on an ecosystem approach to fisheries management (EAFM) in the Maritimes Region was presented by Tana Worcester.

DFO has been moving towards an ecosystem approach to management (EAM). This has been driven by National Legislation (e.g., *Oceans Act* and *Species at Risk Act*), international agreements, and, more recently, by market demands (e.g., ecolabelling and eco-certification). EAM attempts to manage human activities in a way that controls our impacts on the ecosystem and enables us to respond to ecosystem influences on these activities. There are several important reasons to approach EAM in a structured way. Firstly, we must manage impacts of human activities on *all* ecosystem components, not just on the harvested resources. Secondly, we need to be able to integrate cumulative effects across *all* human activities, including fisheries, aquaculture, industrial development, etc. Finally, we need to be able to respond to changing environmental conditions such as effects of climate change. Given the complexities involved, EAM can not be approached in an *ad hoc* manner. Rather, EAM is being addressed through a structured planning process including articulation of overarching objectives, development of more specific strategies that can be used to achieve these objectives, and identification of tactics/tools for implementation.

An ecosystem approach to fisheries management (EAFM) attempts to expand good fisheries management practice to address emerging conservation concerns and ecosystem objectives (e.g., productivity, biodiversity, and habitat). Traditionally, fisheries have been managed to maintain productivity of the harvested resource, focusing largely on controlling exploitation and defining management units that reflected stock structure. Under EAFM, this scope is broadened to include consideration of the role of the harvested species in the food web, the potential for incidental bycatch of other species, and the potential for other impacts to the environment/habitat. Recognizing that each fishery is unique and will have different ecosystem interactions, efforts can be made to prioritize the key interactions of each fishery to focus management and research strategies and to make efficient use of often limited resources. A number of interesting biological characteristics of whelk and potential ecosystem interactions, both of the species and of the fishery, have been identified. These could be investigated further in the context of EAM in general and, more specifically, within the context of an EAM template that has been developed by DFO Maritimes Science.

Discussion

Following the presentation, the EAM template developed by DFO Maritimes Science (see Appendix 4) was distributed to workshop participants in preparation for the discussion on science and management strategies for whelk that would occur during the second day. In

addition, at the suggestion of the Chair, Sherrylynn Rowe made a brief presentation summarizing available information on whelk from snow crab surveys, offshore clam surveys, DFO ecosystem surveys, and the observer database. Most of the programs described only collected information on total weight of whelk captured per set and none included information on size of individual whelk encountered, although it may be possible to conduct whelk sampling as part of these programs in the future.

Science and Management Strategies for Emerging Fisheries
Ross Claytor

Presentation Highlights

For this presentation, new fisheries were defined as:

1) "Fisheries involving new species and/or stocks that are not utilized or not fully utilized, and not currently covered by a management plan," and
2) Fisheries that extend into previously unfished areas or unassessed areas may be considered as new fisheries.

New fisheries are characterized by having sparse information for decisions. A draft protocol for new fisheries science and management has been developed by a joint effort of DFO Oceans and Habitat, Fisheries and Aquaculture Management, and Science. It includes a new emphasis on ecosystem effects, indicates where documentation and review are required, and defines the broad strategies associated with each stage.

The draft protocol is outlined below:

1) Stage I: Screening (1-3 months), fishery potential, and red flags (≤2 seasons).
   a) Goal: Determine if economic catch rates are possible and to identify ecological impacts.
   b) How:
      i) On-board monitoring of catch and effort by position, bycatch, and gear description.
      ii) Experimental licenses, no retention.
      iii) Phase should be short.
   c) Basis for decision: Catch rate or levels indicate money can be made, no ecosystem red flags, information documented and reviewed.

2) Stage II: Evaluate move to a commercial fishery (multi-year).
   a) Goal: Determine if a long-term sustainable fishery strategy is possible.
   b) How:
      i) Biology, geographic distribution, and gear impacts.
      ii) Conduct mitigation experiments if necessary.
      iii) Explore management strategies.
      iv) Define well-managed stock.
   c) Basis for decision:
      i) Well managed stock with objectives can be defined.
      ii) Framework assessment undertaken prior to Stage III commencing.

