

# Seafood Watch

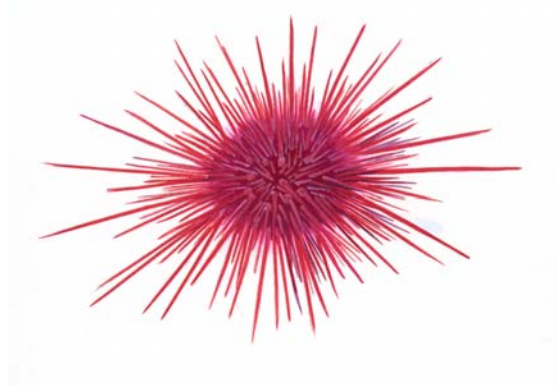
## Seafood Report



MONTEREY BAY AQUARIUM®

### Red Sea Urchin

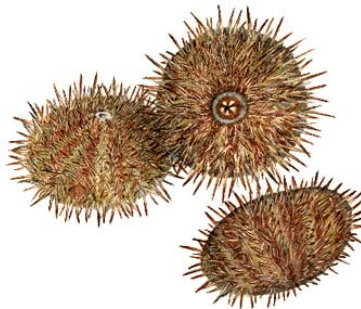
*Strongylocentrotus franciscanus*



(Image © Monterey Bay Aquarium)

### Green Sea Urchin

*Strongylocentrotus droebachiensis*



(Image © Guild Gillespie/www.chartingnature.com)

Final Report  
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Independent Contractor

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## **About Seafood Watch® and the Seafood Reports**

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from the Internet ([seafoodwatch.org](http://seafoodwatch.org)) or obtained from the Seafood Watch® program by emailing [seafoodwatch@mbayaq.org](mailto:seafoodwatch@mbayaq.org). The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices", "Good Alternatives" or "Avoid". The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Fisheries Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

### **Disclaimer**

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch® and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation.

## **Executive Summary**

There are commercial fisheries for both red sea urchins (*Strongylocentrotus franciscanus*) and green sea urchins (*Strongylocentrotus droebachiensis*) in many places around the world, but this report will focus on four particular fisheries in the US and Canada. In the US, there is a red sea urchin fishery in California and a green sea urchin fishery in Maine. In Canada, there is a red sea urchin fishery in British Columbia and green sea urchin fisheries in both British Columbia and New Brunswick. Both red and green urchins are primarily caught for their “roe,” the egg or sperm. The majority of the product from all five fisheries is exported to Japan, which imports more than 80% of the world’s sea urchin roe production. Of the 15.7 million pounds of sea urchin landed in the US in 2005, 13 million remained in the US while only 2.7 million pounds were exported. Meanwhile, 5.3 million pounds were imported.

Both red and green sea urchins are considered to be inherently resilient as they quickly reach maturity (< 5 years), have an assumed high von Bertalanffy growth coefficient (>0.16), and have a high reproductive potential (several million eggs per spawning event). The quality and degree of stock assessment for the five fisheries reviewed in this report varies. Given data gaps or uncertainties and the short historical time span of the fisheries, none of the stocks were categorized as healthy. For the red and green sea urchin fisheries in BC and the green sea urchin fishery in New Brunswick the stocks are considered to be moderately healthy. In these fisheries, the use of precautionary management has resulted in more stable population trends and a lower probability of overfishing. The red sea urchin fishery in California is considered to be in poor condition because the population trends in the fishery are down and good stock assessment models are not available. The green sea urchin fishery in Maine is considered to be in critical condition. As of 2001, the biomass was estimated to be 10% of the virgin biomass according to the stock assessment published in 2003.

Hand collection is the most common fishing method utilized for capturing both red and green urchins and, for the portions of the fishery where this method is used, the habitat has been characterized as resilient to fishing given the minimal impact to the habitat by hand collection. In addition, hand collection results in negligible bycatch. Management frameworks exist for all five fisheries. These management systems have varying levels of sophistication. However, all of the fisheries operate under some form of limited entry, area definition, open season and minimum size limits.




Given the rankings for each fishery for each of the criteria described above, Seafood Watch® concludes that red and green sea urchins from Canada are recommended as a Best Choice, red sea urchins from California are recommended as a Good Alternative, and green sea urchins from Maine receive a recommendation of Avoid.

## Table of Sustainability Ranks

Sustainability Criteria	Conservation Concern			
	Low	Moderate	High	Critical
Inherent Vulnerability	√			
Status of Stocks		√ (Red and Green Sea Urchin – British Columbia and Green Sea Urchin – New Brunswick)	√ Red Sea Urchin – California	√ Green Sea Urchin – Maine
Nature of Bycatch	√			
Habitat Effects		√		
Management Effectiveness	√ (Red and Green Sea Urchin – British Columbia and Green Sea Urchin – New Brunswick)	√ (Green Sea Urchin – Maine) √ (Red Sea Urchin – California)		

### About the Overall Seafood Recommendation:

- A seafood product is ranked “**Best Choice**” if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.
- A seafood product is ranked “**Good Alternative**” if the five criteria “average” to yellow (Moderate Conservation Concern) OR if the “Status of Stocks” and “Management Effectiveness” criteria are both of Moderate Conservation Concern.
- A seafood product is ranked “**Avoid**” if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.

Overall Seafood Recommendation for Sea Urchins		
➤ <b>Canada</b>	Best Choice	
➤ <b>California</b>	Good Alternative	
➤ <b>Maine</b>	Avoid	

## **Introduction**

The red sea urchin (*Strongylocentrotus franciscanus*) and the green sea urchin (*Strongylocentrotus droebachiensis*) are both subtidal omnivores that belong to the phylum Echinodermata meaning “spiny-skinned” animals (CDFG 2001). This report will cover four fisheries in the US and Canada.

Red sea urchins are found in the Pacific Ocean from Baja, California to Alaska. In California, commercial fishing is concentrated in northern and southern California, with a lack of fishing in central California due to urchin predation by sea otters (CDFG 2001). Canada’s commercial fishing was concentrated on the south coast of British Columbia until 1983 when the north coast was opened to fishing. Since 1990, most landings have come from the north coast (DFO 2000a).

Green sea urchins occur in both the Atlantic and Pacific Oceans. In the Pacific Ocean, they are found from northern Washington State to Alaska (DFO 2003), and in the Atlantic Ocean from New Jersey to the Arctic (DFO 2000b). Green urchins are most commonly found in the intertidal and to depths of 10 m, but can be found down to 1,200 meters (DFO 2003) with patchy distributions. They are thought to be more mobile than red sea urchins and may make seasonal migrations between deep waters and the intertidal (DFO 2003). Canada’s Pacific commercial fishery is restricted to two main regions in southern British Columbia: Queen Charlotte Strait and Gulf Islands-Victoria. In the Atlantic, green sea urchins are fished in Maine, US and New Brunswick, Canada.

Red urchin landings in BC have been recorded since 1978. During the 1980s landings increased rapidly until 1993 when landings were stabilized with quotas. Prior to 1983, fishing occurred only along the southern coast of BC. In 1984, the north coast was opened to fishing, and since 1990, the majority of landings have come from that region. The Canadian red sea urchin fishery is managed by the department of Fisheries and Oceans (DFO). Current management includes a minimum harvest size, quotas, limited entry, and area closures (DFO 2000a).

California’s commercial red sea urchin fishery started in southern California in 1971 as part of the National Marine Fisheries Service (NMFS) program to develop fisheries for underutilized species (CADFG 2004). Rapid expansion led to a peak in landings in southern California at 25 million pounds in 1981. During the El Niño of 1982-1983, catches decreased but began to recover in 1985. Landings again peaked in 1990 with 27 million pounds caught in southern California. This peak was followed by a steady decline in catch to 8.8 million pounds caught in 2001 (CDFG 2004). Since 2001, landings have hovered between 8 and 11 millions pounds (CDFG 2006). Commercial fishing for red sea urchin started in northern California in 1972, but landings were insignificant until 1977. The fishery experienced a major expansion starting in 1985. Landings rose from 1.9 million pounds in 1985 to 30.4 million pounds in 1988 (CDFG 2001). This expansion was fueled by decreasing landings in southern California and favorable exchange rates with Japan. The northern California fishery began a steep decline in landings in 1989 and leveled off in 1996 at 3 – 4 million pounds (CDFG 2001). However, since then landings have declined to 1.2 million pounds in 2005 (CDFG 2006).

The commercial green sea urchin fishery in British Columbia began in 1987. The fishery quickly focused on winter (November 1 to March 1) due to good roe quality and the best market prices. Today, there are two major fishing regions for green sea urchin in BC, Queen Charlotte Strait and Gulf Islands (Perry et al. 2006). Landings peaked in 1992 at 1,042 t and were worth \$4.4 million (Perry 2003). Since 1992, landings have declined due in part to management actions. Since 1994, landings have been limited by quotas and have averaged 157 tonnes, and the majority of the landings have come from southern BC because of the better roe quality and proximity to processing plants (DFO 2003). Total landings in 2003 were slightly higher than 2001 and 2002, but 2004 fell to the lowest level since the beginning of the fishery in 1987 (Perry et al. 2006). The lowest level of effort since the start of the fishery was in 2004. At that time, an over-supply of green sea urchins from Russia resulted in low prices in Japan for the product. This imbalance in supply and demand is thought to explain the decline in effort (Perry 2006). Catch per unit effort (CPUE) in the BC green sea urchin fishery reached its highest value in 2003, but fell in 2004 which was the first decline since 1998 (Perry 2006). The 2005/2006 landings were 83,995 lbs (Parker 2007, pers. comm.).

Green sea urchins in Maine were collected and eaten by Native Americans thousands of years ago, but the first recorded commercial landings for green sea urchin in Maine date from 1929. From 1937 to 1986, green sea urchin landings and values varied and the product was marketed in the United States. The urchins were shipped whole to Chicago, Boston, and New York City (Fulton Fish Market) where they were purchased by ethnic groups of Italian, Spanish, Portuguese, German, Greek, and French descent. The international market for green sea urchins began in the mid 1970s with the Japanese expressing considerable interest in North American urchins. This interest led to a rapid expansion of the fishery with landings peaking in 1993 at 19,115 mt (42 million lbs), and the value peaking in 1995 at \$36 million (Hunter 2005). Since then, landings have steadily declined as a result of fishing down an unfished accumulated biomass, as well as harvester attrition, die-offs, shortened seasons, size restrictions, other management actions, overfishing, and ecological shifts caused by fishing (Steneck et al. 2004 as cited in Hunter 2005).

The commercial green sea urchin fishery in New Brunswick began in 1989. The fishery has two main fishing zones, Lobster Fishing Areas (LFA) 38 (Grand Manan) and LFA 36. Fisheries operating in both of these areas are also allowed to fish in LFA 37, which is a small adjoining area. Landings in the fishery have increased by almost two orders of magnitude since 1989. Landings in 1989 were 29 t and by 1999 landings were 1,700 t. Landings peaked at 1,900 t in 1996 and have since declined. The value of the fishery in 1999 was \$4 million. DFO considers the fishery to be poor in terms of both biological and fishery information, and as a result, there are limited data for DFO to interpret and develop management options.

In the US, red sea urchins caught in California are managed by the California Department of Fish and Game (CDFG) and green sea urchins caught in Maine are managed by the Maine Department of Marine Resources (DMR). In Canada, red and green sea urchins caught in British Columbia and green sea urchins caught in New Brunswick are managed by the Department of Fisheries and Oceans (DFO) Canada.

## **Availability of Science**

Substantial data are available for both red and green sea urchins, including life history data and a good understanding of ecosystem interactions. However, there is a range of stock status information and understanding for the five fisheries reviewed in this document. In none of the fisheries is there robust stock assessment information. In fact, a few of the fisheries, including the green sea urchin fishery in New Brunswick, consider the fishery to be data poor; this lack of data impedes management action.

## **Market Availability**

### **Common and market names:**

*Strongylocentrotus franciscanus* are known by the common name red sea urchin (CADFG 2001). *Strongylocentrotus droebachiensis* are known by the common name green sea urchin (DFO 2003). The roe from both species are sold as *uni* in sushi restaurants.

### **Seasonal availability and product forms:**

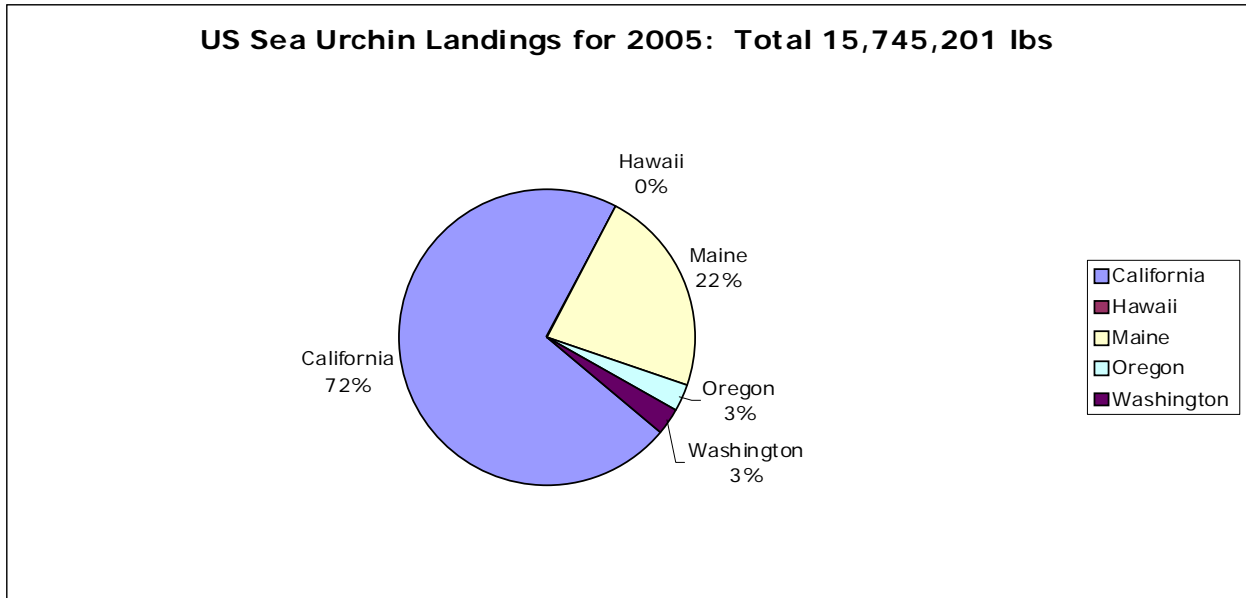
Japan imports more than 80% of the world's sea urchin roe production (Taylor 2004). The roe is served in a variety of forms: raw, with rice, preserved in brine, alcohol, and/or salt, and in casseroles (Taylor 2004). Both red and green sea urchins are caught for their "roe," the egg or sperm.

The best red sea urchin roe comes from urchins caught between October and May. After this period, the quality begins to decrease as the red sea urchins begin to spawn (DFO 2000a). Processors remove the roe from the urchin and place it in shallow trays which are exported to Japan. The roe must be delivered fresh as it is consumed raw. The domestic market for red sea urchin roe in both the United States and Canada is small.

The best green sea urchin roe comes from urchins caught between November and March. During this period, the roe quality, quantity and market prices tend to be the highest (DFO 2003). Once caught, the urchins are either locally processed or shipped live.

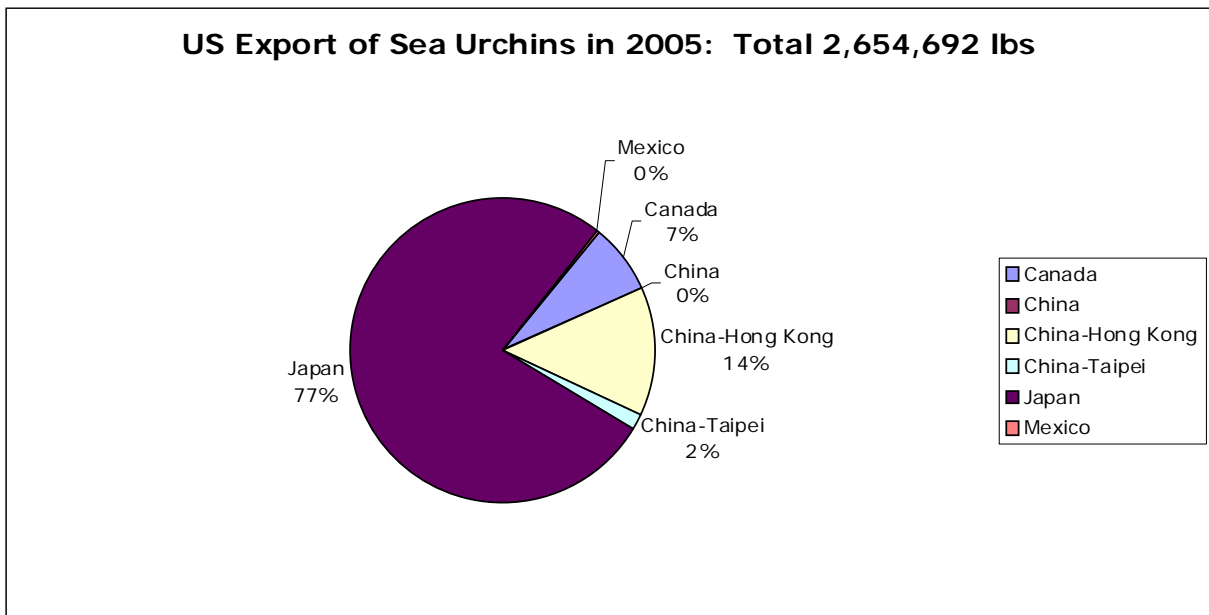
### **Consumption information:**

In 2005, the US landed 15.7 million lbs of sea urchin. Of this amount 72% came from California and 22% from Maine (Figure 1).



