

Sea urchin fisheries, management and policy review

(Activity A4.2.1 of the URCHIN project)

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Report

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<p><i>Summary/recommendation:</i></p> <p>This report gives a brief introduction to the URCHIN project, funded by the Northern Peripheries and Arctic Programme (NPA). The scope of the report is also outlined.</p> <p>This is followed by a summary of the sea urchin fishery management techniques that are used in sea urchin fisheries around the world. These are listed in order of size of the fisheries and include a brief description of the history of the fishery and what management practices have led to the current state of the fishery. There are three more detailed case studies of Fisheries Management from Chile, the world's largest fishery, New Zealand, a small but sustainably managed fishery and Canada, a fishery that has substantial management in place and a sustainable fishery that experiences similar environmental conditions to countries in the NPA.</p> <p>The report then summarises the management practices, or lack of, that have been in place in the participating NPA countries (Ireland, Iceland, Greenland and Norway).</p> <p>Finally, conclusions are made on the history of sea urchin fisheries management in the NPA countries and the impacts that a lack of fisheries management and regulation has had in these countries.</p>	
<p><i>Summary/recommendation in Norwegian:</i></p> <p>Denne rapporten gir en kortfattet innføring i prosjektet URCHIN, finansiert av Northern Periphery og Arctic Programme (NPA). Dette etterfølges av et sammendrag av metoder som brukes i kråkebollefiskerier verden rundt. Disse er listet etter størrelse og inneholder en kort historisk beskrivelse av fiskeriene, og hvordan praksis har påvirket den nåværende tilstanden av fisket. Det er tre mer detaljerte studier av fiskemetoder fra Chile, verdens største fiskeri, New Zealand, et lite, men bærekraftig forvaltet fiskeri og Canada, et fiskeri som har betydelig forvaltning på plass og et bærekraftig fiskeri som har lignende miljøforhold som land innenfor NPA-ordningen.</p> <p>Rapporten oppsummerer forvaltningspraksis, eller mangel på, som har vært på plass i NPA-land. Disse inkluderer Irland, Island, Grønland og Norge.</p> <p>Avslutningsvis er det gitt en rekke konklusjoner på hvordan kråkebollefiskeriene har vært forvaltet og betydningen manglende forvaltning og regulering har hatt i de ulike NPA-landene.</p>	

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1 Executive Summary

This report gives a brief introduction to the URCHIN project, funded by the Northern Peripheries and Arctic Programme (NPA) and the scope of this report.

This is followed by a summary of the sea urchin fishery management techniques that are used in sea urchin fisheries around the world. These are listed in order of size of the fisheries and include a brief description of the history of the fishery and what management practices have led to the current state of the fishery. There are three more detailed case studies of Fisheries Management from Chile, the world's largest fishery, New Zealand, a small but sustainably managed fishery and Canada, a fishery that has substantial management in place and a sustainable fishery that experiences similar environmental conditions to countries in the NPA.

The report then summarises the management practices, or lack of, that have been in place in the participating NPA countries. These include Ireland, Iceland, Greenland and Norway.

There are a number of examples of how a sea urchin fishery can be managed poorly. The most sobering example has been the serial depletion of the Chilean fishery prior to 2002. However, this fishery has undergone a major transformation to implement management strategies to avoid a fisheries collapse. Likewise there are a number of well managed and sustainable sea urchin fisheries around the world. These tend to rely on a good overview of biology of the urchin species present in the area as well as sound knowledge of the dynamics of the sea urchin populations. Comprehensive stock assessment and mapping also appears to be an integral part of successful fisheries management. This report shows that most of these factors are absent in the NPA countries participating in the URCHIN Project (Iceland is in the process of instigating fisheries management). This report is a timely reminder of the importance of effective and appropriate fisheries management for any future sea urchin fisheries in the NPA area and the dangers of not implementing such measures.

2 Introduction

2.1 Introduction to the URCHIN Project

The URCHIN project aims to utilise the sea urchin resource present in the northern arctic regions. The challenges of fishing, sustainable and responsible harvesting of stocks, legislation and supply chains for sea urchin products from isolated and environmentally harsh and challenging areas in the Northern and Arctic region will be addressed. The challenges will be overcome through innovation and national and transnational technology transfer.

Currently there are small scale (<150 tonne p.a.) intermittent fisheries for sea urchins in the NPA. This is despite there being enormous sea urchin resources present in the area. There are a number of challenges that have prevented the expansion of sea urchin fisheries in the NPA. These include environmental challenges to fishing, inadequate and inappropriate legislation and fisheries management and lack of technology and knowledge regarding sea ranching and roe enhancement of poor quality urchins. Research to overcome these challenges has been disparate and there has been no previous transfer of knowledge between the NPA partner countries.

This project aims to gather the existing expertise from Norway, Iceland, Ireland and Greenland, together with knowledge from Canada and Scotland to optimise the fishing of high value sea urchins in Northern and Arctic areas. Furthermore, roe enhancement technology for roe fattening to increase the value of low value sea urchins once they have been collected in the northern arctic regions will be developed in Greenland and Iceland. The project would also investigate sea ranching to repopulate areas that have been extensively overfished in the past in Ireland. Issues regarding the provision of adequate legislation and fisheries management will be identified and legislative organisations will be provided with the appropriate knowledge to provide sensible and sustainable management of sea urchin fisheries. The project will also estimate market needs for sea urchin roe as well as establishing logistic routes from the NPA to markets.