3) Stage III: Full fishery (continuing).
   a) Goal: Implement chosen regulations consistent with long-term sustainable management strategy and objectives.

b) How:
   i) Usual stock assessment and management protocols.
   ii) Increase information base from previous phases.
   iii) Plan and fine tune to changing stock and fishing effort.
c) Basis for decision:
   i) Assessments with frequency outlined in framework.

It was emphasized that the protocol is a living process and is undergoing development. The protocol requires that interaction with Industry, Fisheries and Aquaculture Management, Science, Oceans and Habitat be increased. The major issues to be addressed are:

1) Improving evaluation of ecosystem effects.
2) Evolution of clarification of the differences between Stage I and II.
3) Building the framework – Stage II.
4) Cost.
5) Use of fish.

Discussion

A question was posed regarding how much retention could occur during Stages I and II. Claytor indicated that during Stage I, some samples could be retained for experimental purposes (i.e., research) or market testing (i.e., to examine whether wall thickness of sea cucumber meets market demands), but the quantity should be minimal – the objective of Stage I is to see whether sufficient quantities of the resource exist to make money (largely assumes that markets are in place and product is okay based on background research). Retention can occur during Stage II, but the amount needs to be justified on the basis of aiding the experiment (science or marketing) – making profit is not a good reason. This highlights the importance of having a plan to meet experimental objectives as quickly/efficiently as possible. Claytor indicated that using this protocol, five years might be a reasonable time period over which to develop a commercial fishery, although the exact duration would depend on the target species and information available at the onset. Objectives should be developed in Stage I (e.g., at this meeting) so that expectations are clearly defined.

One participant questioned how the Developing Species Advisory Boards (DSABs) or Regional Developing Species Advisory Board (RDSAB) fit into the process as it appeared from the presentation that they were being excluded. Claytor indicated that Industry proposals will still go to DSAB/RDSAB initially, and then come to DFO and its Emerging Fisheries Working Group for further consideration. Issues such as gear conflicts would be addressed by Industry, through DSAB/RDSAB.

SCIENCE AND MANAGEMENT STRATEGIES

Given our current understanding of the biological processes governing whelk and of whelk fisheries, the following observations were noted with respect to whelk sustainability and potential ecosystem impacts of the fishery:

Reproduction:
- Age and size at maturity have been reported to range among areas from 4 to 7 years of age and 50-75 mm shell height, respectively.
- Larger females lay a greater number of capsules than smaller ones, but the number of embryos per capsule (approximately 2500-3000) seems independent of female size.

- Fewer than 1% of embryos likely survive because many serve as nurse eggs for earlier-developing individuals, and other animals, particularly urchins, prey upon them.
- In addition to loss of reproductive potential to parasitic castration, all females do not seem able to acquire sufficient resources to reproduce in any given year, and populations have also shown evidence of reproductive inactivity owing to senescence in both males and females.

Population structure:

- Larval and adult dispersal is believed to be very limited so that populations are likely isolated from one another over relatively short distances.
- Marked variation in traits such as size at sexual maturity, shell morphology, as well as feeding and anti-predator behaviours, have been reported over relatively short distances (tens to hundreds of kilometres).
- Whelk seem highly attracted to baited traps so they may be susceptible to localized over-exploitation. Extirpation of historically abundant whelk populations has been documented in Europe.
- Micromanagement of exploited whelk populations may be desirable for both economic and conservation purposes.

Whelk has supported directed fisheries off Québec and Newfoundland since at least the 1990s, and a fishery for whelk is currently developing in the Scotia-Fundy portion of the Maritimes. Based on available information from existing directed fisheries, a passive management control strategy with the following elements might be suggested for whelk:

Size limits:

- Gear allowing appropriate escapement.
- At-sea sorting that is not destructive to the resource.
- Small whelk protocol.

Effort controls:

- Number and size of traps.
- Fishing season.