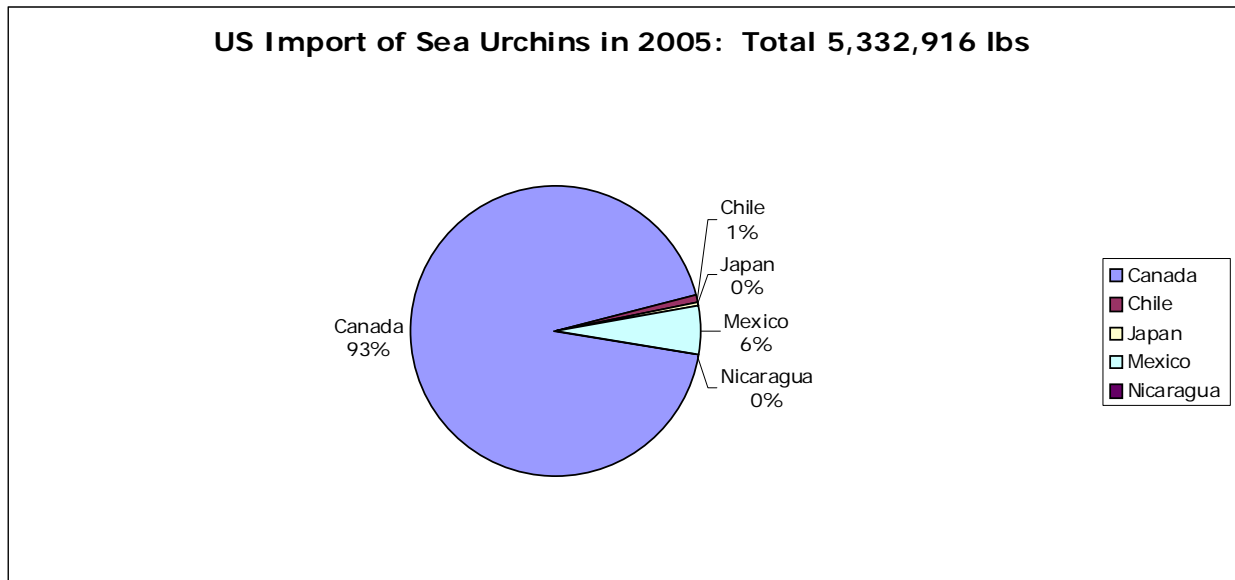
**Figure 1.** US sea urchin landings for 2005 (data from NOAA annual commercial landings statistics [http://www.st.nmfs.gov/pls/webpls/MF\\_ANNUAL\\_LANDINGS.RESULTS](http://www.st.nmfs.gov/pls/webpls/MF_ANNUAL_LANDINGS.RESULTS)).

During the same year, the US exported 2.7 million pounds of sea urchin (Figure 2). Approximately 77% of these exports were to Japan, which is consistent with the fact that Japan imports over 80% of the world’s sea urchin roe production. Given these figures, 13 millions pounds of sea urchin landed in the US remained in the US for domestic consumption.



**Figure 2.** US Exports of sea urchin in 2005 (data from NOAA annual trade statistics [http://www.st.nmfs.gov/st1/trade/annual\\_data/TradeDataAnnualProductCountry.html](http://www.st.nmfs.gov/st1/trade/annual_data/TradeDataAnnualProductCountry.html)).

In addition, the US imported an additional 5.3 million pounds of sea urchin (Figure 3). The majority of these imports (93%) came from Canada. Re-exports of sea urchin from the US were minimal in 2005, at approximately 143,000 lbs.



**Figure 3.** US import of sea urchins in 2005 (data from NOAA annual trade statistics [http://www.st.nmfs.gov/st1/trade/annual\\_data/TradeDataAnnualProductCountry.html](http://www.st.nmfs.gov/st1/trade/annual_data/TradeDataAnnualProductCountry.html))

## **Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species**

### **Criterion 1: Inherent Vulnerability to Fishing Pressure**

*Guiding Principle: Sustainable wild-caught species have a low vulnerability to fishing pressure, and hence a low probability of being overfished, because of their inherent life history characteristics.*

Sea urchins are subtidal omnivores that belong to the phylum Echinodermata or “spiny skinned” animal. This phylum includes sea stars, brittle stars, sea cucumbers, and sand dollars. Echinoderms have hard calcareous shells, called a test, and tube feet, which are used for respiration, locomotion, and grasping.

#### **Red Sea Urchin**

Red sea urchins (*Strongylocentrotus franciscanus*) are found in the Pacific from Baja, California to Alaska, and vary in color from uniform red to dark burgundy. It is a large sea urchin species with a maximum test diameter of over 18 cm (7.09 inches) and maximum spine length of 8 cm (3.15 inches) (DFO 2000a). Tagging studies in the United States have shown that red sea urchins are long-lived, at least 50 years and some large individuals may be older than 100 years old (CDFG 2001). Growth to harvestable size (3.5 inches in the United States) averages six to eight years. These figures suggest a growth rate of 0.44 to 0.58 inches per year. Red sea urchins reach sexual maturity between 2 and 3 inches (CDFG 2001 and DFO 2000a). Using the above

growth rates, red sea urchins are between 3 and 7 years old when they reach sexual maturity. Spawning is seasonal but can vary based on year and locality (CDFG 2001). Fertilization is external, with females spawning up to several million eggs at a time, and success is density-dependant. Studies have shown that densities of less than two red sea urchins per square meter can have poor fertilization success (CADFG 2001). Given these life history characteristics, the intrinsic rate of increase ( $r$ ) and the von Bertalanffy growth coefficient ( $K$ ) are assumed to be high. It has been shown that variability in settlement patterns along the shoreline in California grows with increasing latitude. Red sea urchin are likely affected by large scale oceanographic processes associated with El Nino events (Ebert 1994 as cited in Pfister 1996).

### Green Sea Urchin

Green sea urchins (*Strongylocentrotus droebachiensis*) are found in both the Atlantic and Pacific Oceans. They reach a maximum test diameter at about 10 cm and spawn at test diameters of 4.5-5 cm (DFO 2003). Growth rates are highly variable depending on food availability. Rates of 1 cm/year or more have been recorded in B.C. and Alaska. Green urchins begin to spawn at approximately three years old (Taylor 2004). Spawning generally occurs from February to March (DFO 2003). Female green sea urchins have been shown to spawn up to two million eggs (Taylor 2004). In the Atlantic, green sea urchins have been found up to 20-25 years old (Robinson and MacIntyre 1997 as cited in Perry 2002). In Maine, they had been reported at ages greater the 50 years (Russell 1998 as cited in Perry et al. 2002). Given these life history characteristics the intrinsic rate of increase ( $r$ ) and the von Bertalanffy growth coefficient ( $K$ ) are assumed to be high. Green urchins are most commonly found in the intertidal and depths up to 10 m, but can be found down to 1,200 meters (DFO 2003) with patchy distributions. They are thought to be more mobile then red sea urchins and may make seasonal migrations between deep waters and the intertidal (DFO 2003).


**Table 1.** Sea urchin life history parameters.  
(DFO 2000a; CDFG 2001; DFO 2003; Taylor 2004; and DFO 2000b; Perry et al. 2002.)

Common name	Scientific name	Age @ 50% Maturity	'k'	Max Age	Fecundity (1000s larvae)	Geographical Range in the Eastern North Pacific
Red Sea Urchin	<i>Strongylocentrotus franciscanus</i>	3-7 years	Unknown	At least 50 years	Several million eggs per spawning event	Pacific Ocean from Baja California to Alaska
Green Sea Urchin	<i>Strongylocentrotus droebachiensis</i>	3 years	Unknown	20-25 years up to 50 years	Several million eggs per spawning event	Pacific Ocean from northern Washington to Alaska. Atlantic Ocean from New Jersey to the Arctic

### Synthesis

Seafood Watch® determines a species' inherent vulnerability to fishing pressure using various biological parameters. These rankings are then refined with information on behaviors that might make the species particularly susceptible to fishing. Both red and green sea urchins have a low age at maturity (< 5 years), an assumed high von Bertalanffy growth coefficient (>0.16), are long lived (>30 years), and have a high reproductive potential (several million eggs per spawning event). Red sea urchins have a moderately limited range and green sea urchins have a broad

range. For both species their preferred habitat (nearshore kelp forests) has likely only been moderately altered by non-fishery impacts. In addition, given that the fisheries for sea urchins are primarily hand collection fisheries, some of the depth range of the species would be off limits to the fishery. These demographical characteristics lead to an inherent vulnerability rank of resilient.

<b>Conservation Concern: Inherent Vulnerability</b>	
➤ Red and Green Urchin	Resilient 

### **Criterion 2: Status of Wild Stocks**

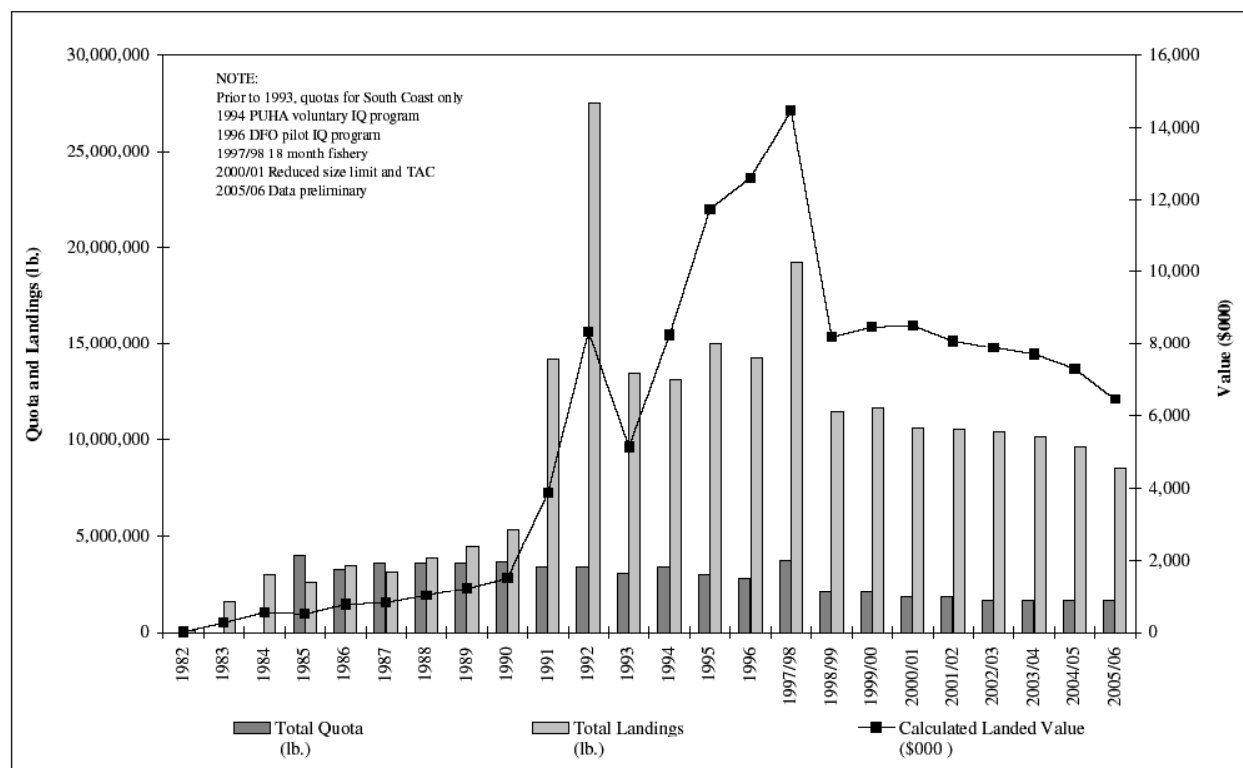
*Guiding Principle: Sustainable wild-caught species have stock structure and abundance sufficient to maintain or enhance long-term fishery productivity.*

Red and green sea urchins are important commercial species along both the Pacific and Atlantic seaboard of the US and Canada. In the US, red sea urchins caught in California are managed by the California Department of Fish and Game (CDFG) and green sea urchins caught in Maine are managed by the Maine Department of Marine Resources (DMR). In Canada, red and green sea urchins caught in British Columbia and green sea urchins caught in New Brunswick are managed by the Department of Fisheries and Oceans (DFO) Canada. The status of stocks for each of these fisheries will be reviewed independently.

#### **Red Sea Urchin – British Columbia, Canada**

Landings have been recorded in the BC commercial red sea urchin fishery since 1978. Historically, fishing occurred only along the southern coast of BC, but in 1984, the north coast was opened to fishing. The majority of landings have come from the north coast since 1990.

During the early 1980s, landings increased rapidly in southern BC (Figure 4), and in the late 1980s, a similar rapid increase in landings occurred in northern BC (DFO 2001). After 1993 landings began to stabilize with the introduction of quotas (DFO 2001). The value of annual landings has generally increased throughout the history of the fishery. In 1997, this value peaked at \$14.4 million. As of 2001, there were 110 licenses in BC with a quota of 4,886 tonnes (DFO 2001). Of this quota, 17.3% was allocated to southern BC and 83% was allocated to northern BC (DFO 2001).



**Figure 4.** Red sea urchin landings in British Columbia from 1982 – 2005/06 (Rogers 2007, pers. comm.).

Stock assessments have been conducted in many areas, but the fishery continues to be managed primarily under a precautionary approach (DFO 2005). Surveys to estimate the standing stock of red sea urchin in BC started in 1976 and have continued at regular intervals up until the most recent assessment in 2001 (Campbell 2001). These surveys were then used as the basis for quota decisions.

To determine biomass and subsequently fishing quota, the BC coast was reviewed in two main regions: the northern coast and the southern coast. These two main regions were then subdivided into Pacific Fishery Management (PFM) areas (Campbell 2001). Using a modified surplus production model, the total estimated biomass of BC red sea urchins in the 90 to 140 mm size range was 203,221 t for the northern coast and 29,026 t for the southern coast (Campbell 2001). The quota system has a conservatively fixed exploitation rate of approximately 2% of estimated biomass. In 2001, the quota was 4,886 tonnes. Of this quota 17.3% was allocated to southern BC and 82.7% was allocated to northern BC (DFO 2001). Quotas have declined in recent years, but this decline is attributed mainly to refined assessment techniques rather than to significant declines in stock biomass (DFO 2001).

The red sea urchin in BC is a limited entry fishery. The number of licenses peaked in 1989 with 240 and subsequently declined to 110 in 2001. Campbell (2001) notes that between 1983-1996, there are no overall trends in annual catch per unit effort (CPUE). The lack of a trend suggests that either the fishery is still in the development stage or CPUE data are not an accurate indicator for the fishery due to any number of factors including serial depletion and changes in search methods due to market demands.

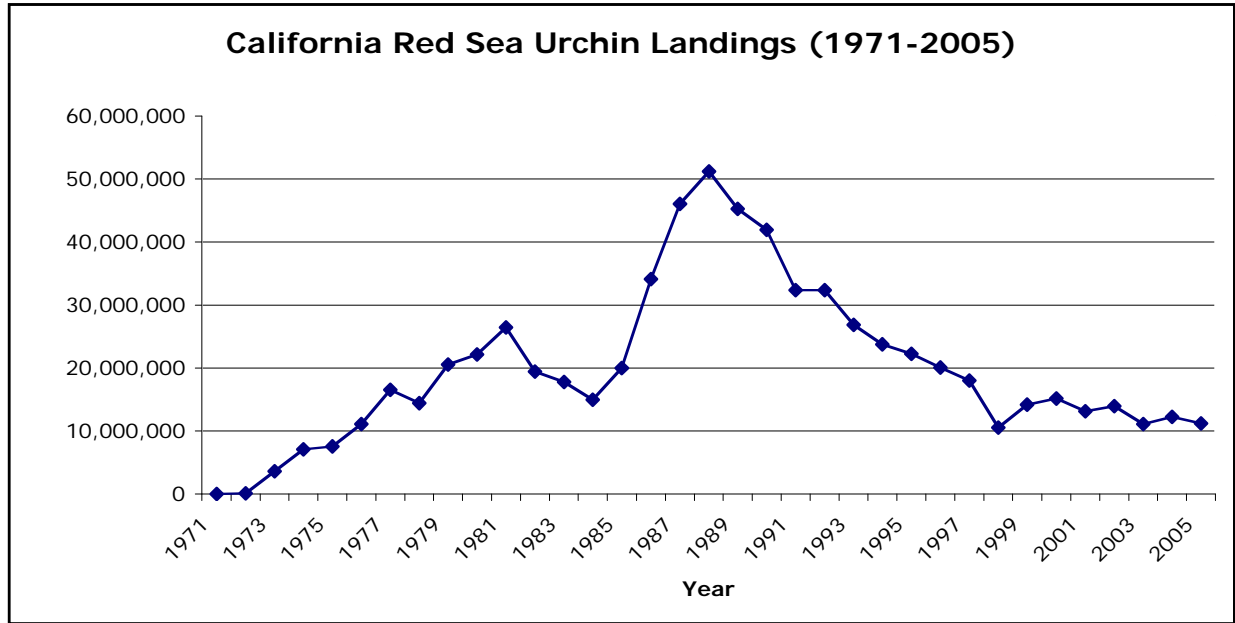
According to DFO, “there is no indication of concern for red sea urchin stock at this time” (2005). DFO is currently working on a new version of the assessment framework for the BC red sea urchin fishery, but it is not publicly available at this time (Rogers 2006, pers. comm.). In addition, the 2005/06 post-season review is currently being finalized and should be available shortly (Rogers 2006, pers. comm.).