2.2 Scope of the Report

The aim of this report is to produce a short review of previous and current management strategies that have been and are used in the NPA and to compare these to other strategies used to manage sea urchin stocks around the world.

3 Summary of the Fisheries Management techniques used around the world

3.1 Introduction

In a comprehensive review of world sea urchin fisheries, Andrews *et al.* (2002) lists the following countries around the world as sea urchin producers (in decreasing order of production in 2002): Chile, Japan, Maine (USA), British Columbia (Canada), California (USA), Mexico, New Brunswick (Canada), Russia, Alaska (USA), South Korea, Nova Scotia (Canada), Philippines, New Zealand, Spain, Fiji, Washington (USA), China, Oregon (USA), Australia, North Korea, Peru, France, Ireland, Iceland, Taiwan (Norway, Greenland and Scotland are not listed in this reference due to the very small size of the fisheries in these countries). In the interim years there have been various small scale changes in production but this list of sea urchin producers has remained relatively stable in the past 12 years. The fisheries in all these countries and areas have a variety of management practices in place which primarily include;

- Permits
- Fishing limitations (season, size etc.)
- Quota management systems

3.2 Summary of management Techniques utilised in worldwide sea urchin fisheries

The following is a brief summary of the sea urchin management strategies used in the various fisheries around the world (based on the summaries provided by Andrews *et al.*, 2002). This gives an overview of the types of fisheries management techniques that have been utilized in the larger sea urchin fisheries around the world.

- *Chile* (see following case study)
- *Japan*

There are six species of sea urchin harvested in Japan and the fishery is divided into 16 Prefectures. All fisheries are closed during the spawning season when the roe quality is not considered good enough. The timing of these closures depends on the spawning patterns of individual species in the different Prefectures and is based on an extensive knowledge of these reproductive patterns. Exclusive fishing rights are provided to fishers Associations which are allocated areas of seafloor to fish. The fishing rights are not tradable but can be inherited. The Japanese government is involved in setting sea urchin fishery management policies for each 'sea area' and may include MLS's, closed areas and seasons and fishing method restrictions. The Japanese fishery has been managed this way for over 50 years indicating its sustainability. However, Japan has become increasingly dependent on imported sea urchin products to meet demand (Andrews *et al.*, 2002).
- *Maine (USA)*

As with many large sea urchin fisheries in the early years the stock was seen to be inexhaustible and there were no management strategies in place prior to 1992. Legislation and regulations to limit access to the fishery to licensed harvesters and to restrict their harvesting techniques were then introduced. Management of the fishery involves restricting

the fishing effort but there are no limits to individual or total catch. Due to continuing overfishing the number of fishing licenses was restricted and a plan put in place to reduce the number over time. Fishing restrictions include drag width limits, banning night fishing, creating of fishing zones, fishing seasons and a MLS. Six small areas were excluded from the fishery and set aside as a reference sites for unfished populations (Andrews *et al.*, 2002).

- *British Columbia (Canada)* (see following case study)

- *California (USA)*

This is exclusively a dive fishery utilizing surface air supply that has been very passively regulated without any fishery management plan. Since 1987 there has been a moratorium on the issue of any new dive permits and in 1988 there was a MLS introduced into the fishery, restrictions to the number of days that could be fished in various fishing zones and a permit reduction scheme. Currently it is believed the fishing effort is regulated by catch availability rather than the management restrictions (Andrews *et al.*, 2002).

- *Mexico*

The fishery in Mexico was unregulated prior to 1987 when it became a permit fishery with exclusive rights to fish certain areas. This was to try and curb the excessive overfishing taking place. Permits are tradeable and therefore provided security and a promoted commitment to a long term sustainable fishery. An MLS was also introduced in 1987, closed season and catch reporting was introduced. In 1996 there was a moratorium on new permits, daily catch restrictions were introduced and fishing was restricted to five days per week. There is a TAC but this is a precautionary tool that is not strictly adhered to (eg the TAC can be exceeded if fishing effort is high) Population assessments are based on catch and effort data as well as fishery-independent surveys (Andrews *et al.*, 2002).

- *New Brunswick (Canada)* (see following case study)

- *Russia*

There is little information regarding the Russian sea urchin fishery but there have been substantial rises and falls in catch rates which would indicate boom and bust fishing has occurred. There is a TAC in place and a MLS in some areas (Andrews *et al.*, 2002).

- *Alaska (USA)*

The fishery began in the 1980's but was sporadic and small. In the 1990's the fishery was developed based on a TACC based on 2 % of the estimated biomass (taken from stock assessment surveys. These efforts also failed due to the invasion of sea otters into the fishing areas. A third attempt was made in 1994 in an area where there were no otters and this has developed to the present day. Commercial harvest levels are based on biomass estimates derived from population surveys. A TACC was estimated for all of the fishing areas and an Olympic style fishery is in place beginning on October 1 each year and closing when the TACC is met (Andrews *et al.*, 2002).

- *South Korea*

The shallow (less than 10m) dive fishery in Korea is dominated by woman divers and the fisheries are owned and operated by local villages. There are no MLS or other limits on catch but the village decide how many divers can work and when. Fishing in depth greater than 10m is restricted to licensed vessels and the number of these is restricted (Andrews *et al.*, 2002).