Preventative TACs:

- Latent effort needs to be controlled as fishing power in emerging fishery will improve.
- Controlled through landing slips.

There was considerable discussion regarding management and assessment measures to address concerns regarding fishery sustainability and ecosystem impacts, as well as research and monitoring that would be required to support these management and assessment strategies. Whelk science and monitoring pertaining to ecosystem objectives and strategies is summarized in Appendix 4.

RESEARCH PROGRAM NEEDS AND NEXT STEPS

In reviewing science and monitoring requirements pertaining to ecosystem objectives and strategies, three issues were deemed to be of particular importance:

1) Distribute population component mortality as a percentage of component biomass.

   Population structure is unknown, but limited ability for dispersal suggests potential isolation of populations over short distances. Distribution and relative abundance of whelk should be assessed, as well as associations with various habitat characteristics (e.g., depth, temperature, and bottom type). Population structure may also be elucidated through basic biological sampling (including examination of features such as size at maturity, growth, and morphology) across areas, genetics, tagging, and common garden experiments. The feasibility of gathering information on whelk during annual ecosystem surveys of the Scotian Shelf or other activities involving mobile gear or diving should be explored to prevent problems related to selectivity associated with baited traps.

2) Manage percentage of size/age/sex of capture.

   Size measurement and maturity staging protocols need to be developed so that size/age at maturity and growth rates can be defined, as well as catch composition and appropriate trap design and minimum legal size for desired selection determined. Temperature and bottom type information should be used as a guide for identifying sampling locations. Beware of species identification issues. Sampling using mobile gear or diving would be preferred over use of baited traps, whereby selectivity might be a concern. Monitoring should include documentation of catch composition by size (and potentially sex) through use of at-sea observers and port sampling technicians.

3) Permit sufficient spawning biomass to evade exploitation.

   Size/age at maturity is reported to vary over short distances. In addition, there is evidence to suggest that senescence and parasite-induced sterility could impact the reproductive output of whelk populations. Monitoring would involve recording size and sex composition, as well as reproductive state of individuals, in both the catch and broader population. A population model should be developed to assess population growth and reproductive potential (e.g., number of eggs produced) under various potential minimum legal size limits or other management regimes.

Time did not permit detailed discussion of timelines and costs associated with these research and monitoring priorities, nor how they might be accomplished. However, it was noted that baseline data should be collected in areas before the fishery begins or areas should be set aside as fishery reserves in which the work can be done over time. Further discussion of these issues will be required in the future.

CONCLUDING REMARKS

The Chair confirmed that the draft proceedings would be circulated for review and comment before being finalized. He then thanked all the participants for a stimulating discussion and adjourned the meeting.

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Appendix 1. Terms of Reference

Workshop on Canadian Science and Management Strategies for Whelk

3–4 June 2008

George Needler II Boardroom
Bedford Institute of Oceanography, Dartmouth, Nova Scotia

Terms of Reference

Context

The waved whelk (*Buccinum undatum*) is a gastropod mollusc that is found along the western Atlantic coast from New Jersey to Labrador, including the Gulf of St. Lawrence. Although waved whelk has supported directed fisheries off Québec and Newfoundland since at least the 1990s, a whelk fishery has yet to develop in the Scotia-Fundy portion of the Maritimes despite some preliminary test fishing activities. During the last few years, there has been renewed interest in launching an experimental fishery for whelk off Nova Scotia. In this regard, there is a need to develop an understanding of the information that exists to assist management, the approaches that could be used for management, and future information needs.

Objectives

- To develop a conceptual model, including uncertainties, on the biology of the whelk resource
- To discuss fishery sustainability and ecosystem considerations
- To discuss management approaches to the whelk fishery and related decision support tools
- To discuss information requirements for future management of the resource
- To outline a research program in support of the management decision making

Outputs

CSAS Proceedings
CSAS Research Document (if appropriate)

Participation

DFO Science representatives
Industry members knowledgeable about the fishery
Fisheries managers
Members of the university community and other non-governmental organizations

Topics for Discussion

Potential topics for discussion are outlined below by elements of the decision process. This is not an inclusive list but rather is to indicate the breadth of the expected discussion.