### **Red Sea Urchin – California, US**

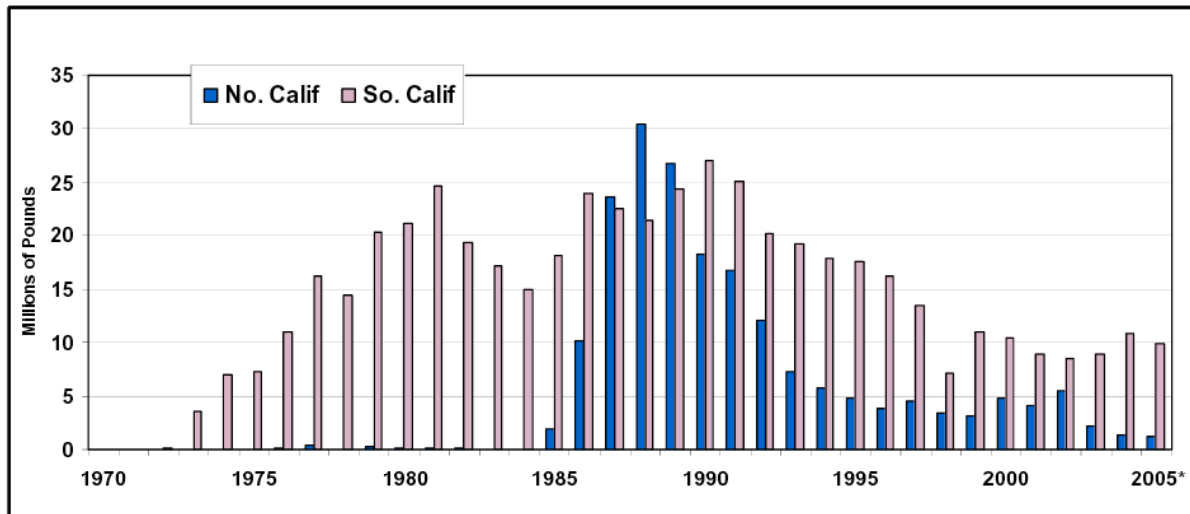
California’s commercial red sea urchin fishery occurs in both southern and northern California. There is no commercial fishery in central California because of otter predation on the sea urchin population (CDFG 2003).

The fishery in southern California started in 1971 as part of the National Marine Fisheries Service (NMFS) program to develop fisheries for underutilized species (ADFG 2004). The fishery was also seen as a way to limit the destructive grazing of sea urchins on giant kelp (CDFG 2003). Rapid expansion led to a peak in landings in southern California at 25 million pounds in 1981. After the El Niño of 1982-1983, catches decreased due to weakened or killed kelp resulting from the warmer water (CDFG 2003). Landings began to recover in 1985 due in part to economic incentives created by the strengthening of the Japanese yen relative to the dollar (CDFG 2003). Landings again peaked in 1990 with 27 million pounds caught in southern California. This peak was followed by a steady decline in catch to 8.8 million pounds caught in 2001 (CDFG 2004). Since 2001 landings have hovered between 8 and 11 millions pounds (CDFG 2006).

Commercial fishing for red sea urchin started in northern California in 1972, but landings were insignificant until 1977 (Figure 5). The fishery experienced a major expansion starting in 1985. Landings rose from 1.9 million pounds in 1985 to 30.4 millions pounds in 1988 (CDFG 2001). This expansion was fueled by decreasing landings in southern California (Figure 6) and favorable exchange rates. The northern California fishery began a steep decline in landings and catch per unit effort (CPUE) in 1989. Landings leveled off in 1995 at 3 – 4 million pounds and CPUE leveled off in 1993 at 700 to 800 lb per fishing day (CDFG 2003). Since then, landings have further declined to 1.2 million pounds in 2005 (CDFG 2006).



**Figure 5.** California red sea urchin landings from 1971-2005 (data from CDFG 2004 and 2006).



**Figure 6.** Northern and southern California commercial red sea urchin catch 1970 – 2005 (CDFG 2006).

There is no formal stock assessment for the California red sea urchin fishery. However, there are fishery independent survey data for both northern and southern California which helps define the status of the stock. In southern California, there are three main lines of inquiry for the sea urchin surveys:

- 1) Academic researchers in the Channel Islands, Santa Barbara and La Jolla have done localized investigations of relative abundance and size frequency distribution information over a relatively limited geographic range.
- 2) Since 1987, the National Park Service has conducted annual benthic ecological surveys at permanent transects around the northwest Channel Islands.

- 3) Since 1994, CDFG has been surveying sea urchin and abalone populations around the Channel Islands (Kalvass 1997).

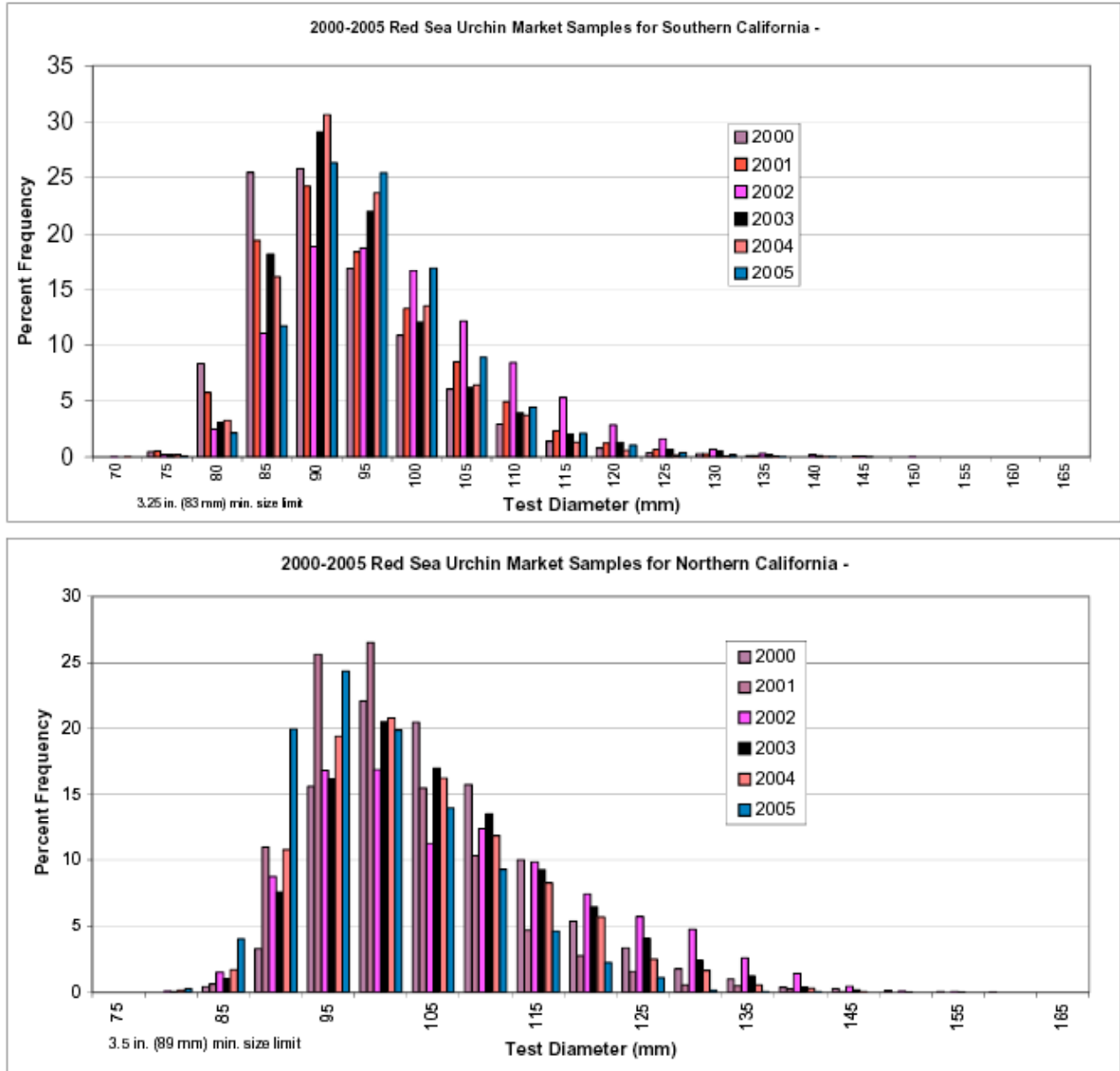
The red sea urchin fishery in southern California is considered fully exploited by CDFG and portions of the southern California fishery may also be overfished (CDFG 2003). From 1985 to 1995, legal-sized red sea urchins in survey sites in southern California declined from 15% to 7% (CDFG 2003). And while fishing has reduced densities in many areas and CPUE has declined, consistent settlement rates have been noted (CDFG 2003).

In northern California, subtidal sea urchin surveys have been conducted since 1988, and an exploratory biomass estimate was made. The results of the Leslie regression showed that the pre-1988 fishable biomass estimate was 76,290 t and would have supported an annual harvest of 6,103 t instead of the boom and bust cycle (Kalvass 1997).

The red sea urchin fishery in northern California is considered fully exploited and overfished (CDFG 2003). Fishery dependent modeling of the northern California fishery during the period of rapid decline from 1988 to 1994 estimated that the 117 million lb of red urchin harvested represented 70% of the harvestable stock in 1988 (CDFG 2003). Effort also declined from 126 divers in 1991 to 79 in 2000, and catch per permittee declined 40% from 1999 to 2000. The fishery is believed to have become a recruitment fishery due to episodic and infrequent recruitment combined with intensive harvesting. The size limits and areas closures are thought to have kept the fishery from collapse, but are unlikely to improve recruitment (CDFG 2003).

Since 2000, CDFG has conducted market sample survey of red sea urchins in California (Figures 7 and 8). This work demonstrates a gradual increase in the size of urchins in southern California since 2000 and a noticeable jump in the number of smaller legal-sized urchins in 2005 in northern California (CDFG 2006). However, the population appears to be skewed.

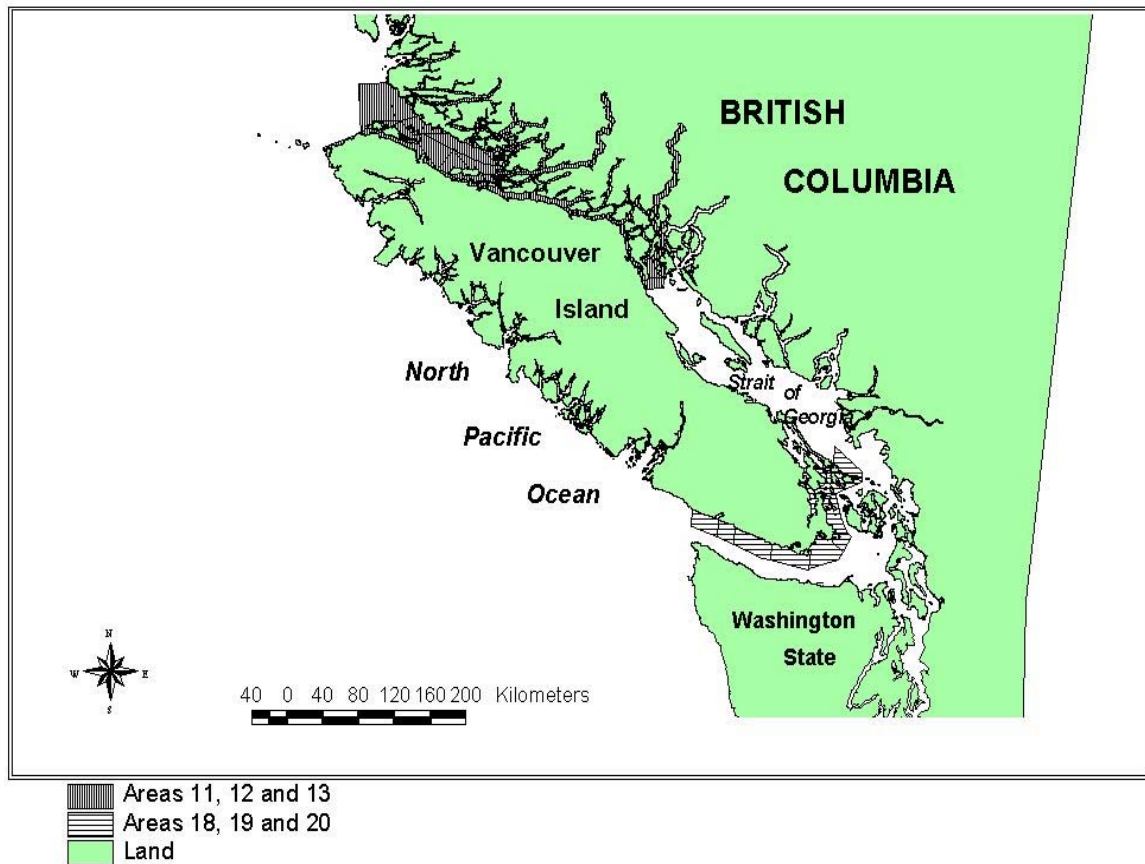
**Because red sea urchin is fully exploited, has a declining CPUE trend, and the population is skewed, Seafood Watch® considers the status of the California stock to be a high conservation concern.**



**Figures 7 and 8.** Size frequency for red sea urchins in Southern and Northern California from 2000 – 2005 (CDFG 2006).

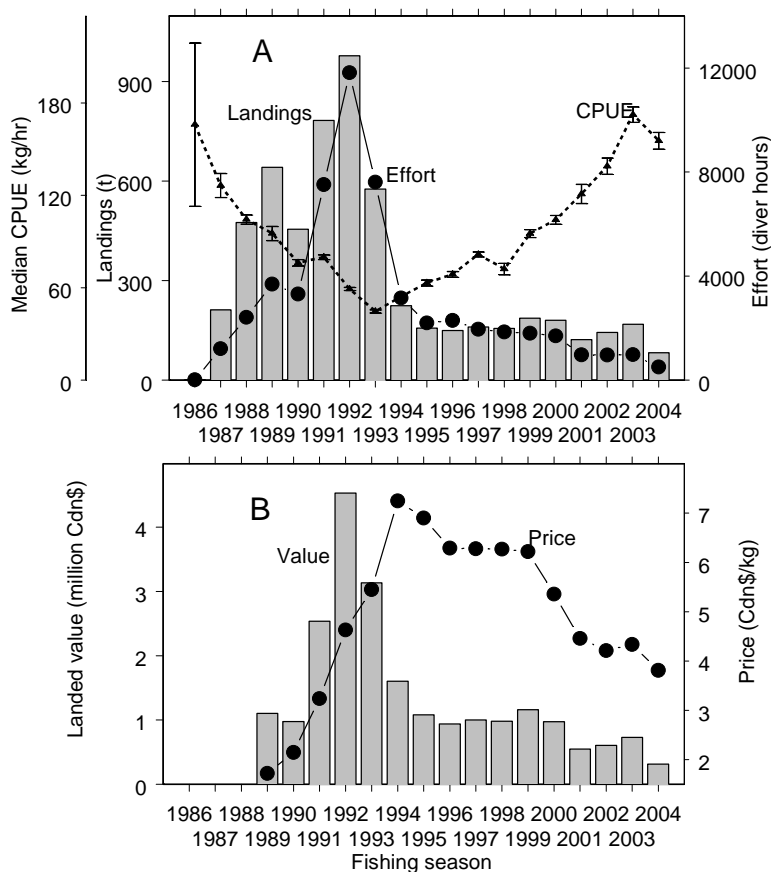
**Green Sea Urchin – British Columbia, Canada**

In the late 1980s, a commercial green sea urchin fishery developed in British Columbia (Figure 9). Today, Queen Charlotte Strait and Gulf Islands are the two main fishing regions (Perry 2006). The fishery is mainly conducted in winter (November 1 to March 1) because the quality of the roe is at its best and the fishery is able to command the best market prices.



**Figure 9.** Map of southern BC showing the two main areas for green sea urchin fishing – Queen Charlotte Strait and Gulf Islands (Perry 2006).

Landings peaked in 1992 at 1,042 t and were worth \$4.4 million (Perry et al. 2006). Since 1992, landings have declined due in part to management actions. These actions were put in place based on conservation concerns resulting from the quick explosion of effort and catch and the lack of management in the early fishery. Quotas have limited landings since 1994. These landings have averaged 157 tonnes, and the majority of the landings have come from southern BC because of the better roe quality and proximity to processing plants (DFO 2003). Total landings in 2003 were slightly higher than 2001 and 2002, but 2004 fell to the lowest level since the beginning of the fishery in 1987 (Perry et al. 2006). Landings in 2003 were 168 t and were worth \$731,000, and in 2004, landings were 83 t and worth \$315,000 (preliminary data) (Perry et al. 2006). In 2004, effort was the lowest since the start of the fishery. This decline appears to be a result of low prices in Japan resulting from an over-supply of green urchins coming from Russia (Perry 2006, pers. comm.). In addition, the overall CPUE reached its highest value in 2003, but fell in 2004, which was the first decline since 1998 (Figure 10).