- *Nova Scotia (Canada)* (see following case study)
- *Philippines*
In the 1970's there was an unregulated open fishery which resulted in a collapse of sea urchin stocks. In 1988 a seasonal closure was put in place but this did little to stop fishing pressure and the fishery collapsed again in 1992. Efforts to restock the fishery have been made since 1999 (Andrews *et al.*, 2002).
- *New Zealand* (see following case study)
- *Spain*
Breath hold diving is the most common method of collection and divers required to have a license to collect shellfish. The fishery is not capped by a TAC. There are no size limits or closed seasons (Andrews *et al.*, 2002).
- *Washington (USA)*
A range of measures were introduced into this fishery in 1977 including a rotational fishing scheme, seasonal and size limits were also put in place. A drastic increase in the fishing fleet led to a fisheries collapse and a limited entry scheme was introduced in 1988 until 1993 when a model based quota system was introduced (Andrews *et al.*, 2002).
- *China*
Few formal statistics are available from the Chinese sea urchin fishery and there are known to be seasonal and size restrictions in place in different areas of China.
- *Oregon (USA)*
In 1988 a MLS was introduced as well as mandatory logbooks for sea urchin fishers. Site restrictions were put in place and the number of divers in the fishery was restricted. Several areas are closed for fishing and used as fishing control areas (Andrews *et al.*, 2002).

4 Case studies of sea urchin Fisheries Management

The following is a more in depth look at three particular sea urchin fisheries. The first is the Chilean fishery which is the largest in the world but which is facing a number of management issues. The second is the New Zealand fishery which has been a very stable fishery with strong management practices, particularly since the introduction of a Quota System in 2002. The third is the Canadian fishery which faces many of the challenges that NPA countries face and yet also has strong management practices and a longstanding fishery.

4.1 Chile

4.1.1 The Sea Urchin Fishery

The fishery for the endemic sea urchin *Loxechinus albus* is the largest in the world. It has a history of heavy exploitation followed by the introduction of effective management strategies. Andrew *et al.* (2002) divided the history of the fishery into three phases: 1) a small fishery, 2) rapid expansion, 3) full exploitation and decline. The fishery peaked in 1995 when Chile produced 54,609t which at the time was 45% of the world production (Andrew *et al.*, 2002). Catches have subsequently declined but the fishery remains the largest in the world, still supplying in the order of half the world catch (Moreno *et al.*, 2006).

4.1.2 National Fisheries Policies and management measures

In the north of Chile the fishery has been managed by the Caletos system, a small-scale co-management system based on input from the local fisherman. This has managed to preserve artisanal sea urchin fishery in this area (Moreno *et al.*, 2006). South of these areas there has been very little or ineffective management (prior to 2002) which has allowed over excessive exploitation of the resource. This is despite national attempts to restrict fishing which included: 1) closure of a number of Regions between 1983 and 1987, 2) Creation of a National Registration of Fishermen, 3) Summer closures during the spawning season, 4) Introduction of a minimum legal size MLS of 100mm in 1974, this was later reduced and much of the catch that was landed was under the legal MLS (Andrew *et al.*, 2002). Due to the unregulated nature of the majority of the fishery and the apparent north to south serial depletion of the sea urchin populations there was a feeling of imminent disaster for the sea urchin fishery in Chile in the year 2000 (Moreno *et al.*, 2006). However, in 2002 the government led an effort to bring all parties together to discuss the future of the fishery. This led to the formation of participatory forum with representatives from Fishers, processors, managers and scientists. This results in a formal management plan with short, medium and long term goals for the fishery. Rotational fishery practices, the creation of reproductive reserves and utilizing the extensive traditional knowledge of the fishery have all contributed to the success of this plan and although the Chilean fishery remains perilous it is still the world's largest sea urchin fishery (Moreno *et al.*, 2006).

4.2 New Zealand

4.2.1 The Sea Urchin Fishery

The fishery for sea urchins (commonly referred to by their Maori name of kina) in New Zealand is based on a single endemic urchin species (*Evechinus chloroticus*). Sea urchins are fished in New Zealand by commercial, recreational and Maori customary fishers. In some areas the Maori customary catches have been reported to be up to 50% of the commercial catch (McShane, 1992; Andrew *et al.*, 2001). Sea urchin have been commercially fished since 1986 using breath-hold diving. The exception was in 1998-99 when approximately 10% of the total catch was collected by dredge. The sea urchin fishery in New Zealand currently harvests around 750t of sea urchin per year, compared with a Total Allowable Commercial Catch (TACC) of 1147t (Miller and Abraham, 2011). A small amount of sea urchin bycatch (an average of less than 5t per year) is reported from fisheries targeting other species. The sea urchin industry is small, with 75 % of the catch in the 2008–09 fishing year being harvested by nine vessels. Since the introduction of kina into the QMS, the number of vessels fishing for sea urchin has decreased, and the average catch per vessel per year has increased (Miller and Abraham, 2011).