Population Model

The population model summarizes our understanding of the processes governing the whelk population from the biology through to the fishery.

Regarding the population, what is known about movement and population structure? Other key issues concern production and mortality processes. What is to be learned from its growth processes? Through analogies with related species and stocks, what can be said about recruitment production? What do we know and need to know about the role of whelk in the ecosystem?

Regarding the fishery, there is a need to understand its impacts on the ecosystem. What do we know and what research is required?

In summary, what is our understanding of the biological processes governing whelk and what research is required?

Assessment Model

The assessment model includes both observational activities, such as the industry logbooks, and procedures used to supply indicators for management decisions.

There are a number of possible assessment models to pursue, all of which have their strengths and weaknesses – from Surplus Production, through Delay-Difference to Age/Size Models. Information requirements and thus costs vary dramatically by model. It is likely that size-based methods will be needed. What are the program requirements of the most appropriate and cost-effective assessment approach?

What other information would be beneficial for management?

Decision Support

Management decisions are linked to particular levels or directions of the indicators termed ‘reference points’ and ‘reference directions’ respectively. These decision points depend upon the objectives that one hopes to achieve. Can we state these, at least in a preliminary way? What research do we need to undertake to define appropriate reference points?

Management Measures

Management needs to regulate the fishery. How can this best be achieved - quotas, effort controls, size limits, area restrictions, etc.? What are the related monitoring requirements?

Appendix 2. List of Participants

Workshop on Canadian Science and Management Strategies for Whelk

3–4 June 2008
George Needler II Boardroom
Bedford Institute of Oceanography, Dartmouth, Nova Scotia

Participant	Affiliation
Valerie Bradshaw	DFO Maritimes – FAM
Mike Campbell	DFO Maritimes – Policy & Economics
Andy Chapman	Canadian Centre for Fisheries Innovation (CCFI)
Ross Claytor	DFO Maritimes – Science
Jeff Cline	DFO Maritimes – FAM
Scott Coffen-Smout	DFO Maritimes – Oceans & Habitat
John Couture	DFO Maritimes – FAM
Bill Dennis	NL Dept of Fisheries & Aquaculture
Alan Dwyer	DFO Gulf – FAM
Isabelle Elliott	DFO Gulf – FAM
Linde Greening	NS Dept of Fisheries & Aquaculture
Dannie Hansen	Louisbourg Seafoods
Bruce Hatcher	Cape Breton University
Peter Hurley	DFO Maritimes – Science
Chris Jones	DFO Maritimes – FAM
Jemie Lent	DFO Maritimes – FAM
Barry MacDonald	DFO Maritimes – Science
Tara McIntyre	DFO Maritimes – Science
Colin McVarish	Cape Breton University
Adam Mugridge	Cape Breton University
Patricia Power	DFO Gulf – FAM
Tim Rawlings	Cape Breton University
Rémy Rochette	University of New Brunswick
Amelie Rondeau	DFO Gulf – Science
Sherrylynn Rowe	DFO Maritimes – Science
Bernard Sainte-Marie	DFO Québec – Science
Robert Sciocchetti	D'Eon Fisheries
Tana Worcester	DFO Maritimes – CSA
Larry Yetman	DFO Newfoundland – FAM

Appendix 3. Agenda

Workshop on Canadian Science and Management Strategies for Whelk

3–4 June 2008

George Needler II Boardroom
Bedford Institute of Oceanography, Dartmouth, Nova Scotia