**Figure 10.** A) landings, effort, and CPUE for the BC green sea urchin fishery since 1987. B) Landed value and unit price for the BC green sea urchin fishery (Perry 2006, pers. comm.).

The first formal assessment of the green sea urchin fishery in BC was conducted in 1995 (DFO 2003). This assessment resulted in fishing being restricted to the two major areas described above: Queen Charlotte Strait and Gulf Islands. The fishery is managed through an Integrated Fishery Management Plan (IFMP) which was historically prepared every three years but is now prepared every two years (Perry 2006, pers. comm.; Guyer 2007). Stock assessments, utilizing both fishery dependent and independent information, are required and provide the basis for the IFMP. Perry et al. 2006 will provide the basis for the 2006-2008 IFMP.

For the 2006 stock assessment, three versions of the biomass dynamic model were used: Schnute, time series fitting, and Bayesian. All three versions produced similar results for each region as shown in Table 2.

**Table 2.** Estimates of maximum sustainable yield (MSY) from the three versions of the biomass dynamic model (Perry et al. 2006).

Model	Queen Charlotte Strait (PFMA 11-13)		Gulf Islands (PFMA 18-20)	
	MSY (t)	95% Confidence Interval (+/- t)	MSY (t)	95% Confidence Interval (+/- t)
Schnute	265	50	105	30
Time Series	321	51	91	12
Bayesian	318	194	93	75

Many of the assumptions of surplus production models are not likely true for developing fisheries like the BC green sea urchin fishery. As a result, the MSY values calculated in Perry et al. (2006) are considered limit reference points and management should ensure that these limit reference points are not exceeded. In addition, Perry et al. (2006) notes that the target reference points should be set sufficiently far from the limit reference points such that the probability of the target reference points being larger than or equal to MSY is low. Table 3 is a summary of target reference point options given various reductions from the MSY values. For 2004, the quota for Queen Charlotte Islands was 159.5 t and the quota for Gulf Islands was 26.5 t. Similar quotas for the 2006-2009 period would have a 1.7% probability in Queen Charlotte Strait and a 0.2% probability in Gulf Island of being equal to or greater than MSY (Perry et al. 2006).

Since 1995, ten surveys have been conducted, one each year, just prior to the opening of the fishing season in PFMA 12. In 2003, the highest biomass of legal-sized urchins in the time series occurred. This was not a surprise given the abundance of sub legal-sized urchins noted in the 2002 survey (Perry 2006). Perry et al. 2006 notes that while this survey work has helped to understand population trends in the BC green urchin fishery, continued and additional surveys, especially in the Gulf Islands, are important to provide a time series independent of the fishery in order to assess the fishery.

**Table 3.** Target reference points, probabilities, and allocation of quotas for Queen Charlotte Strait and Gulf Islands.

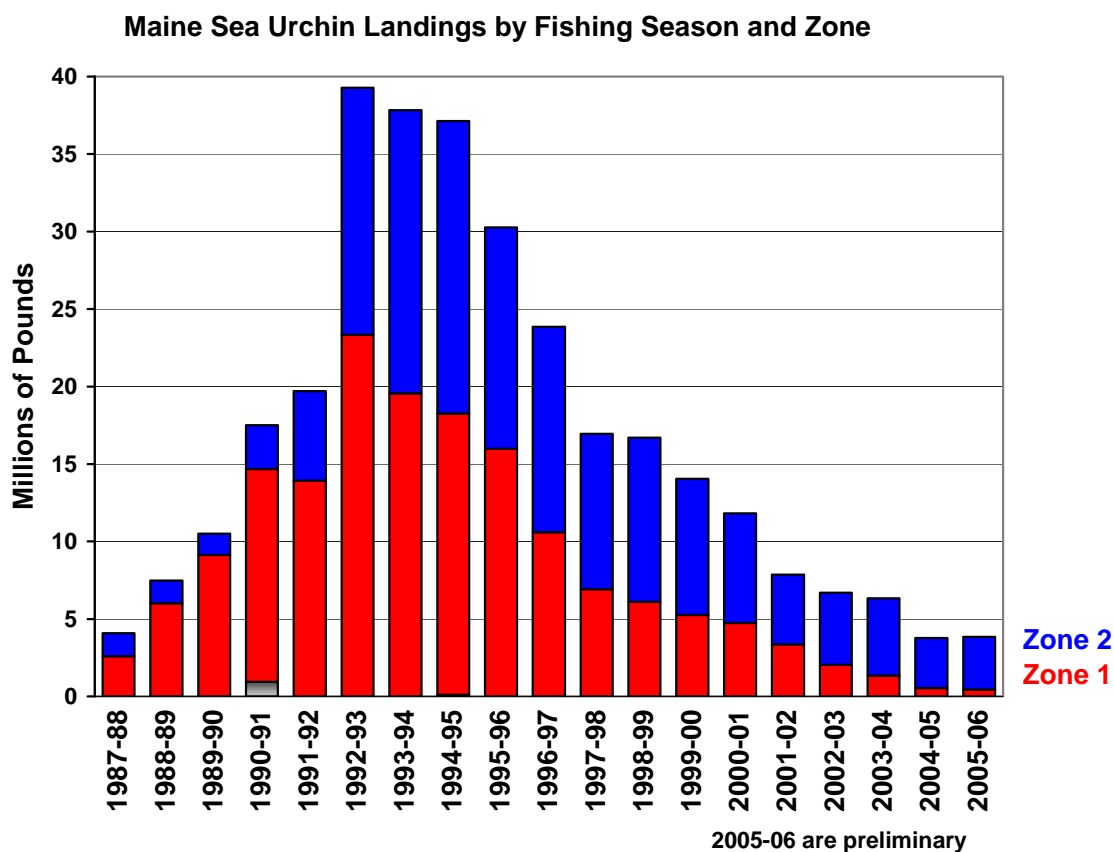
	<b>Target Reference Point (Total for PFMA 11-13; t)</b>	<b>Probability that the target reference point is equal to or greater than the true MSY (%)</b>	<b>Target Reference Point for PFMA 11 (t)</b>	<b>Target Reference Point for PFMA 12 (t)</b>	<b>Target Reference Point for PFMA 13 (t)</b>
Proportion caught (1995-2004 fishing seasons)			0.009	0.632	0.359
Limit reference point (median MSY)	318	50	3	201	114
0.9* median MSY	287	33.4	3	181	103
0.8* median MSY	254	18.8	2	161	91
0.7* median MSY	223	9.3	2	141	80
0.6* median MSY	191	4.1	2	121	68
0.5* median MSY	158	1.6	1	100	57
0.4* median MSY	127	0.5	1	80	46
0.3* median MSY	95	0.1	1	60	34
0.2* median MSY	64	<0.1	1	40	23
0.1* median MSY	31	<0.1	0	20	11

	<b>Target Reference Point (Total for PFMA 18-20; t)</b>	<b>Probability that the target reference point is equal to or greater than the true MSY (%)</b>	<b>Target Reference Point for PFMA 18 (t)</b>	<b>Target Reference Point for PFMA 19 (t)</b>	<b>Target Reference Point for PFMA 20 (t)</b>
Proportion caught (1995-2004 fishing seasons)			0.431	0.452	0.117
Limit reference point (median MSY)	93	50	40	42	11
0.9* median MSY	84	35.4	36	38	10
0.8* median MSY	75	22.6	32	34	9
0.7* median MSY	65	12.6	28	29	8
0.6* median MSY	56	7.2	24	25	7
0.5* median MSY	46	3.2	20	21	5
0.4* median MSY	37	1.2	16	17	4
0.3* median MSY	28	0.3	12	13	3
0.2* median MSY	18	<0.1	8	8	2
0.1* median MSY	9	<0.1	4	4	1

### Green Sea Urchin – Maine, US

The first recorded commercial landings for green sea urchin in Maine date from 1929. From 1937 to 1986, green sea urchin landings have varied between 3,008 and 180,085 lbs (1.4 – 81.6 mt), and have been valued between \$306 and \$9,078 (Hunter 2005). Historically, these urchins were marketed in the United States. They were shipped whole to Chicago, Boston, and New

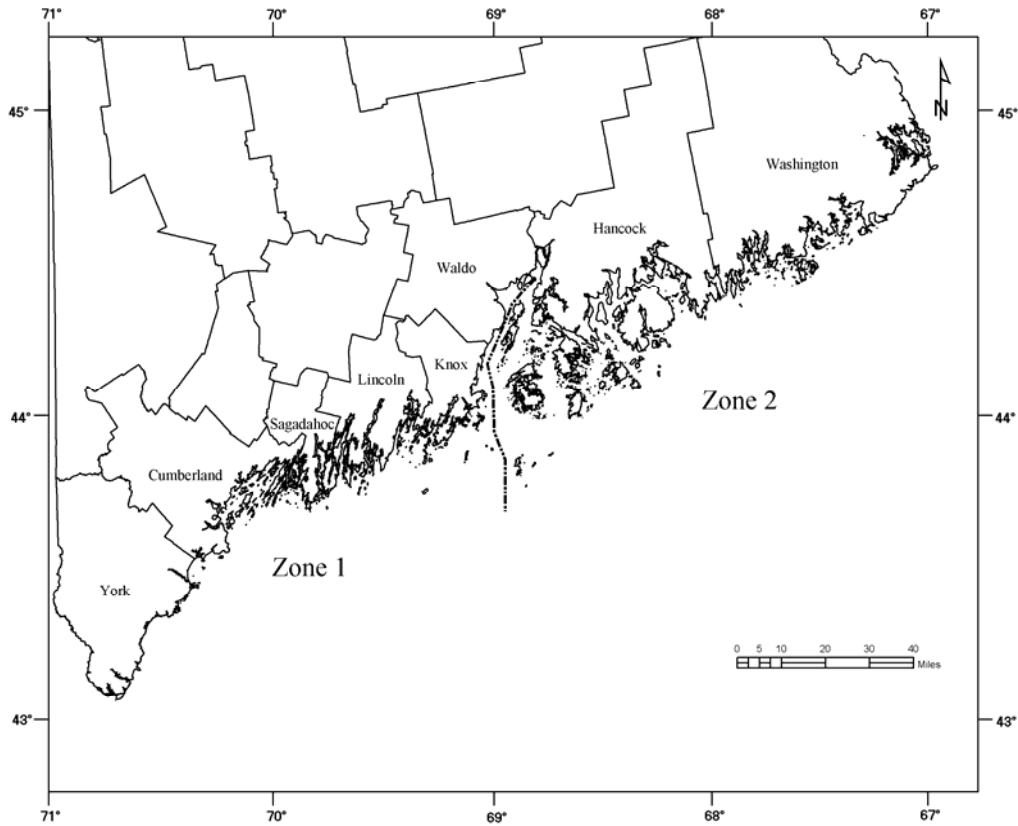
York City (Fulton Fish Market) where they were purchased by ethnic groups of Italian, Spanish, Portuguese, German, Greek, and French descent. The international market of green sea urchins began in the mid 1970s with the Japanese expressing considerable interest in North American urchins. By 1986, because of an improved yen/dollar exchange rate and a decline in the California fishery, the value of Maine sea urchins increased and the sea urchin fishery in Maine expanded rapidly. Maine green sea urchin landings peaked in 1992/1993 at 19,115 mt (42 million lbs), and the value of Maine's green sea urchins peaked in 1995 at \$36 million (Hunter 2005). Landings have declined steadily since then (Figure 11) as a result of fishing down an unfished accumulated biomass, as well as harvester attrition, die-offs, shortened seasons, size restrictions, and other management actions, overfishing, and ecological shifts caused by fishing (Steneck et al. 2004 as cited in Hunter 2005). Positive adjustments in the price have allowed the fishery to continue. The fishery maintained a value of about \$20 million annually until 2001 when it dropped to \$13 million. Preliminary landings for 2004 are 2,607 mt (5.7 million lbs) valued at \$7.9 million (Figure 10) (Hunter 2005). These data were compiled by NMFS port agents until the 1996-1997 fishing season at which time the state of Maine implemented a mandatory dealer reporting system ("logbook"), from which landings are now derived (Hunter 2005).



**Figure 11.** Maine sea urchin landings by fishing season and zone, 1987-2005 (Hunter 2006).

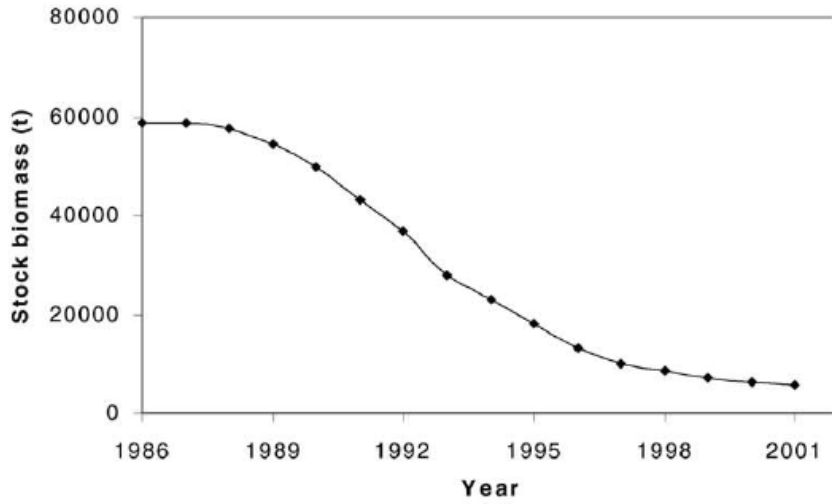
The green sea urchin stock in Maine was most recently assessed in 2003 using data through 2001, and prior to this study, no formal stock assessment had been conducted (Chen 2003). In addition, no information is available for the population dynamics of the stock. Since no fishery

independent survey of the fishery had been conducted, the stock assessment used information available from the fishery such as landed catch, fishing effort, and estimates of size composition of the catch for each defined management areas: Zone 1 and Zone 2 (Figure 12)

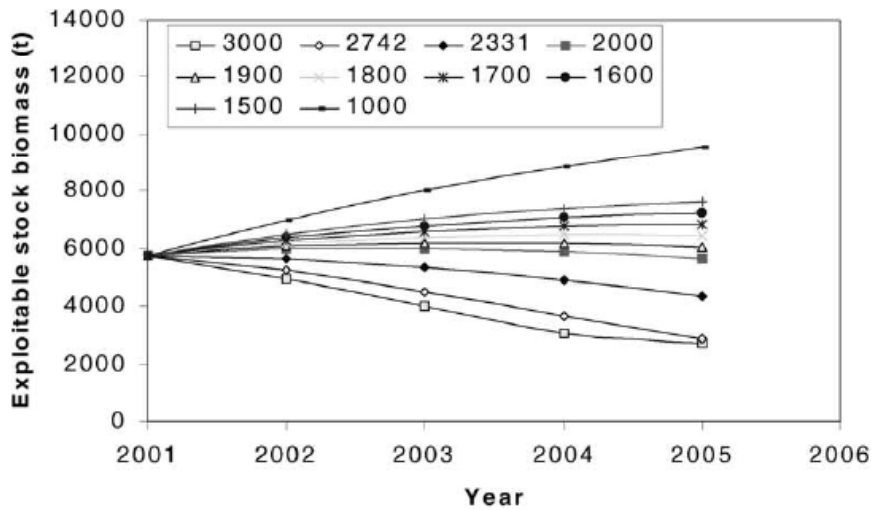


**Figure 12.** Map of the two management zones for green sea urchin in Maine (Chen 2003).

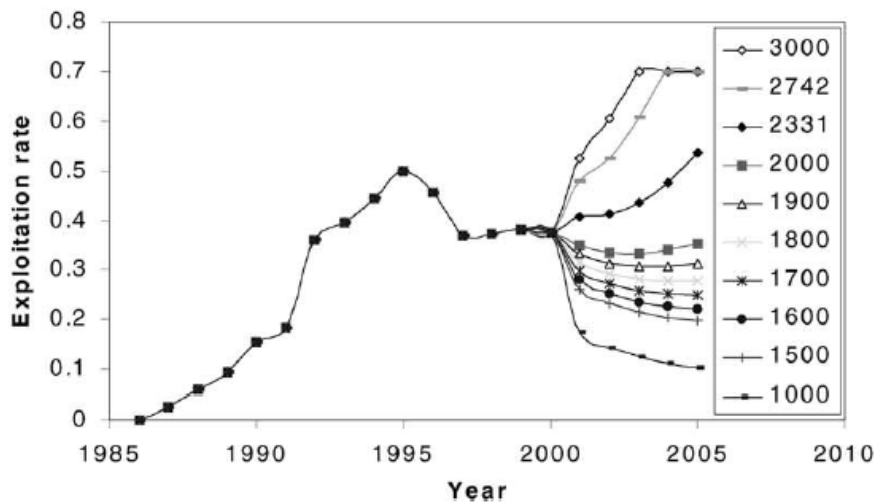
Over the last decade the estimated exploitable biomass has decreased from 60,000 metric tons to less than 10,000 metric tons. This stock biomass is estimated to be only 10% of the virgin biomass (Figures 13 through 15) (Chen 2003).