4.2.2 Management Measures

Currently the fishery is managed using a range of regulatory measures including: a moratorium on new permit holders since 1992, limits on fishing methods (only breath hold diving is allowed), competitive TACs and daily catch limits in some fisheries and area closures. The sea urchin fishery in New Zealand is divided into ten fishing areas but commercial harvesting is concentrated in four of the ten areas (Fig. 1). Total allowable catches (TAC's) were set for each of the four fishing areas in 1988. Fishers were required to obtain permits to fish, or fish on behalf of permit holders, for all non-quota species, including sea urchins. Annual catches in all areas have since varied erratically and there have been major declines in catch and effort in several of the fisheries since that time. In 2002 sea urchins were introduced into the Quota Management System (QMS) along with a number of other species. The TAC for any new species introduced into the QMS is normally set according to an assessment of stock sustainability. However, there was no reliable stock assessment information or estimates of biomass available for any of the sea urchin fishing areas and the TACC was set based on the average annual catch for the fishing years from 1993/4 to 2001/2. The amount of sea urchin caught in the New Zealand fishery since the introduction of the species into the QMS has been variable with a peak occurring in the 2001/2 year (847t). The TACC for the entire New Zealand fishery in 2003/4 was 937t but only 58% of the TACC (548t) was caught, primarily due to the low value of the landed product and the difficulty of consistently fishing good quality sea urchin. (all catch figures are taken from: 'The New Zealand Commercial Fisheries: The Atlas of Area Codes and TACC's', available online at www.fishinfo.co.nz).

Andrew (2000) stated a decade ago that management of the sea urchin fishery in New Zealand was inadequate, and suggested the use of management plans that would set local catch limits, and prescribe patterns of fishing to enhance roe quality and reduce the risk of serial depletion. He suggested that the following are the key attributes required for improved management of the sea urchin fishery: 1) the ability to manage sea urchin at the appropriate spatial scale; 2) continuity of management through time; 3) a property rights institution that rewards commitment to the fishery; and 4) through the allocation of property rights, the establishment of clear rights and responsibilities

of stakeholders. Andrew’s (2000) first recommendation to manage sea urchin at the appropriate spatial scale, is still to be met in New Zealand. However, since QMS introduction, the Kina (Sea Urchin) Industry Council, representing the interests of kina quota owners, has evolved, and in accordance with Andrew (2000), provide a means for cooperation in the fishery, while the introduction of sea urchin into the QMS allows for continuity of management through time, places kina within a property rights institution (thereby providing incentives to invest in the fishery), and establishes stakeholder rights and responsibilities (Miller and Abraham 2011).

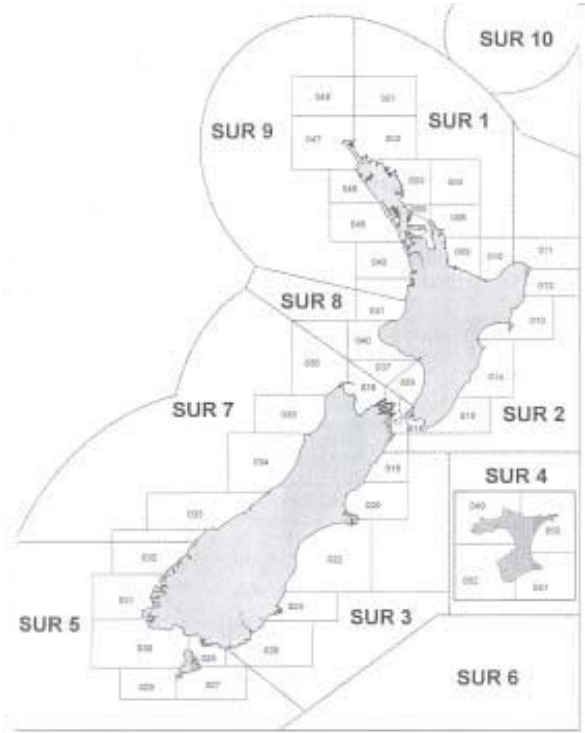


Figure 1 The fisheries management areas (FMA's) and Statistical Reporting Areas (SRA's) for the New Zealand kina fishery (Note the areas are designated as SUR 1-10 with SUR being the Ministry of Fisheries code for Sea Urchin). The main four catch areas are SUR 3, 4, 5, 7.

4.3 Canada

4.3.1 The Sea Urchin Fishery

Canadian fisheries are monitored and managed regionally. Over 200,000 kilometers of coastline are divided into six regions and the Green Sea Urchin (*Strongylocentrotus droebachiensis*) fishery takes place in the following four: Pacific, Quebec, Maritimes, and Newfoundland and Labrador (Fig. 2). Among regions, fishing techniques and management measures differ, however overarching National policies aimed at ensuring sustainable and economically prosperous fisheries apply across the country.



Figure 2 Map of Canada showing the six regions managed by Fisheries and Oceans Canada. Green Sea Urchins are harvested within the Pacific, Maritimes, Quebec, Gulf, and Newfoundland and Labrador regions.