Agenda

3 June 2008 – Tuesday

09:00 – 09:15	Introduction (Claytor)
09:15 – 09:45	Overview of Whelk Ecology (Rochette)
09:45 – 10:15	Whelk Ecology Discussion – *conceptual model of whelk population*
10:15 – 10:30	Break
10:30 – 11:30	Fisheries and Resource Assessment for Whelk in Québec (Sainte-Marie)
11:30 – 12:00	Fisheries and Resource Assessment for Whelk off Newfoundland (Yetman/Stansbury)
12:00 – 13:00	Lunch
13:00 – 13:30	Fisheries and Resource Assessment for Whelk in the Maritimes (MacDonald/Kenchington)
13:30 – 14:15	Proposed Experimental Fishing Activities for Whelk in the Maritimes (Rawlings/Hatcher/Mugridge)
14:15 – 14:45	Whelk Fisheries and Management Discussion – *current management measures and data inputs from fishery*
14:45 – 15:15	Fishery Sustainability and Ecosystem Considerations (Worcester)
15:15 – 15:30	Break
15:30 – 17:00	Fishery Sustainability and Ecosystem Considerations Discussion – *Given our current understanding of the biological processes governing whelk and of whelk fisheries, what are our concerns surrounding whelk sustainability and broader ecosystem impacts of the fishery?*

4 June 2008 – Wednesday

09:00 – 09:30	Science and Management Strategies for Emerging Fisheries (Claytor)
09:30 – 10:30	Science and Management Strategies for Whelk Discussion – *What are the best management and assessment measures to address concerns regarding fishery sustainability and ecosystem impacts?* – *What research and monitoring would be required to support these management and assessment strategies?*
10:30 – 10:45	Break
10:45 – 12:00	Research Program Needs and Next Steps Discussion – *What are the priorities for research and monitoring?* – *What timelines and costs would be associated with these research and monitoring priorities?* – *How might research and monitoring be accomplished?*
12:00 – 13:00	Lunch
13:00 – 14:30	Research Program Needs and Next Steps Discussion continued
14:30	Adjournment

Appendix 4. Science and Monitoring Pertaining to Ecosystem Objectives and Strategies

Objective – Sub-objective	Operational or emerging strategy with performance indicator	Guide rule incorporating management measure, performance indicator or proxy, reference point	Operational science analysis supporting measure/decision or strategic science analysis for emerging issues or improving advice	Associated or proposed monitoring	Rationale
Productivity – Primary productivity	Limit alteration (excluding catch removals) of essential nutrient concentrations affecting primary production	No guide rule at present.			Not applicable. Whelk operations do not notably alter nutrient concentrations.
Productivity – Community productivity (trophic structure)	Limit trophic level removals with respect to trophic demands of higher levels	Ensure removals do not exceed reference point (to be developed).	Examine existing diet information (e.g., DFO Maritimes Stomach Data Base) and inclusion of whelk in Ecopath models.		Inclusion of whelk in Ecopath models may help elucidate role in ecosystem.
Productivity – Community productivity (trophic structure)	Limit total removals within system production capacity	Ensure removals do not exceed reference point (to be developed).			
Productivity – Population productivity	Keep fishing mortality moderate	Developing fishery. Limit number of licences, size and number of traps, area fished.	Assess CPUE trends, undertake depletion or tagging experiment, define growth rates and size/age at maturity.	Logbooks, DMP of landings, at-sea observers. Record location by string, bait, soak time, gear configuration, bottom temperature.	No mortality estimates at present, no definition of moderate fishing mortality.
Productivity – Population productivity	Permit sufficient spawning biomass to evade exploitation	Selectivity > size at maturity (to be determined).	Develop population model.	Record size and sex composition, reproductive state of population and catch.	Size/age at maturity reported to vary over short distances. Evidence for senescence and parasite-induced sterility.