**Figure 13.** Stock biomass from 1986 to 2001 (Chen 2003).

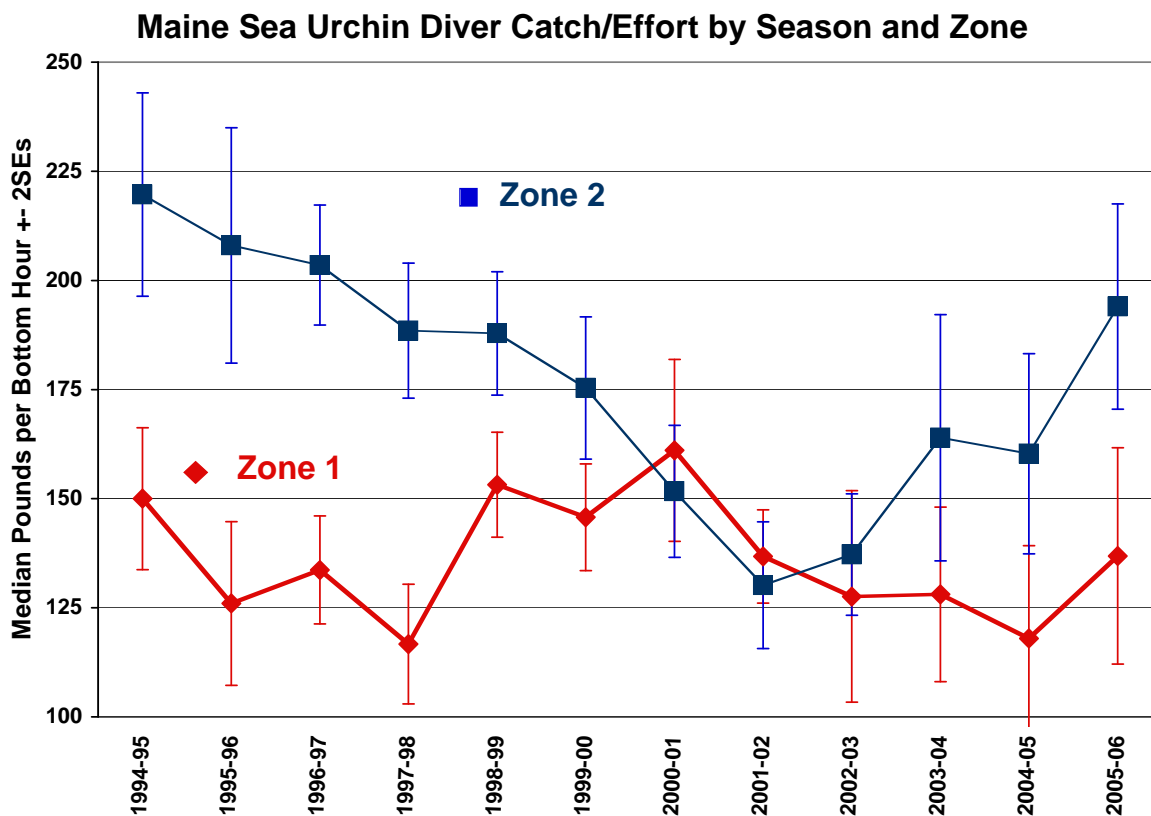


**Figure 14.** Estimates of the exploitable stock biomass. For 2001-2005, the exploitable stock biomass is projected for different levels of catch ranging from 1,000 to 3,000 t (Chen 2003).



**Figure 15.** Estimates of the exploitation rate. For 2001 to 2005, the exploitation rate is projected for different levels of catch ranging from 1,000 to 3,000 t (Chen 2003).

The 2003 stock assessment concluded that a management plan needed to be developed for the recovery of the fishery and there would need to be a large reduction in catch levels to allow for recovery. For example, the assessment determined that a catch level set at 2,000 mt would give the stock a 40% chance of recovery (Chen and Hunter 2003). Catch per unit effort data show a long-term declining trend with a recent increase in Zone 2, while Zone 1 CPUE has been relatively stable (Figure 16).

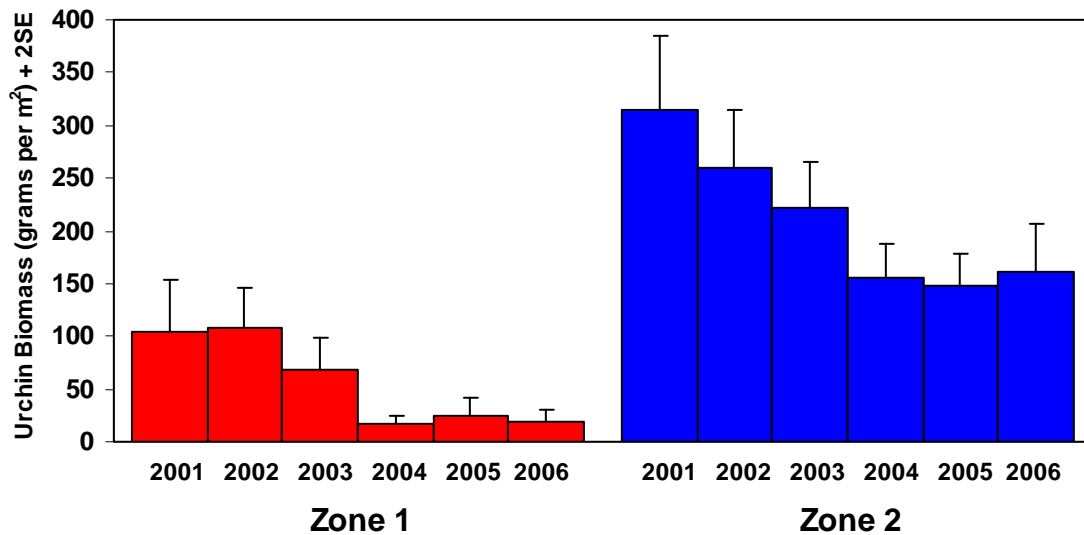


**Figure 16.** CPUE for the Maine green sea urchin fishery (Hunter 2006, pers. comm.).

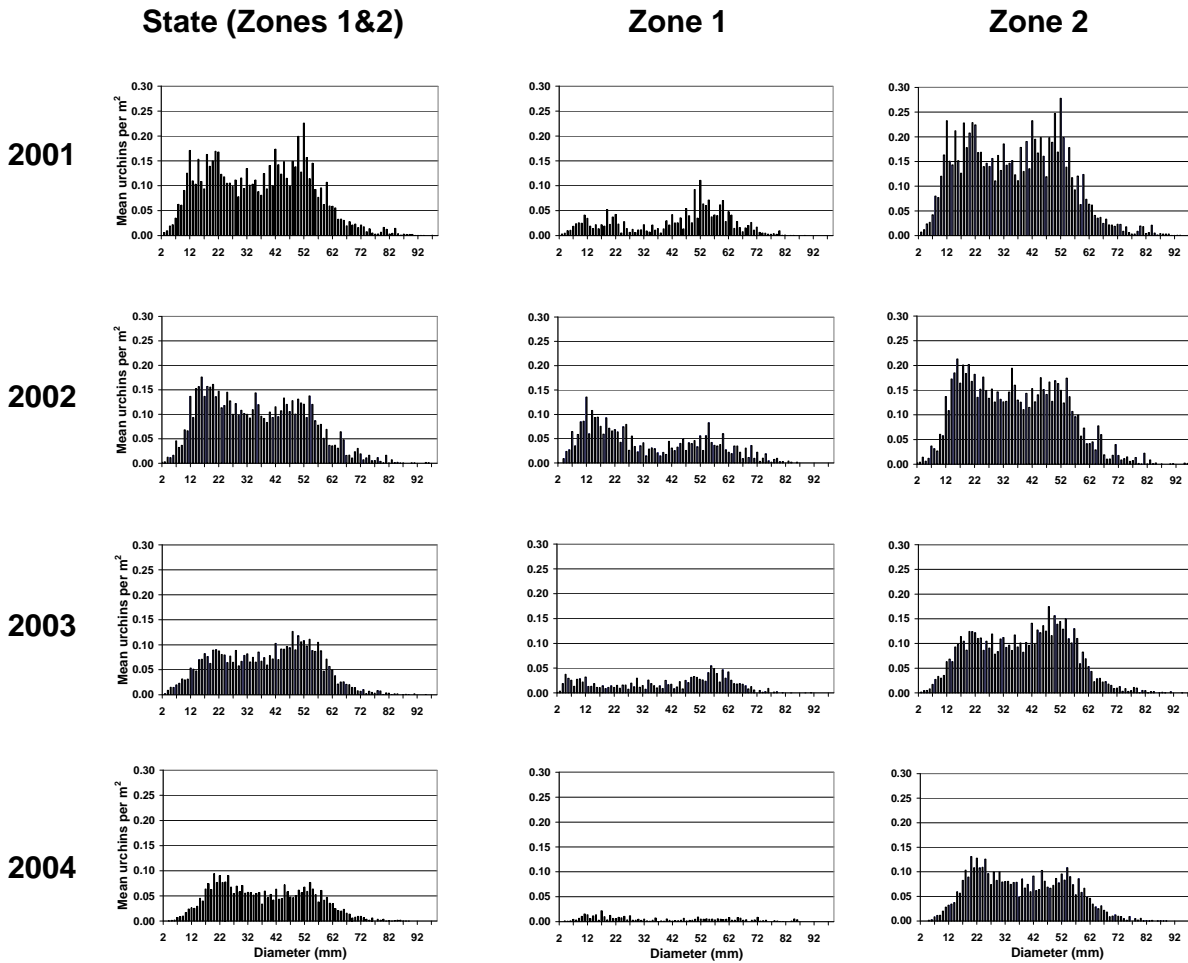
Hunter (2005) notes that CPUE is not a good index of stock abundance. CPUE has been higher in Zone 2 for the majority of the time series, and according to anecdotal evidence, the resource is thought to be in better condition in Zone 2. The drop in CPUE for both zones in 2000 – 2002 could be attributed to an increase in the minimum size (Hunter 2005). Since then, the rise in CPUE in Zone 2 is not credited to an improvement in the resource but instead is attributed to increases in attrition. Similarly, attrition in Zone 1 could account for the lack of decline in CPUE. In other words, the Zone 1 fishery has reached an economic threshold, and CPUE alone will not be a useful indicator for stock status.

Since the 2003 stock assessment, the DMR has implemented a coast-wide random-stratified urchin dive survey, which they consider to be their most reliable assessment tool and data source (Hunter 2006, pers. comm.). According to Hunter (2005) the objective is to “conduct a survey of Maine’s sea urchin resource using SCUBA diving and underwater video camera techniques to

develop a time series of abundance and biomass indices and estimates for the state by region.” The survey utilizes methods that have been in place since 2001. Biomass estimates have generally declined since the original stock assessment in 2003 and have only very recently leveled off (Figure 17). The decline in biomass was apparently halted by management actions (season reductions) in 2004. Since then, biomass indices have been stable. An updated assessment document is slated to be written this fall (Hunter 2006, pers. comm.). This same survey looked at size distributions in nine regions in Zones 1 and 2. Declines have occurred in both Zones and for all sizes since 2001 (Figure 18).



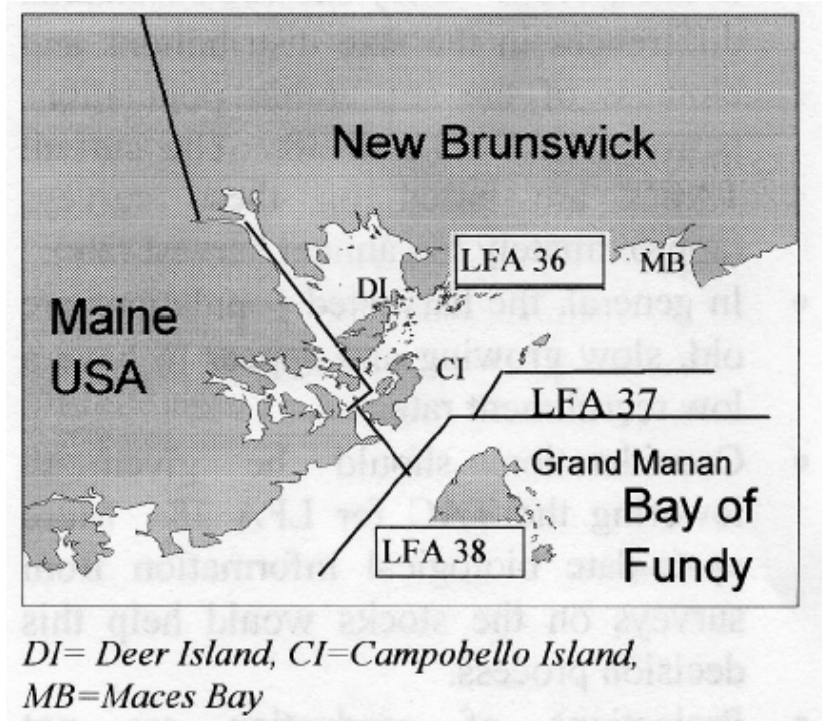
**Figure 17.** Biomass estimates for 2001 to 2006 (Hunter 2006, pers. comm.).



**Figure 18.** 2001-04 spring sea urchin survey information showing size (diameter) frequencies for regions 1-3 combined (Zone 1), and for regions 4-9 combined (Zone 2), depths 0-15m (Hunter 2005).

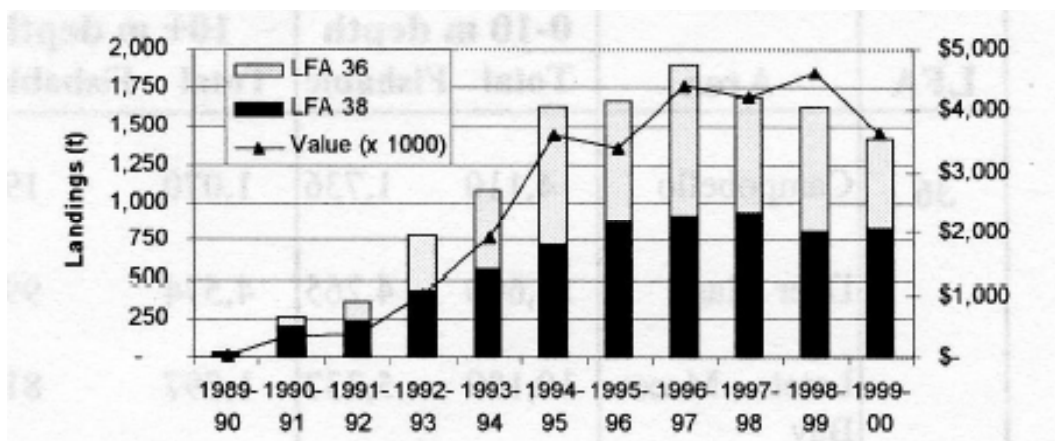
**Green Sea Urchin – New Brunswick, Canada**

The commercial green sea urchin fishery in New Brunswick began in 1989. The fishery is described in management as Lobster Fishing Areas (LFA) 36-38. The two main fishing zones are LFA 38 (Grand Manan) and LFA 36. Fisheries operating in both of these areas are also allowed to fish in LFA 37, which is a small adjoining area (Figure 19).



**Figure 19.** A map of the three fishing areas (LFA 36-38) for the New Brunswick green sea urchin fishery (DFO 2000b).

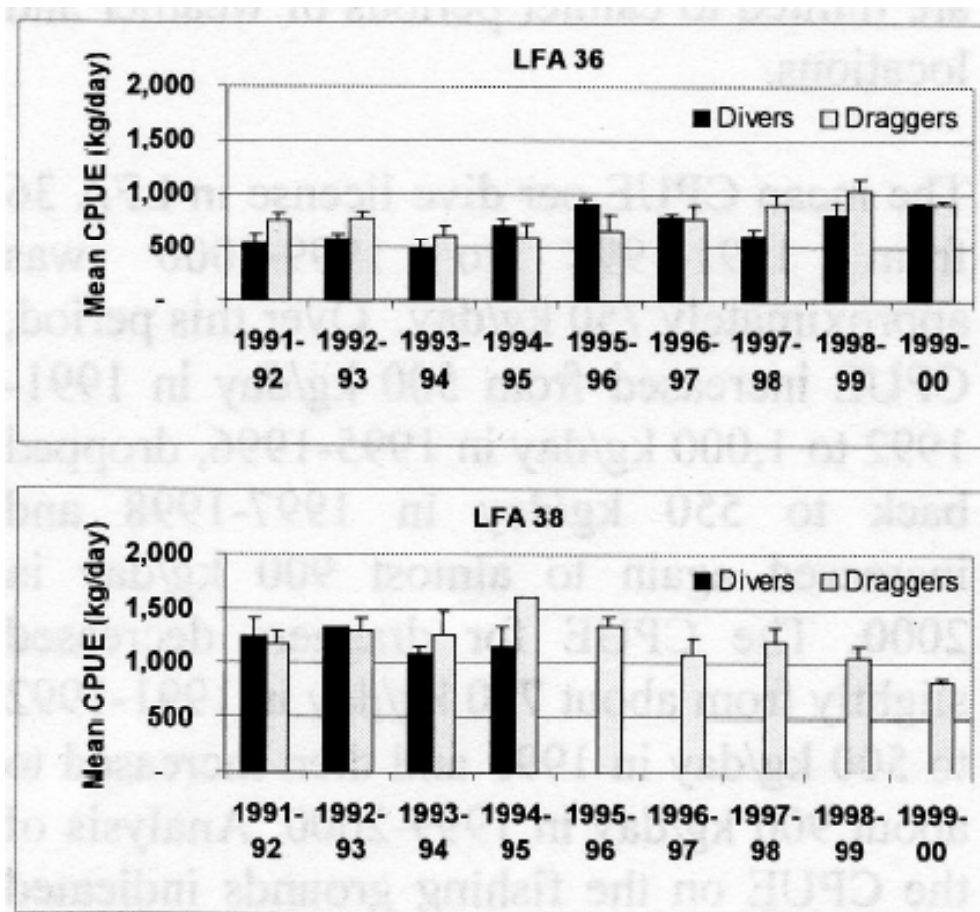
Since 1989, landings in the fishery have increased by almost two orders of magnitude (Figure 20). Landings in 1989 were 29 t and by 1999 landings were 1,700 t. Landings in the New Brunswick fishery peaked in 1996 at 1,900 t and have declined since. The value of the fishery in 1999 was \$4 million.