4.3.2 National Fisheries Policies

All fisheries in Canada are governed by the Fisheries Act (R.S., 1985, c. F-14) and regulations made thereunder, including the Fishery Regulations (e.g., conditions of licence, open times, closed areas, etc.). In addition, the Sustainable Fisheries Framework provides the basis for ensuring Canadian fisheries are conducted in a manner which support conservation and sustainable use and contains policies for adopting an ecosystem-based approach to fisheries management. These policies include:

- A Fishery Decision-Making Framework Incorporating the Precautionary Approach (April 2009).
- Guidance for the Development of Rebuilding Plans under the Precautionary Approach Framework: Growing Stocks out of the Critical Zone (April 2013).
- New Emerging Fisheries Policy (2008).
- Managing Impacts of Fishing on Benthic Habitat, Communities and Species (April 2009).
- Ecological Risk Assessment Framework (ERAF) for Coldwater Corals and Sponge Dominated Communities (April 2013).
- Policy on New Fisheries for Forage Species (April 2009).
- Policy on Managing Bycatch (April 2013).

Along with existing economic and shared stewardship policies, these assist Fisheries & Oceans Canada to meet objectives for long-term sustainability, economic prosperity, and improved governance.

The Precautionary Approach (PA) is about being cautious when scientific information is uncertain, unreliable or inadequate and to ensure that the absence of adequate scientific information is not used as a reason to postpone or fail to take action to avoid serious harm to the resource. Canada is committed to using the PA in managing domestic, as well as stocks that straddle international boundaries. A key component of the generalized framework is accounting for uncertainty and risk.

In 1995, a precautionary framework was applied to avert collapse of the Pacific Region's Green Sea Urchin fishery (Perry *et al.* 2002). Using a framework approach for new and developing fisheries (Perry *et al.* 1999), a phased method for the collection of scientific information supported new recommendations and a re-evaluation of management actions. 'Phase 0' allowed for the collection of existing information from harvest logbooks; 'Phase 1' involved collecting new information including landed weights from a mandatory dockside validation program and Green Sea Urchin density estimates from fishery-independent surveys. This approach rebuilt the fishery to being both sustainable and profitable.

4.3.3 Management measures

Pacific Region

In the Pacific Region, the Green Sea Urchin fishery takes place in four Management Areas along the east coast of Vancouver Island: Areas 12, 13, 18 and 19 (DFO 2013). Each area is allocated a quota, which is divided among licence holders. Commercial licences were limited in 1991 due to concerns over increasing fishing effort, and currently there are 49 eligible licences for this fishery. Individual quotas are allocated equally among licence holders, with Green Sea Urchin individual quotas set at 1/49th of the annual coast-wide quota. Two percent of the coast-wide total allowable catch (TAC) reserved during planning for First Nations fisheries for food, social and ceremonial purposes

Harvesters are required to report harvest time and location information to a service provider prior to harvesting, following harvesting, and prior to landing. In order to track daily harvests and ensure that area quotas are not exceeded, all catch must be weighed and validated at the first point of landing by a Fisheries and Oceans Canada certified observer. Harvest logs and chart data must be recorded accurately and submitted to Fisheries and Oceans Canada Shellfish Data Unit. A minimum test diameter (TD) size of 55 mm is implemented, which is intended to allow the urchins at least two spawning events prior to becoming available to the commercial fishery.

Quebec Region

The management measures in effect for Green Sea Urchins in the Quebec region are aimed at controlling harvesting effort and protecting reproductive potential (DFO 2012). There is no TAC, but there are a limited number of exploratory licences, divers, and traps for each harvesting area. The minimum legal size is 50 mm TD. Harvesting via underwater diving is authorized from March 26 to December 31 and the use of traps is prohibited from April 1 to September 23. Logbooks are mandatory. The logbooks indicate the duration of the trips and the landings, the harvesting method, the locations where catches were made and, if applicable, the number of divers or traps and their immersion time, as well as the duration, depth and composition of the sea floor at each dive.

Maritimes Regions

In the southwest New Brunswick Area of Maritimes Region, Green Sea Urchin harvesting takes place in two Management Areas, Area 36 and Area 38, and management measures are area specific. Area 36 is mostly a dive fishery, with 14 dive and four drag licences, and they harvest a competitive fleet TAC of 900 mt from October 1 to May 15 (Robichaud, 2010a). The conversion of a drag licence to a dive license is permanent, and is a management measure intended to gradually move the fishery toward an all-dive fishery. The diver-based harvesting consists of a maximum of four divers in the water and two skiffs with a maximum length of 7.3 m each. Dragging operations are required to use urchin drags with a maximum opening width of 3 m. Additional management measures include: a minimum size limit of 51 mm TD; sea urchins are to be sorted and sized on the harvesting grounds as soon as possible; sub-legal animals are to be returned to the sea immediately upon being measured, in a manner that causes the least harm; harvesting is only to occur between sunrise and sunset; mandatory submission of logbooks; and, dockside monitoring of 50 % of all landings (trips). In Area 38, there are 13 licensed dragging operators with the option of converting (not permanently) to dive licences if requested by the harvesters (Robichaud, 2010b). Eight of the 13 licences are issued to three different First Nations as commercial communal licences. The remaining five licences are issued to independent core harvesters and are subject to the owner-operator policies. There is a fleet TAC of approximately 176mt divided equally amongst 13 licences and harvested as individual quotas. Management measures include: a minimum size limit (TD) of 51mm; sea urchins to be sorted and measured at sea; harvesting between sunrise and sunset; mandatory submission of logbooks; and, 100% dockside monitoring of landings. The Nova Scotian fishery operates under a habitat-based management regime (Miller and Nolan, 2000; DFO 2000). There are two categories of licences: exploratory and restricted. When entering the fishery, harvesters must first harvest competitively on a section of the coast under an exploratory licence. After meeting specified guidelines, they can apply for an individual restricted zone (one licensee per area). In exchange for the privilege of exclusive access to a harvesting zone, harvesters are obligated to fully use and enhance the habitat carrying capacity. Restricted zones are surveyed every few years for habitat characteristics. Urchin biomass is not monitored; instead, the number of licences and the state of the habitat within are used as indicators of the state of the fishery.