Objective – Sub-objective	Operational or emerging strategy with performance indicator	Guide rule incorporating management measure, performance indicator or proxy, reference point	Operational science analysis supporting measure/decision or strategic science analysis for emerging issues or improving advice	Associated or proposed monitoring	Rationale
Productivity – Population productivity	Promote positive biomass change when biomass is low	No guide rule at present. Apply additional TAC restriction so risk of not achieving positive biomass change is low.	Determine how to convert CPUE from logbooks in baited trap fishery to biomass indices.	Logbooks.	No biomass estimates at present.
Productivity – Population productivity	Manage % size/age/sex of capture	Needs to be developed. Set minimum capture size.	Develop size measurement and maturity staging protocols, define size/age at maturity and growth rates, determine catch composition and appropriate trap design and minimum legal size for desired selection.	At-sea observers, port sampling. Record catch composition.	
Productivity – Population productivity	Prevent disturbing activity in spawning areas/seasons	No guide rule at present. Set closed areas/seasons to protect spawning.	Assess life history including location and timing of spawning.	Conduct basic biological sampling.	Location and timing of spawning unknown.
Productivity – Population productivity	Manage discarded catch for all commercial species	Needs to be developed. Minimize bycatch including whelk discards.	Quantify bycatch of commercial species, review mitigation strategies as necessary, assess survival of discards, determine best practices for release.	Logbooks, at-sea observers. Record bycatch including whelk discards.	Bycatch of other commercial species, particularly lobster, potentially a concern. Unknown level of whelk discarding at sea. Survival of discards unknown.

Objective – Sub-objective	Operational or emerging strategy with performance indicator	Guide rule incorporating management measure, performance indicator or proxy, reference point	Operational science analysis supporting measure/decision or strategic science analysis for emerging issues or improving advice	Associated or proposed monitoring	Rationale
Biodiversity – Biotope/ seascape (community diversity)	Limit % area disturbed of biotope/seascape types	No guide rule at present. Prohibit fishing in closed areas, develop rule if closed areas inadequate to protect diversity and if traps have measurable impact.	Quantify impact of traps on different bottom habitats.	Logbooks. Record location by string, gear configuration.	
Biodiversity – Biotope/ seascape (community diversity)	Limit trophic level removals to keep trophic levels in proportion in order to conserve trophic structure	Ensure removals do not exceed reference point (to be developed).	Determine catchability of whelk to survey gear to estimate absolute biomass and abundance, assess trophic structure of ecosystem and changes over time, quantify impacts of fishing on trophic structure, use modeling to assess sensitivity of ecosystem to changes in trophic structure.	RV surveys, industry surveys, CPR, AZMP.	
Biodiversity – Species diversity	Limit incidental bycatch or mortality for all non-commercial species	Needs to be developed. Minimize bycatch.	Quantify bycatch, entanglements, temporal-spatial overlap between fishery and marine mammals and turtles. Review mitigation strategies as necessary.	Logbooks, at-sea observers. Record bycatch, entanglements, marine mammal and turtle sitings, incidence of lost gear.	Bycatch potentially a concern. Potential for marine mammal and turtle entanglement but no reported incidents.
Biodiversity – Species diversity	Minimize change in distribution of invasive species	No guide rule at present.	Quantify bycatch of invasive species. Review mitigation strategies as necessary.	Logbooks, at-sea observers. Record bycatch of invasive species.	Gear transfer among areas potentially a concern.

Objective – Sub-objective	Operational or emerging strategy with performance indicator	Guide rule incorporating management measure, performance indicator or proxy, reference point	Operational science analysis supporting measure/decision or strategic science analysis for emerging issues or improving advice	Associated or proposed monitoring	Rationale
Biodiversity – Population diversity	Distribute population component mortality as % of component biomass	No guide rule at present.	Document distribution and abundance, examine associations with habitat, determine population structure.	Basic biological sampling, genetics, tagging, common garden experiments.	Population structure unknown but limited dispersal suggests potential population isolation over short distances.
Habitat – Bottom	Limit % area disturbed of habitat types	No guide rule at present.	Quantify impact of traps, anchors, and groundlines on different bottom types.	Logbooks. Record location by string, gear configuration. In-situ observation (i.e., ROV).	Gear may get displaced in rough weather or dragged along bottom during retrieval.
Habitat – Water column	Limit amounts of contaminants, toxins, and waste introduced in habitat	No guide rule at present.			Not applicable.
Habitat	Minimize amount of lost gear	No guide rule at present. Minimize ghost fishing.	Determine deterioration rate of gear.	Logbooks. Record incidence of lost gear.	Low incidence of gear loss. Biodegradable trap components minimize ghost fishing.
Habitat	Control noise or light level/ frequency	No guide rule at present.			Not applicable.