**Figure 20.** Landings and value information for the New Brunswick green sea urchin fishery by region and season (DFO 2000b).

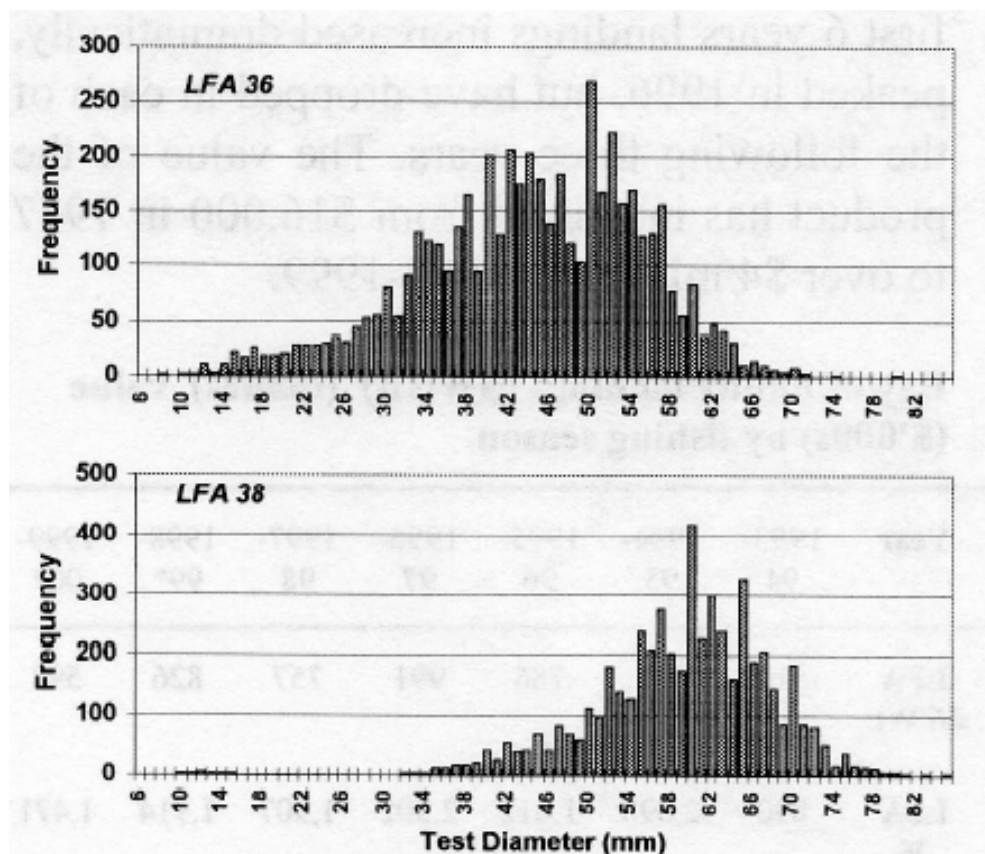
DFO (2000b) notes that the fishery is poor in terms of both biological and fishery information and, as a result, there is an impact on DFO’s ability to interpret the information and develop management options.

The status of the stock is primarily monitored through logbooks submitted regularly by fishermen to the dockside monitoring service. Compliance is high as logbook submission is linked to license conditions (DFO 2000b). The logbook data are used to calculate CPUE indices. In LFA 36, CPUE from 1991 to 2000 was 750 kg/day for the dive licenses. Over this period, CPUE has ranged from 500 to 900 kg/day and analysis has indicated that the areas yielding the highest CPUE have been stable for the last three years of the data set (Figure 21). In LFA 38, CPUE from 1991 to 1995 was 1000 kg/day for the dive licenses. There is not dive CPUE information after this date because the one diver was allowed to convert his license to dragging.



**Figure 21.** Catch rates for the drag and dive licenses from 1991 to 2000 (DFO 2000b).

From 1992 to 1994 a large-scale diver survey was done for much of the commercially fished areas to determine and subsequently monitor density and size distribution (DFO 2000b). This work showed a distinct shift from small urchins in LFA 36 to large urchins in LFA 38. In addition, very little recruitment has been observed for LFA 38 (Figure 22).



**Figure 22.** New Brunswick green sea urchin size distribution from LFA 36 and 38 from 1992 to 1994 (DFO 2000b).

A biomass estimate was done for LFA 36 between 1992 and 1994. For the three areas surveyed the biomass was 34,500 tonnes of which a total of 13,245 or 38% was fishable (DFO 2000b). A total allowable catch (TAC) for each LFA was calculated in 1996 from the biomass estimates. The TAC has remained the same since. The annual quota for LFA 36 was 900 t or 6.8% of the estimated 13,245 t of legal fishable urchins. In LFA 38, the annual quota was set at 979 t or 3.3% of an estimated 29,879 t of legal fishable urchins (DFO 2000b). The percentage of TAC to estimated biomass is lower in LFA 38 due to lack of recruitment observation.

Resurveying was done in 1993 to 1995 and DFO (2000b) concludes that there were no clear changes in population size, density, or distribution based on the surveys.

**Table 4.** Stock status of red and green sea urchins by geographic location.

Species/ Complex	Man. class. status	Current abundance ( $B_{CURR}/$ $B_{MSY}$ )	Current fishing mortality ( $F_{CURR}/$ $F_{MSY}$ )	Last assess./ Uncertainty in status	Long term trend	Short term trend	Pop skewed?	Conservation Concern
Red Sea Urchin – British Columbia	Unknown	Unknown	Unknown	No formal full assessment – last published surveys done in 2001	Flat	Flat	Unknown	Moderate
Red Sea Urchin – California	Fully exploited	<50% $B_{MSY}$	Unknown	No formal assessment	Down	Flat	Yes	High
Green Sea Urchin – British Columbia	No overfishing	Unknown	Unknown	2006	Flat	Up	Unknown	Moderate
Green Sea Urchin - Maine	Overfished	10% $B_{MSY}$	Unknown	2003	Down	Flat	Yes	Critical
Green Sea Urchin – New Brunswick	Unknown	Unknown	Unknown	2000	Flat	Flat	Yes	Moderate

## Synthesis

### Red Sea Urchin – British Columbia

Overall, the red sea urchin stock in BC appears to be in reasonably good health. The fishery is primarily managed using a precautionary approach given uncertainty and limitations in stock assessments. DFO utilizes survey data and a modified surplus production model to determine quotas on an annual basis. The quota system has a conservatively fixed exploitation rate of approximately 2% of estimated legal sized biomass. In addition, the fishery is limited entry. The long-term trend in CPUE is variable, the short-term trend is flat, and the size distribution is unknown. Given these trends, Seafood Watch® concludes that the red sea urchin stock in British Columbia receives a rank of moderate.

### Red Sea Urchin – California

There is no formal stock assessment for the California red sea urchin fishery. However, the status of the stock is assessed through a number of survey techniques. The southern California fishery is considered fully exploited and portions of the fishery may also be overfished (CDFG 2003). In northern California, the fishery is considered fully exploited and overfished (CDFG 2003). Since 2000, CDFG have been conducting market sample survey of red sea urchins in

California. This work demonstrates a gradual increase in the size of urchins in southern California since 2000 and a noticeable jump in the number of smaller legal sized urchins in 2005 in northern California (CDFG 2006). However, the population appears to be skewed. Given these trends, Seafood Watch® concludes that the red sea urchin stock in California receives a rank of poor.

### **Green Sea Urchin – British Columbia**

Overall, the green sea urchin stock in BC appears to be in reasonably good health. The fishery is managed through an Integrated Fishery Management Plan (IFMP), which is updated every three years (Perry et al. 2006). Stock assessments, utilizing both fishery dependent and independent information, are required and provide the basis for the IFMP. Perry et al. 2006 will provide the basis for the 2006-2008 IFMP. The BC management system is precautionary, thus the MSY values calculated in Perry et al. 2006 are considered limit reference points. Target reference points are set sufficiently far from the limit reference points such that the probability that the target reference points being larger than or equal to MSY is low. In 2004, the quota for Queen Charlotte Islands was 159.5 t and the quota for Gulf Islands was 26.5 t. Similar quotas for the 2006-2009 period would have a 1.7% probability in Queen Charlotte Strait and a 0.2% probability in Gulf Island of being equal to or greater than MSY (Perry et al. 2006). Overall the green sea urchin stock in BC appears to be in good health. The CPUE is at similar levels to when the fishery began, the long-term trend is flat and the short-term trend is up. Given these trends, Seafood Watch® concludes that the green sea urchin stock in British Columbia receives a rank of moderate.

### **Green Sea Urchin – Maine**




The biomass estimates for Maine's green sea urchin fishery have been trending down since the beginning of the time series with a flattening in the decline in recent years. As of 2001, the biomass was estimated to be 10% of the virgin biomass according to the stock assessment published in 2003. Catch per unit effort data are not considered to be a reliable estimate of abundance. Estimates of size distributions display skewness and there is a reduction in the numbers of all sizes of urchins over the time series. The green sea urchin stock in Maine is overfished (it is unknown if overfishing is occurring), and exhibits a declining long-term and stable short-term trend. Overall the stock is ranked as having a "critical" conservation concern according to Seafood Watch® criteria.

### **Green Sea Urchin – New Brunswick**

Since the beginning of the commercial green sea urchin fishery in New Brunswick in 1989, landings in the fishery have increased by almost two orders of magnitude from 29 t to 1,700 t. The status of the stock is primarily monitored through logbooks, submitted regularly by the fishermen to the dockside monitoring service, which is used to calculate catch per unit effort indices. Analysis of LFA 36 has indicated that the areas yielding the highest CPUE have been stable for the last three years of the data set. Dive survey work has shown a distinct shift from small urchins in LFA 36 to large urchins in LFA 38 and very little recruitment for LFA 38. A biomass estimate for LFA 36 between 1992 and 1994 showed that the biomass was 34,500 tonnes of which a total of 13,245 tonnes or 38% was fishable. Resurveying done from 1993 to 1995 demonstrated no clear changes in population size, density, or distribution based on the surveys. DFO admits that the fishery is data poor in terms of both biological and fishery

information and, as a result, there is an impact on DFO's ability to interpret the information and develop management options. Given these trends, Seafood Watch® concludes that the green sea urchin stock in New Brunswick receives a rank of moderate.

### Status of the Stocks Rank:

Conservation Concern: Status of Stocks	
<ul style="list-style-type: none"> <li>➤ Red Sea Urchin – British Columbia</li> <li>➤ Green Sea Urchin – British Columbia</li> <li>➤ Green Sea Urchin – New Brunswick</li> </ul>	Moderate (Stock Moderate) 
<ul style="list-style-type: none"> <li>➤ Red Sea Urchin - California</li> </ul>	High (Stock Poor) 
<ul style="list-style-type: none"> <li>➤ Green Sea Urchin – Maine</li> </ul>	Critical 

### Criterion 3: Nature and Extent of Discarded Bycatch<sup>1</sup>

*Guiding Principle: A sustainable wild-caught species is captured using techniques that minimize the catch of unwanted and/or unmarketable species.*

Both red and green sea urchins for all five fisheries reviewed in this document are caught primarily in dive fisheries. The divers collect the urchins by hand or use hand racks and scoop the urchins into bags, which are then periodically hauled to the surface (DFO 2000a; CADFG 2001; DFO 2003). Due to the highly selective nature of the fishery technique, the probability that bycatch is above 10% is highly unlikely. There are no data available to demonstrate this assertion, but assuming that bycatch is very low, the resulting impact on bycatch population levels will also be very low. While there is no evidence that the ecosystem has been altered in response to bycatch, there are consequences of removing urchins from the ecosystem. These


<sup>1</sup> Bycatch is defined as species that are caught but subsequently discarded because they are of undesirable size, sex or species composition. Unobserved fishing mortality associated with fishing gear (e.g., animals passing through nets, breaking free of hooks or lines, ghost fishing, illegal harvest and under or misreporting) is also considered bycatch. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, accounted for, and managed in some way.

consequences are reviewed under Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems.

Both New Brunswick and Maine have components of their urchin fisheries which are caught by drag. In Maine, during the winter of 1997-1998, observers recorded bycatch during 64 urchin dragger trips. Animal bycatch averaged 22% of the total catch, and was mostly sea cucumbers, mollusks, and crustaceans. Most animals were returned to the sea alive (Creaser and Weeks, 1998, and unpublished data). Information on the nature of bycatch in the New Brunswick drag fishery is unknown.

### Synthesis

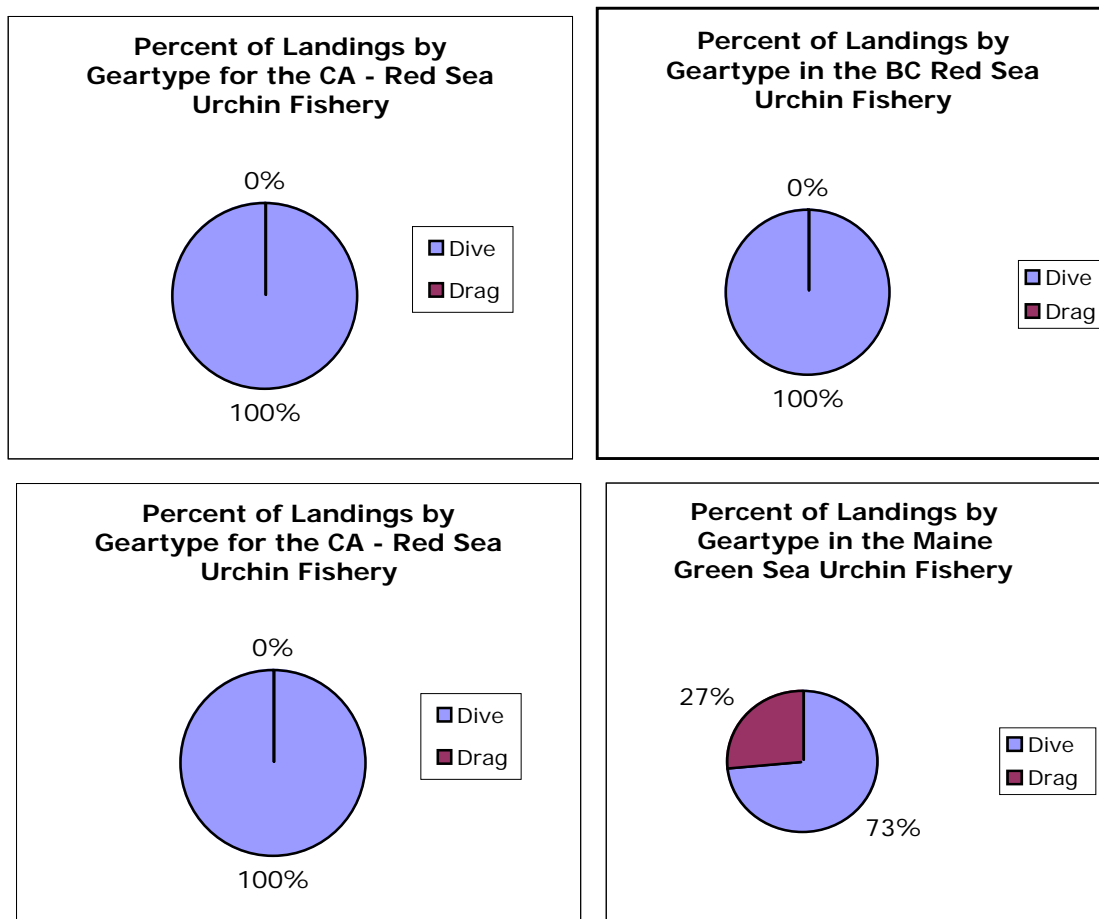
For the five urchin fisheries reviewed in this document, there is very little primary literature about the nature of bycatch. In general, when there is an absence of information, the Seafood Watch® program uses a precautionary approach and ranks bycatch as a moderate concern. However, this approach is not appropriate for these fisheries given that the urchins are being captured primarily by hand collection. Given the above facts, the red and green sea urchin fisheries receive a rank of low concern for the nature of bycatch. If additional information is found in the future that invalidates this assumption, then that information will be taken into account.