Newfoundland and Labrador Region

In Newfoundland, the Green Sea Urchin fishery does not have a total allowable catch, however the fishery is managed by Fisheries and Oceans Canada under the following conditions: licences are restricted to a specified area, which aligns with Lobster Fishing Areas (LFA's); harvesting method is limited to SCUBA diving with a maximum four divers authorized per licence; only vessels less than 19.8 m and registered with Fisheries and Oceans Canada may participate in the fishery; the minimum retention size is 48 mm test diameter; and harvesting seasons are set for specific harvesting areas (Pisces Consulting Ltd 2014).

5 Summary of current management strategies utilized in NPA countries

5.1 Norway

5.1.1 The Fishery

There is no tradition of consuming sea urchins in Norway. As a result there is a very limited domestic market for sea urchin roe and a very limited history of fishing and exporting sea urchins. Currently, sea urchin fishing in Norway is still sporadic and intermittent despite the lucrative value of sea urchin roe on both domestic and export markets and the enormous estimated biomass of *S. droebachiensis* (estimated at a massive 80 billion individual animals, or 56,000 tons) (Gundersen *et al.*, 2010). The total annual catch has been sporadic (between 10-100t annually) and the current annual harvest is less than 10 ton with the one long term fishing company (Arctic Caviar AS) being the only company to consistently fish urchins for over a decade.

5.2 Sea Urchin Fisheries Policies and Management

5.2.1 Summary from Roderick Sloan, Arctic Caviar AS, Norway

Norway currently has no quota system for managing its sea urchins fisheries. This lack of a quota system carries the associated risks of multi-user conflicts, overexploitation of the urchin stocks amongst others. There is also no fisheries management plan available from the Norwegian Directorate of fisheries (Roderick Sloan, Arctic Caviar AS, pers. comm.).

Case Study – Application procedures and requirements for fishing an urchin site in Norway:

Required:

- a) A boat
- b) A diving license

The chosen site needs a classification for fishing from Mattilsynet and there are four kinds of classification.

A Classification – The site has been tested for 12 months for *E. coli* and algae toxins without any failed results. Additionally the urchins must be tested for Heavy Metals every 4 years. Obtaining this classification means the sea urchins can go directly to the consumer.

B Classification – There's been a failure of *E. coli* or algae toxin. These sea urchins can't be sold directly to the consumer and must be heat-treated.

C Classification – A constant failure of *Escherichia coli*, or algae toxins. The site can be fished, but the sea urchins have to be moved onto an A, B or separate land site for a period of purification.

Seasonal Fishing Classification – This is a temporary classification of a site and is probably the most relevant to sea urchin fishermen. You need *E. coli*, algae toxin and Heavy Metal testing. Three *E. coli* tests are needed to take place in a three week period with no failed results before any fishing can take place, followed by *E. coli* every 4 weeks during the period of fishing.

Additionally- You need a site map showing industrial and residential areas, a site map highlighting sewage outlets and a sea currents chart.

There is currently no legislation around the size of a site (this is up to the individual food health authorities) but they are usually around 5km².

Case Study – Requirements once a site has been approved and fished:

- a) When the catch is landed it must be reported to the Fishermen's Association.
- b) You need a packing centre that has been approved by the food health authority, with annual inspections and 3-yearly audits.
- c) For exporting within the EU: urchins currently need a catch and health certificates and an export licence.
- d) For exporting to the US and Japan: Need a health certificate for the export, issued by the food and health authorities.

Possible future requirements:

Norovirus testing may be applied to the fishery at some point.

5.3 Iceland

5.3.1 The Fishery

The green sea urchin is common around Iceland but the distribution is very patchy. It is commonly associated with laminaria kelp which it feeds on. Harvesting started in 1983 by divers which was not economically feasible and stopped in 1989. In 1993 the fishing started again using dredging and peaked in 1994 when 1 500 tonnes were landed. After that the fishery declined dramatically and stopped in 1997. In 2005 exploitation of the stock started again and but only in Breidifjörður, west Iceland. Since 2007 the yearly landings have been about 150 tonnes until 2014 when it reached 230 tonnes. Since 2007 CPUE has been steady ranging from 365-478 kg/hour fished. The main fishery has always been in a small area of the southern part of Breidifjörður and focused on small hot spots.

5.3.2 Urchin Fisheries Policies

The Icelandic sea urchin fishery has been subject to relatively passive regulation. There were no regulations in 1993 when the sea urchin fishery started and no limits on quantity of catch. The only requirements were that the boat was legally operated had a dredge or a diver and a legal fishing permit.