<b>Conservation Concern: Nature and Extent of Bycatch</b>	
➤ Red and Green Sea Urchins (all diver-caught fisheries)	Low (Bycatch Minimal) 

### **Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems**

*Guiding Principle: Capture of a sustainable wild-caught species maintains natural functional relationships among species in the ecosystem, conserves the diversity and productivity of the surrounding ecosystem, and does not result in irreversible ecosystem state changes.*

For the five fisheries reviewed in this document, divers collect the majority of both red and green sea urchins by hand or by using hand racks to scoop the urchins into bags, which are then periodically hauled to the surface (Figure 20) (DFO 2000a; CADFG 2001; DFO 2003).



**Figure 20.** Percent of landings by gear type by fishery.

In Maine approximately 73% of the sea urchins landed are hand-harvested by SCUBA divers. The remaining 27% are caught by small (30-45 ft) draggers (Hunter 2005). The majority of this dragging occurs in Washington County, where extreme tides causing strong currents and poor visibility, make diving difficult. The draggers typically use a lighter version of the chain sweep, which is a modified scallop dredge (Taylor 2004). In Maine, drag widths are limited by statute to no more than 5.5 feet in width. They are generally of a much lighter construction than scallop drags (about 300 lbs vs. 900-1,000 lbs for scallop drags). Descriptions of the drags can be found in Creaser and Weeks (1998), and Wahle (1999). Depths are shallow (24-39 feet (Hunter, 2005)) and the bottom type is hard, generally ledge or cobble. Habitats range from kelp beds to “barrens” (urchins and coralline algae) (Hunter 2006, pers. comm.). Almost all fishing, both dragging and hand collection, occurs in shallow (0 – 30 m) water (Hunter 2005). For New Brunswick, the percentage of the landings caught by hand-harvest versus drag is unknown.

### Habitat Effects

There is very little primary literature about the habitat impacts of the hand collection fisheries for green and red sea urchins. In general, when there is an absence of information, Seafood Watch® uses a precautionary approach and ranks the fishery as moderate. However, this approach is not appropriate for these fisheries given that the urchins are being captured primarily by hand

collection. If additional information is found in the future that invalidate this assumption then that information will be taken into account.

The sea urchin drag in Maine was developed by John Green of Arundel, Maine, and is much lighter and does less environmental damage than the scallop drags that were initially used to harvest sea urchins in Maine before the Green drag was developed in the early 1990s (Wahle 1999).

The effects of dragging in New Brunswick are unknown due to a lack of knowledge about the gear.

### **Ecosystem Effects**

Urchins are important organisms in kelp forest ecosystems. Many scientists have described the relationships in kelp forests between urchins (and other invertebrates), the kelps, and in some ecosystems, sea otters (Estes 1995; Dayton 1998; Steneck 2002). Kelp is constrained by physical factors including light, substrata, sedimentation, nutrients, water motion, salinity and temperature (Dayton 1998). In addition to these physical factors, Dayton (1998) states that the best known biological factor limiting kelp is the cascading relationship between sea otters, kelps, and sea urchins. Without the predation of sea otters on sea urchins, the urchins can eliminate the kelp. Given this intertwined relationship, there is every reason to believe that fishing urchins in kelp ecosystems, either with or without the presence of sea otters, has an effect on the ecosystem.

In fact, there are a number of papers that describe the effects of sea urchin fishing on kelp ecosystems. Dayton (1998) showed that before the red sea urchin fishery in southern California grew to full strength, urchins were common throughout the canopy. Once fishing pressure grew, there were still urchins along the edges of the kelp forests, but they were functionally absent from the interior. This paper goes on to describe the importance of older urchins for both urchin and abalone populations and concludes that the absence of urchins in the canopy reduced recruitment.


Steneck (2002) discusses the green sea urchin fishery in Maine and shows that, in response to fishing pressure, the kelp forests that were being consumed by the urchins recovered, but were left without a functional herbivore trophic level. This resulted in increased primary productivity, which then resulted in increased recruitment potential for some fish. As such, the kelp forest moved to an herbivore-free alternate stable state dominated by kelp. Steneck (2002) also discussed similar phase shifts in the California kelp forests as a result of the development of the commercial fishery for red sea urchin.

Given the wealth of primary literature written on the ecosystem relationships between sea urchins and kelp forests and the characterized impacts of removing urchins from these ecosystems, Seafood Watch® ranks the ecosystem impacts of the fishery as moderate.

### **Synthesis**

Dive or hand collection fisheries have very minimal, if any, direct impacts on the habitats. However, in the case of sea urchin fisheries, there are a number of primary literature papers that describe the impacts of fishing on the kelp forest ecosystems. Steneck (2002) describes phase

shifts as a result of the commercial fishery of urchins and Dayton (1998) describes functional changes in recruitment as a result of commercial fishing. In addition, dragging is a small component of the Maine fishery and the fishery has taken precautions to minimize impacts. As a result, Seafood Watch® concludes that the effects of hand collection on habitats and ecosystems in the red and green urchin fisheries are moderate.

<b>Conservation Concern: Habitat and Ecosystem Impacts</b>	
➤ Green and Red Sea Urchins (Dive)	Moderate (Fishing Effects Moderate) 

### **Criterion 5: Effectiveness of the Management Regime**

*Guiding Principle: The management regime of a sustainable wild-caught species implements and enforces all local, national and international laws and utilizes a precautionary approach to ensure the long-term productivity of the resource and integrity of the ecosystem.*

The status of the management regime for each of these fisheries will be reviewed separately.

#### **Red Sea Urchin – British Columbia, Canada**

There has been a commercial red sea urchin fishery in BC since 1978. Rapid expansion of this fishery occurred in the early 1980s (DFO 2001). After 1993, landing began to stabilize with the introduction of quotas (DFO 2001).

In 1989, a consultative process was initiated for the red sea urchin fishery and became the basis for the planning for the commercial fishery. The consultative body for this fishery is the Red Sea Urchin Sectoral Committee. The body includes stakeholders from Fisheries and Oceans Canada (DFO), commercial license holders, processors, First Nations, BC Ministry of Agriculture and Lands, and recreational fishermen (DFO 2005). This body meets annually to provide advice to DFO.

Management of the BC red sea urchin fishery is managed under a precautionary regime. The management measures for the red sea urchin fishery are captured in the Integrated Fisheries Management Plan (IFMP). The IFMP for 2005 to 2006 includes the following measures:

- 1) A minimum test diameter of 90 mm (this was reduced from 100 mm in 2000). This minimum test diameter allows for about 3 to 5 years of spawning prior to harvest.
- 2) A quota system with a conservatively fixed exploitation rate of approximately 2% of estimated biomass. In 2001 there was a quota of 4,885.9 tonnes. Of this quota, 17.3% was allocated to southern BC and 82.7% was allocated to northern BC.
- 3) A limited entry license system. As of 2001, there were 110 licenses in BC.
- 4) An Individual Quota (IQ) system where the quota is equally divided among the licenses. The quota system is enforced through port validation. The individual quota

is 1/110 of the coast-wide commercial TAC.

In addition to the port validation for the IQ system, additional enforcement and research includes on-ground monitoring of fishing activity and fishing beds, processing plant samplers to examine the size range of harvested urchins, and vessel and diver surveys for biomass estimation. The industry pays for this management and research through their association fees (DFO 2001).

DFO considers enforcement in the fishery to be good. Generally, compliance with the regulations and conditions for the license is good because of the dockside validation system and the mandatory harvest and validation logs (DFO 2005).

### **Red Sea Urchin – California, US**

The management authority for the California red sea urchin fishery originally resided with the California legislature, but in 1973, the legislature authorized the Fish and Game Commission, a five-member body appointed by the governor of California, to set regulations for the commercial harvest of sea urchins (Kalvass 1997). In 1987, the legislature established the Director's Sea Urchin Advisory Committee (DSUAC) which consists of industry representatives from the diver and processor communities, a California Sea Grant representative, and a CDFG member. The primary purpose of the DSUAC was to advise the CDFG on the use of dedicated funds for sea urchin management and enhancement, but was also used as a forum for consensus-based management. This forum was the starting point for most management measures, prior to consideration by the Fish and Game Commission (Kalvass 1997). In 2002, the DSUAC was reformed through legislation as the Sea Urchin Fishery Advisory Committee (SUFAC). The primary focus of the group continues to be advising the CDFG on relevant issues (CDFG 2003).

The red sea urchin fishery in California was originally developed in southern California as an experimental fishery in 1971, and until the late 1980s, the fishery was not actively managed beyond a requirement for a commercial license and a voluntary logbook program (Kalvass 1997). Beginning in 1985, this changed with the requirement of permits; in 1987, a moratorium was placed on issuing new permits; and in 1989, a restricted access program began. This restricted access program is reviewed every five years for consistency with the Fish and Game Commission's policy (CDFG 2003).

Also in 1989, a statewide minimum test diameter was adopted and the CDFG set a target goal of reducing the sea urchin harvest by 20-30% of the previous year (Kalvass 1997). This measure resulted in changes to the season and legal size. While the harvest reduction was achieved, the new level (8,027 t) was determined not to represent a sustainable yield because the CPUE continued to decline. As a result, additional restrictions to the season and legal size limit were implemented in 1992 (Kalvass 1997).

The full set of regulations for the California Red Sea Urchin fishery is captured in "Title 14, Sec. 120.7 – Fish and Game Commission Urchin Regulation." This document provides the details for the permit system, the fishing season, logbooks, closed areas, size limits, etc (Table 5).

**Table 5.** A summary of the current regulations for the California red sea urchin fishery (Title 14).

<b>Permits</b>	<ul style="list-style-type: none"> <li>• Any person taking or assisting in the taking of sea urchins for commercial purposes shall have obtained a valid sea urchin permit and shall be in possession of said permit when engaged in such activities.</li> <li>• To provide an economic incentive for cooperative sea urchin management and research activity, the department may authorize the holder of a valid sea urchin diving permit to harvest (take, possess, land and/or sell) red sea urchins during a closed season or in a closed area, subject to such restrictions regarding date(s), location(s), time(s), size, poundage or other matters as specified by the department. Any data collected during such harvest activity shall be made available to the department.</li> </ul>
<b>Fishing Season</b>	<ul style="list-style-type: none"> <li>• From November 1 through March 31 the open season for red sea urchins is seven days per week.</li> <li>• In April, May, September and October the open season for red sea urchins is Monday, Tuesday, Wednesday and Thursday.</li> <li>• In June and August the open season for red sea urchins is Monday, Tuesday, and Wednesday.</li> <li>• In July the season for red sea urchins is Monday and Tuesday.</li> </ul>
<b>Logbooks</b>	<ul style="list-style-type: none"> <li>• Any person who operates a vessel used for the commercial harvest of sea urchins shall prepare a daily record of the vessel's sea urchin fishing activities on a form (DFG-120.7 (5/99)), incorporated herein by reference, provided by the department before the sea urchins are landed</li> </ul>
<b>Closed Areas</b>	<ul style="list-style-type: none"> <li>• The Gerstle Cove area in Salt Point State Park (Sonoma County) is closed to all commercial fishing for sea urchins.</li> <li>• The South Caspar Point area in Mendocino County is closed to all commercial fishing for sea urchins.</li> </ul>
<b>Size Limits</b>	<ul style="list-style-type: none"> <li>• In southern California (south of the Monterey-San Luis Obispo county line) no red sea urchin between one and one-half (1 1/2) and three and one-quarter (3 1/4) inches in shell diameter, not including the spines or any portion of their ball-and-socket attachment to the shell, may be taken, possessed, sold, or purchased, except that not more than thirty (30) such red sea urchins per permittee per load may be taken, possessed, sold or purchased.</li> <li>• In northern California (north of the Monterey-San Luis Obispo county line) no red sea urchin between one and one-half (1 1/2) and three and one-half (3 1/2) inches in shell diameter, not including the spines or any portion of their ball-and-socket attachment to the shell, may be taken, possessed, sold or purchased, except that not more than thirty (30) such red sea urchins per permittee per load may be taken, possessed, sold or purchased.</li> <li>• Red sea urchins less than one and one-half (1 1/2) inches in shell diameter shall not be considered as part of the thirty (30) undersized red sea urchins per permittee per load that may be taken, possessed, sold or purchased.</li> <li>• Every sea urchin permittee shall carry and use an accurate measuring device, to determine the size of red sea urchins being taken as specified in subsections (p)(1) and (p)(2) above, while diving for sea urchins for commercial purposes.</li> </ul>

The last set of changes to Title 14 became effective on September 2, 2003. According to Kalvass (2003) these changes included:

- 1) The elimination of the once-monthly, week-long closures in May, June, August and September that has been a fixture of the fishery since 1992.
- 2) The month of July was opened to fishing in northern California, providing for a statewide uniform season.
- 3) The minimum landing requirement for renewal of a sea urchin permit, established in 1990, was repealed.
- 4) The existing procedure for issuing new permits via a random drawing among qualified sea urchin crewmember permittees was modified to give greater opportunity for obtaining a permit to crewmembers that have been active in the fishery for a longer period of time.
- 5) The due date for sea urchin fishing activity records was modified from the fifth day of the month to the tenth day in order to make this regulation consistent with other fisheries.
- 6) In order to provide an economic incentive for divers to participate in a cooperative program to gather data for a long-term time series that will assist in the stock assessment of sea urchins, the proposed regulations would allow DFG to authorize a sea urchin diving permit holder to take, possess, land and/or sell red sea urchins during a closed season or in a closed area, subject to terms and conditions DFG may specify.

The most recent round of proposed regulation changes began in January 2006. The current “Notice of Proposed Changes” includes minor changes to allowed fishing days to help fishermen allow a steadier stream of product to processors. The proposed changes should not allow for increased effort (FGC 2006).

### **Green Sea Urchin – British Columbia, Canada**

There has been a commercial fishery for green sea urchins in BC since 1987. However, prior to 1991, the fishery was managed with few restrictions including the 1988 establishment of the 55 mm minimum size. Perry et al. 2002 noted that the fishery can be described in three periods: “developing” from 1986 to 1991, “crisis” from 1991 to 1993, and “rebuilding to sustainable since 1994.” In 1991, licenses were capped at 49 to control high catches and effort (DFO 2003). The same number of licenses remains today. In 1994, an arbitrary total allowable catch of 449 mt was established for southern BC (DFO 2003). In 1995, this was followed by the first formal stock assessment and the establishment of individual quotas with validation at designated landing ports (Perry et al. 2006). This assessment resulted in fishing being restricted to the two major areas, Queen Charlotte Strait and Gulf Islands (DFO 2003). In 1996, the total allowable catch became 166 t in the restricted areas and the very small northern fishery was closed (Perry et al. 2002). In 2001, the total allowable catch was slightly increased to 179 t (DFO 2003b). These efforts have resulted in stabilized landings, effort, landed value, and unit price. They have also allowed the CPUE to increase (Perry et al. 2002).

Green sea urchins are currently fished in BC from November 1 to March 1. This winter fishery was developed due to the better quality of the roe and the better price that can be fetched during this period of the year (Perry et al. 2006). In addition to the fishing season, the current management measures include use of a 55 mm test diameter size limit, license cap, area quotas, individual quotas, and areas closures (Perry et al. 2006). The license year is defined from June 1

to May 31 of each year and the fishery is conducted by SCUBA divers hand-picking (Perry et al. 2006). These fishery management measures are captured in the Integrated Fishery Management Plan (IFMP) which is prepared every two years (Perry et al. 2006). Stock assessments, utilizing both fishery dependent and independent information, are required and provide the basis for the IFMP. Perry et al. (2006) will provide the basis for the 2006-2008 IFMP.

According to Perry et al. (2002) the crisis period that the BC green sea urchin fishery experienced was sufficient to push management from a passive system to an active one. In addition, there were a number of factors which were pivotal to the success of the “rebuilding to sustainable” period:

- 1) The fishery went from a coast-wide fishery to a regional one where only a few of the regions were fished. This identification of the relevant special scales ultimately led to the development of the quota system and later individual quotas.
- 2) The availability of logbook data from the beginning of the fishery was also an essential component in being able to establish appropriate management measures.
- 3) The establishment of an industry association and the development of collaborative relationships between fishermen, scientists, and managers was the third crucial aspect to implementation of successful management.

Compliance with the regulations and conditions for the license is good generally because of the dockside validation system and the mandatory harvest and validation logs (DFO 2003b).

### **Green Sea Urchin – Maine, US**

Since 1992, green sea urchins in Maine have been managed through the Maine state legislative process, or using the Department of Marine Resources (DMR) commissioner’s regulatory authority and public process (Hunter 2005). In addition, the Maine Sea Urchin Zone Council (SUZC) advises both the DMR and the legislature. This group, which was created in 1996, consists of 6 divers, 6 draggers, 4 buyers, 1 tender, and 2 independent scientists (Hunter 2005).

The DMR also has a sea urchin research program that has five components:

- 1) a port sampling project;
- 2) a dealer logbook project;
- 3) a fishery-independent spring survey;
- 4) a computer model to identify possible biological reference points (Chen and Hunter 2003);
- 5) and other contracted and in-house research projects which, during 2004, monitored larval settlement, made further refinements to the computer model, and produced a summary of research results which was distributed to the industry (Taylor 2004 as cited in Hunter 2005).

In Maine, there are no formal management plans for most state-managed species, including urchins, but there is a very restrictive management regime in place for urchins. Current management includes closed entry, fixed, short fishing seasons, the creation of two exclusive

management zones (**Zone 1 and Zone 2 which correspond to variation in spawning times along the coast**), minimum and maximum size limits (**2<sup>1</sup>/<sub>16</sub> and 3 inches respectively, or 52mm and 76mm, with a 5% tolerance**) and gear restrictions (Hunter 2006, pers. comm.).

There is no formal TAC for the fishery, but the model described by Chen and Hunter, 2003 is run annually and used for guidance in setting input controls (primarily season length). The model is designed to limit catches to levels projected by the model as sustainable (Hunter 2006, pers. comm.).

Table 6 below summarizes the history of Maine's management system and the year-to-year changes in the regulations. Due to the lack of management restrictions in the early 1990s, the stock declined. In the late 1990s and early 2000s, much more restrictive measures were implemented, but the stock continued to decline. In 2004, the fishing season was cut from 94 open days to just 10 days in Zone 1 and 45 days in Zone 2 and since then biomass declines have leveled off (Hunter 2006, pers. comm.).

**Table 6.** The history of management laws and DMR regulations for the Maine green sea urchin fishery (Hunter 2005).

<b>Before 1992</b>	<ul style="list-style-type: none"> <li>Commercial fishing license (\$20) required annually (law)</li> </ul>
<b>1992</b>	<ul style="list-style-type: none"> <li>\$89 sea urchin licenses required for hand harvesting and dragging annually (law)</li> </ul>
<b>1993</b>	<ul style="list-style-type: none"> <li>Minimum size limit of 2 in. (law) (probably not enforced until Jan. 1, 1994)</li> <li>Authority to adopt rules on drag size, nighttime dragging, and tolerance on under-sized urchins granted to DMR commissioner (law)</li> <li>Sea urchin boat tender license required for tenders (law)</li> <li>Season closed May 15 to August 7 for 1993, to August 15 for 1994 (law)</li> <li>Nighttime harvesting of urchins prohibited (reg, effective May 25, 1994)</li> <li>10% tolerance on sea urchins less than 2 in. (reg, effective Jan. 1, 1994)</li> <li>Urchin drag width restricted to 5½ ft. (reg, effective Aug. 8, 1994)</li> </ul>
<b>1994</b>	<ul style="list-style-type: none"> <li>Research surcharge on licenses: \$160/harvester, \$500/buyer, \$2500/processor annually (law, effective Jan. 1, 1995)</li> <li>Sea urchin research fund established (law)</li> <li>Moratorium on new licenses (law, effective July 1994)</li> <li>Two fishing zones established with seasons (effective Jan. 1, 1995) (law): Zone 1: Closed Apr. 1 - Aug. 15, Zone 2: Closed May 15 – Oct. 1</li> <li>Authority to adopt rules for processor/buyer logbooks granted to DMR commissioner (law)</li> <li>Permits for buyers and processors required (law)</li> <li>Safety training required for divers, effective 1995 (law)</li> </ul>
<b>1995</b>	<ul style="list-style-type: none"> <li>Modified season closures (law): Zone 1: Apr. 1 - Aug. 31 (not enacted in time for Zone 1 opening on Aug. 16, 1995) Zone 2: May 1 - Oct.</li> <li>Hand-raking and trapping license added (\$89 plus \$160 surcharge annually) (law)</li> <li>Exception to license moratorium due to medical conditions, and deceased license transfer to family members (law)</li> <li>Authority to extend closing dates for entire zones or portions thereof, to conserve</li> </ul>

	<p>spawning urchins, granted to DMR commissioner (has never been exercised) (law)</p> <ul style="list-style-type: none"> <li>• License (\$89) and surcharge (\$35) annually and safety training required for tenders (law)</li> </ul>
<b>1996</b>	<ul style="list-style-type: none"> <li>• Sea Urchin Zone Council established (to advise on selection of fishing days), consisting of: 3 draggers, 3 divers, 1 buyer, and 1 processor from each zone plus 2 scientists (law)</li> <li>• Fishing days limited to 150 per year in Zone 1 and 170 in Zone 2 (law)</li> <li>• Limitations on switching zones - cap at the zone's previous year's total (law)</li> <li>• Logbooks required from buyers/processors (reg)</li> <li>• Modified zone season closure: May 1 – July 31, for both zones (law)</li> <li>• Draggers not allowed to fish during August or September (law)</li> <li>• Violations of sea urchin laws result in mandatory \$500 fine (law)</li> </ul>
<b>1997</b>	<ul style="list-style-type: none"> <li>• Fishing days limited to 120 per year in each Zone (reg)</li> <li>• Role of Sea Urchin Zone Council expanded: recommend fishing days, advise on the spending of the research fund, and other matters of interest to the urchin industry (law)</li> <li>• Harvesters cannot switch zones during the open season (law)</li> </ul>
<b>1998</b>	<ul style="list-style-type: none"> <li>• Role of Sea Urchin Zone Council expanded: recommend limited entry ratio (law)</li> <li>• Lottery for issuing a limited number of new licenses with a 1:5 exit ratio (law and reg)</li> <li>• Up to 30% of license surcharge may be used for enforcement overtime (law)</li> <li>• Two seasons in Zone 2 (harvester chooses one) (law) Early: Oct.-Mar. or Late: Nov.-Apr.</li> <li>• Tender added to Zone Council (law)</li> </ul>
<b>1999</b>	<ul style="list-style-type: none"> <li>• Surcharge may be used for Council support, 30% for law enforcement (law)</li> <li>• Failure to submit logbook reports may prevent license renewal (law)</li> <li>• No possession of urchins on boat during no-fishing day (law)</li> <li>• Mandatory suspension of license for violation of season or zone restrictions (law)</li> <li>• Condition for switching zones: 1 in for 1 out (law)</li> <li>• Sea Urchin Zone Council membership changed to 2 buyer/processors per zone (law)</li> <li>• Six small areas closed for research (reg)</li> </ul>
<b>2000</b>	<ul style="list-style-type: none"> <li>• No exceptions to the license moratorium for medical conditions; no transfer of deceased harvester's license to family members (law)</li> <li>• Minimum size tolerance reduced from 10% to 5% (reg)</li> <li>• Season reduced to 110 days per year (reg)</li> <li>• Maximum size of 3½" established, with a 5% tolerance, to be reduce to 3 3/8" in 2001 and reduced again to 3¼" in 2002 (reg) (but see 2001)</li> <li>• Casco Bay research area closed for reseeding (reg)</li> </ul>
<b>2001</b>	<ul style="list-style-type: none"> <li>• Season reduced to 94 days per year (reg)</li> <li>• Minimum size increased to 2 1/16", 5% tolerance (reg)</li> <li>• Maximum size reduced to 3.0", 5% tolerance (reg)</li> <li>• DMR given authority to implement limited entry system (law, see 2002 for reg)</li> <li>• Drag license holder must be on boat, exceptions for multiple license holders, one-time transfer of license allowed (law)</li> <li>• Surcharge may be used for Council travel expenses (law)</li> <li>• Mandatory suspension of license for violation of closed areas (law)</li> </ul>

	<ul style="list-style-type: none"> <li>• Diving from a vessel with urchins aboard illegal without license etc. (law)</li> <li>• Processor's surcharge reduced from \$2500 to \$1000. (law)</li> </ul>
<b>2002</b>	<ul style="list-style-type: none"> <li>• One-time expansion of drag license eligibility (law)</li> <li>• Limited entry license lottery system as defined in law in 1998 repealed and repromulgated in regulation with minor changes. (reg)</li> </ul>
<b>2003</b>	<ul style="list-style-type: none"> <li>• License lottery exit ratio changed from 1 in for 5 out to 1 in for 10 out (reg)</li> <li>• DMR commissioner given authority to prohibit new entry to protect fishery from imminent depletion (law)</li> <li>• Surcharge may be used for safety training and other management programs (law)</li> <li>• Mandatory \$1000 fine for 2<sup>nd</sup> violation of minimum size rule and mandatory 1 to 3 -year license suspension for 3<sup>rd</sup> violation of minimum size rule within 5 years (law)</li> <li>• Zone 1 divers must "cull on bottom", 20% tolerance (law and reg)</li> <li>• Zone 1 dragger season shortened from 94 days to 84 days (reg)</li> <li>• Western Zone 2 closed for an additional 10 days (reg)</li> <li>• Zone 2 divers must use large-mesh catch bags (reg)</li> <li>• Zone 2 draggers must use large-mesh "escape panel" in back of drag (reg)</li> <li>• License fees increased from \$89 to \$111 for harvesters and tenders (effective 1/1/04), and from \$217 to \$385 for buyers and processors (effective 4/1/04), research surcharges unchanged (law)</li> </ul>
<b>2004</b>	<ul style="list-style-type: none"> <li>• Six of the seven areas closed for research in 1999-2000 re-opened (reg)</li> <li>• License lottery (new entry) suspended indefinitely (reg)</li> <li>• Zone 1 season reduced from 94/84 days to 10 days (reg)</li> <li>• Zone 2 season reduced from 94 days to 45 days (reg)</li> </ul>

### **Green Sea Urchin – New Brunswick, Canada**

The green sea urchin fishery in New Brunswick started in 1989 and is managed by the Department of Fisheries and Oceans (DFO). The fishery is described in management as Lobster Fishing Areas (LFA) 36-38. The two main fishing zones are LFA 38 (Grand Manan) and LFA 36. Fisheries operating in both of these areas are also allowed to fish in LFA 37, which is a small adjoining area. A Conservation Harvesting Plan (CHP) for LFA 36-38 was developed with stakeholder input from all of the license holders, and there are currently different versions of the CHP for LFA 36 and LFA 38 (DFO 2000b). According to DFO (2000b), both versions of the CHP have a number of factors in common:

- 1) Both versions have the same minimum size limit of 50 mm.
- 2) They both require that urchins are sorted and culled at sea.
- 3) They both require all harvesting occurs between sunrise and sunset.
- 4) There is a mandatory submission of logbooks.
- 5) There is a requirement to establish protected areas for scientific research.
- 6) All participants in the fishery must have a license and be the operator of the fishing vessel.

In addition to these common regulations in LFA 36, the season is from October 1 to May 15 and fishing gear is limited to "green" drags with a maximum width of 10 ft or diver-based techniques. Up to four divers can be in the water with two skiffs within 457 m of their mother ship. There is also an overall quota for this area with maximum limits for each individual license

(DFO 2000b).

In LFA 38, the season is from November 1 to April 15 and fishing gear is limited to “green” drags with a maximum width of 6 ft or diver-based techniques. This portion of the fishery has a program for individual quotas with dockside monitoring (DFO 2000b).



The total allowable catch (TAC) for each LFA was calculated in 1996 from the biomass estimates calculated in 1992-1994. The TAC has remained the same since. The annual quota for LFA 36 was 900 t or 6.8% of the estimated 13,245 t of legal fishable urchins. In LFA 38, the annual quota was set at 979 t or 3.3% of an estimated 29,879 t of legal fishable urchins (DFO 2000b). The percentage of TAC to estimated biomass is lower in LFA 38 due to lack of recruitment observation.

### **Synthesis**

All five commercial fisheries for sea urchin reviewed in this document have functional management systems. However, these management systems vary in their levels of sophistication. The red and green sea urchin fisheries in British Columbia as well as the green sea urchin fishery in New Brunswick all have fishery management plans that are updated on a regular basis. All three fisheries are limited entry and have quota systems. They also have specific fishing seasons, gear types, defined fishing areas, and minimum size limits. These fisheries are also all well-enforced. Given these characteristics Seafood Watch® ranks these three fisheries as having highly effective management systems.

The management system for the green sea urchin fishery in Maine is quite similar to the Canadian management systems described above. However, the management system in Maine was not sufficient to prevent substantial decline in the stock and has not yet been effective in recovering the stock. As a result Seafood Watch® ranks Maine’s green sea urchin management system as moderately effective.

In California, the red sea urchin fishery is managed by the CDFG. There is currently no formal management system for the fishery, but the current regulations are captured in Title 14. In contrast to the other management systems, California does not employ quotas to manage the fishery and there are not strict enforcement measures. In addition, the management system in California was not sufficient to prevent substantial decline in the stock and has not been effective in fully recovering the stock. As a result, the Seafood Watch® program ranks California’s red sea urchin management system as moderately effective.

<b>Conservation Concern: Effectiveness of Management</b>	
<ul style="list-style-type: none"> <li>➤ Red Sea Urchin – British Columbia</li> <li>➤ Green Sea Urchin – British Columbia</li> <li>➤ Green Sea Urchins - New Brunswick</li> </ul>	Low (Management Highly Effective) 
<ul style="list-style-type: none"> <li>➤ Green Sea Urchin – Maine</li> <li>➤ Red Sea Urchin – California</li> </ul>	Moderate (Management Moderately Effective) 

## **Overall Evaluation and Seafood Recommendation**

### **Inherent vulnerability**

Both red and green sea urchins are considered to be inherently resilient. They have a low age at maturity (< 5 years), an assumed high von Bertalanffy growth coefficient (>0.16), are long lived (>30 years), and have a high reproductive potential (several million eggs per spawning event). Red sea urchins have a moderately limited range and green sea urchins have a broad range. Both species prefer near shore kelp forest habitat and this habitat has likely only been moderately altered by non-fishery impacts. In addition, given that the fisheries for sea urchins are primarily conducted by hand collection, there is habitat beyond the depth range of the divers that acts as a reserve.

### **Stock status**

For all five sea urchin populations reviewed in this document, there is some degree of uncertainty or gaps in available data. In the red and green sea urchin fisheries in BC and the green sea urchin fishery in New Brunswick, the stocks are considered to be moderately healthy. All of these fisheries use some degree of precautionary management and the population trends for these three fisheries are flat or upward trending population trends. The red sea urchin fishery in California is considered to be in poor condition. Although it is considered fully fished, there is no formal stock assessment, and the population trends in the fishery are down. The green sea urchin fishery in Maine is considered to be in critical condition. According to the stock assessment published in 2003, the biomass as of 2001 was estimated to be 10% of the virgin biomass, and biomass estimates for the fishery have been trending down since the beginning of the time series with a flattening in the decline in recent years.

### **Bycatch**

There is very little primary literature about the nature of bycatch in any of the five urchin fisheries reviewed in this document. When there is an absence of information Seafood Watch® generally uses a precautionary approach and ranks bycatch as a moderate concern. However, this approach is not appropriate for these fisheries given that the urchins are being captured primarily by hand collection which is known to result in very minimal bycatch. Therefore, in this case, the red and green sea urchin fisheries receive a rank of low concern for the nature of bycatch. If additional information is found in the future that invalidates this assumption, then that information will be taken into account.

### **Habitat and ecosystem impacts**

Hand collection is the most common fishing method utilized for capturing both red and green sea urchins. Generally speaking, dive or hand collection fisheries have very minimal, if any, direct impacts on the habitats. However, in the case of sea urchin fisheries, there are a number of primary literature papers that describe the impacts of fishing on the kelp forest ecosystems. Steneck (2002) describes phase shifts as a result of the commercial fishery of urchins and Dayton (1998) describes functional changes in recruitment as a result of commercial fishing. As a result, Seafood Watch® concludes that the effects of hand collection on habitats and ecosystems in the red and green sea urchin fisheries are moderate.

**Management**




All five commercial fisheries for sea urchin reviewed in this document have functional management systems. However, these management systems vary in their levels of sophistication. The red and green sea urchin fisheries in British Columbia as well as the green sea urchin fishery in New Brunswick all have fishery management plans that are updated on a regular basis, and all three fisheries are limited entry and have quota systems. They also have specific fishing seasons, gear types, defined fishing areas, and minimum size limits. These fisheries are also all well-enforced. Given these characteristics, Seafood Watch® ranks these three fisheries as having highly effective management systems. The management system for the green sea urchin fishery in Maine is quite similar to the Canadian management systems described above. However, in Maine, the system was not sufficient to prevent substantial decline in the stock and has not yet been effective in recovering the stock. As a result, Maine's green sea urchin management system is ranked as moderately effective. CDFG manages the California red sea urchin fishery, and while there is no formal management system for the fishery, the current regulations are captured in Title 14. In contrast to the other management systems, California does not employ quotas to manage the fishery and there are not strict enforcement measures. The management system in California was also not sufficient to prevent a substantial decline in the stock and to date as not been effective in fully recovering the stock. As a result, California's red sea urchin management system is ranked as moderately effective.

**Synthesis**

Given the rankings for each fishery for each of the criteria described above, Seafood Watch® concludes that red and green sea urchins from Canada are a "Best Choice", red sea urchins from California are a "Good Alternative", and green sea urchins from Maine are recommended as "Avoid."

**Table of Sustainability Ranks**

Sustainability Criteria	Conservation Concern			
	Low	Moderate	High	Critical
Inherently Vulnerability	✓			
Status of Stocks		↓ (Red and Green Sea Urchin – British Columbia and Green Sea Urchin – New Brunswick)	✓ Red Sea Urchin – California	✓ Green Sea Urchin – Maine
Nature of Bycatch	✓			
Habitat Effects		✓		
Management Effectiveness	✓ (Red and Green Sea Urchin – British Columbia and Green Sea Urchin – New Brunswick)	✓ (Green Sea Urchin – Maine) ✓ (Red Sea Urchin – California)		

Overall Seafood Recommendation for Sea Urchins	
➤ <b>Canada</b>	Best Choice 
➤ <b>California</b>	Good Alternative 
➤ <b>Maine</b>	Avoid 

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*Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.*

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