In 1993 Ministry of Fisheries introduced regulations to limit access to the sea urchin fishing where it was claimed that only vessel with a legal fishing permit and a contract with a legal processing company approved by the Directorate of Fisheries were allowed to harvest sea urchins. The government could limit the permit if necessary by demanding reports on the fishing, maximum size of boats, size and kind of fishing gear used and the fishing season. Each license was limited to one big area (7 areas around Iceland) but there were no limitations for number of licenses that could be granted (Regulation no 492/1993).

In November 2013 a new regulation was introduced and now there are no limitations to areas, and fishing reports are demanded weekly instead of monthly (logbook). Classification of harvesting areas and monitoring of biotoxins and poison algae are required by the competent authority (Icelandic Food and Veterinary Authority) (Mast) and the catch has to be monitored by authorities when landed (Regulation no 1010/2013).

5.3.3 Management measures

The sea urchin fishery operates without a fishery management plan, where no restrictions on catch, effort, no of boats, dredge constructions, area closure or fishing seasons exists. The only requirements for the fishermen to be able to catch sea urchins are that the boat is legally operated and has a fishing permit. No regulations regarding size limits exist but the market demand is that the urchins have reached 40-50mm in diameter. There are no limited fishing seasons but because of market demands for roes of good quality (> 10 %, right colour and quality) which can only be reached between September and April in Icelandic waters, the fishery is conducted in these months only. However, loogbook information is required weekly, where catch, location and effort is reported for every fishing day and the stock status (CPUE) has been determined annually from that information by the MRI.

The Directorate of Fisheries is an Icelandic government institution responsible for implementing government policy on fisheries management and handling of seafood products. It collects processes and publishes data on fisheries in collaboration with Statistics Iceland. Information on sea urchin catch (by fishing boats) by area, day and effort is available on the Directorates web site (<http://fiskistofa.is>).

5.4 Greenland

5.4.1 The Fishery

There is currently no commercial fishery for sea urchins in Greenland, although there have been attempts to fish for sea urchins in mid-1990's. In 2006 there were a project funded by NORA (North Atlantic Cooperation) with the aim of locating where sea urchins best thrive and when the roe content was suitable for fishing. In 2009 a report was published by scientists from Nofima, Norway describing an initial investigation to search for areas in Greenland where sea urchin stocks may exist (Siikavuopio S.I. and Labansen, J.P., 2009). Several searches were made along selected sections of the Greenland coastline to chart stocks, assess the quality of these and investigate whether commercialisation of this resource is possible. Using traps the roe size, colour, taste and consistency was assessed at different sites with promising results. However, in order for sea urchins to demand the highest market prices, they need to be delivered to a processing plant or to markets relatively quickly. Such plants do not currently exist in Greenland and the road network is not sufficiently developed. Therefore, sea urchins must be transported by boat to the airport which adds time and cost. An alternative is to store the sea urchins until sufficient quantities are available to transport more economically. This is also challenging as they are vulnerable to damage, frost, temperature and sunlight.

In 2014-2015 Royal Greenland A/S had a trial fishery for sea urchins in Maniitsoq and Nuuk, both West Greenland. There appeared to be sufficient sea urchins present in these areas. Royal Greenland

A/S ran trial fisheries over a year, where the main objective was to find out what time of the year the roe were in prime quality and a seasonal variation was detected. Royal Greenland A/S recommends that fishing season should be from September to March where the roe content is good. Different types of fishing gear was tested, the traps developed by Nofima were shown to be effective. A bottom dredge developed from Thorisholmi was also very effective, especially when modified to bottom conditions in Greenland, and the return for catch effort was high. These trials showed that there are popular spaces for the sea urchins to accumulate around archipelagos with a lot of currents and good seaweed. In these conditions it is possible to fish the sea urchins from a small area then return a day later and larger sea urchins have returned. It appears that these areas are surrounded by sea urchins that will replenish those removed from the fishery. As this is a virgin fishery there is no way of knowing how long this replenishment would continue without adequate population monitoring over time.

5.4.2 Urchin Fisheries Policies and Management of sea urchin fisheries

If a sea urchin fishery was established in Greenland there are legislative tools available to regulate it but as there has never been a fishery there is no experience at managing the species. Greenland Institute of Natural Resources (the national institute that monitors the use of both terrestrial and marine species and gives scientific advice to the government) has not undertaken surveys on sea urchins and has no plans to do so in the near future.

5.5 Ireland

5.5.1 The Fishery

Paracentrotus lividus or the purple sea urchin is the main species of urchin fished in Ireland due to its high market value. *Paracentrotus lividus* inhabits subtidal rock pools and rocky shorelines. Harvesting of this species of urchin can be carried out by hand picking in the intertidal zone or by divers operating from boats.

In certain parts of the west coast of Ireland, in particular the inner Galway bay large colonies of urchins lived buried below the surface of coral sand. These areas were the first areas to be completely harvested in the late 1970s, and since then there has been little or no recovery. These confined areas in the inner Galway bay were subject to increased fishing pressure from divers during slack tides. Large harvests were reported in some cases up to two t per day. During this exploitation of the fishery competing groups of harvesters and divers traveled the west coast once catch volumes began to decline in fished areas.

This decline in the fishery was due to lack of regulation and collection of catch data during the boom years of the fishery.

5.5.2 Urchin Fisheries Policies and Management measures

Many factors contributed to the collapse of the Irish fishery including long term variation in recruitment but overfishing is the most likely predominant cause (Andrew *et al.*, 2000). Throughout the 30 years the fishery grew and expanded there was no government imposed restraints on catch or effort, no formal stock assessment and no formal assessment of stock recovery. Today there is still

no government policy for harvesting echinoderms in Ireland, which includes sea urchins and sea cucumber. A market size restraint of a minimum 45-50mm test size is the only restraint on the fishery and is set by the market and not by regulations from state bodies.

6 Conclusions for development of Management Strategies and Policy in NPA Countries

There are a number of examples of how a sea urchin fishery can be managed poorly. The most sobering example has been the serial depletion of the Chilean fishery prior to 2002. However, this fishery has undergone a major transformation to implement management strategies to avoid a fisheries collapse. Likewise there are a number of well managed and sustainable sea urchin fisheries around the world. These tend to rely on a good overview of biology of the urchin species present in the area as well as sound knowledge of the dynamics of the sea urchin populations. Comprehensive stock assessment and mapping also appears to be an integral part of successful fisheries management. This report shows that most of these factors are absent in the NPA countries participating in the URCHIN Project (although Iceland is in the process of initiating more robust fisheries management). This report is a timely reminder of the importance of effective and appropriate fisheries management for any future sea urchin fisheries in the NPA area and the dangers of not implementing such measures.

7 References

- Andrew, N.L., Agatsuma, Y., Ballesteros, E., Bazhin, A.G., Creaser, E.P., Barnes, D.K.A., Botsford, L.W., Bradbury, A., Campbell, A., Dixon, J.D., Einarsson, S., Gerring, P., Bebert, K., Hunter, M., Hur, S.B., Johnson, C.R., Juinio-Menez, M.A., Kalvass, P., Miller, R.J., Moreno, C.A., Palleiro, J.S., Rivas, D., Robinson, S., M.L., Schroeter, S.C., Steneck, R.S., Vadas, R.L., Woodby, D.A., Xiaoqi, Z., 2002. Status and management of world sea urchin fisheries. *Oceanographic Marine Biology Annual Review* 40, 343-425.
- DFO. 2000. Nova Scotia green sea urchin. DFO Science Stock Status Report C3-48(2000).
- DFO. 2012. Assessment of the Green Sea Urchin Fishery in the Estuary and the Gulf of St. Lawrence in 2011. *Can. Sci. Advis. Sec. Sci. Advis. Rep.* 2012/055.
- DFO. 2013. Integrated Fisheries Management Plan Green Sea Urchin. September 1, 2013 to August 31, 2016.
- DFO. 2014. Stock status update and quota options for the Green Sea Urchin (*Strongylocentrotus droebachiensis*) fishery in British Columbia, 2013-2016. *DFO Can. Sci. Advis. Sec. Sci. Resp.* 2014/052.
- Gendron, L. and S. Robinson (eds.) 1994. The development of underutilized invertebrate fisheries in Eastern Canada. Workshop proceedings. *Can. Manusc. Rep. Fish. Aquat. Sci.* 2247: vii + 129 p.
- Miller, R.J. and S.C. Nolan, 2000. Management of the Nova Scotia Sea Urchin Fishery: a Nearly Successful Habitat Based Management Regime. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2000/109.
- Miller, ... and Abraham, ..., 2011. Characterisation of New Zealand kina fisheries. *New Zealand Fisheries Assessment Report 2011/7*, March 2011. 95pp.
- Moreno, C. A., Barahona, N., Molinet, C., Orensanz, L., Parma, A. M., Zuleta, A., 2006. From Crisis to Institutional Sustainability in the Chilean Sea Urchin Fishery. DOI: 10.1002/9780470996072.ch3 In book: *Fisheries Management: Progress Towards Sustainability*, pp.43 – 67.
- Perry, R.I., Walters, C.J., and J.A. Boutillier. 1999. A framework for providing scientific advice for the management of new and developing invertebrate fisheries. *Reviews in Fish Biology and Fisheries* 9: 125-150.
- Perry, R.I., Zhang, Z. and R. Harbo. 2002. Development of the green sea urchin fishery in BC - back from the brink using a precautionary framework. *Fisheries Research* 55: 253-266.
- Pisces Consulting Limited. 2014. Sea Urchin Fishery Review. Submitted to: Director Licensing and Quality Assurance, Department of Fisheries and Aquaculture, Government of Newfoundland and Labrador, 40p + xi.
- Robichaud, D. 2010a. Assessment of the Bay of Fundy sea urchin fishery, Lobster Fishing Area 36. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2010/002. vi + 60 p.
- Robichaud, D. 2010b. Assessment of the Bay of Fundy sea urchin fishery, Lobster Fishing Area 38. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2010/003. vi + 43 p

Appendix

The Activities from the Urchin Project covered by this report.

Activity 4.2	<i>Activity title</i> Literature review	<i>Start month</i> 03.2015	<i>End month</i> 08.2015
<i>Description:</i> Nofima will produce a short review of previous and current management strategies that have been and are used in the NPA and compare these to other strategies used to manage sea urchin stocks			<i>Deliverables:</i> Report on management strategies to manage sea urchin stocks
<i>4.2.1</i>	<i>Deliverable</i> Review of fisheries policies	<i>Target value</i> Supply Review to all participating NPA countries	<i>Delivery month</i> 09.2015

