DEVELOPMENT OF REFERENCE POINTS IN THE CONTEXT OF A PRECAUTIONARY APPROACH (PA) FOR LOBSTER OF THE GASPÉ (LFAS 19, 20 AND 21)

Context

This document is a Science Response to a request from Fisheries Management at the DFO Area Office in Gaspé, Quebec regarding implementation of a precautionary approach (PA) for lobster in the Gaspé (LFAs 19, 20 and 21). More specifically, Management would like Science to determine the appropriate stock status indicators and reference points delineating the three stock status zones (healthy, cautious and critical) and contribute to the establishment of decision rules for the fishery, for each of the three zones. This Science Response results from the Science Special Response Process of November 21, 2013 on the “Development of reference points for the precautionary approach for lobsters in Gaspé, Quebec (LFA 19, 20 and 21)”.

Background

In the past few years, progress has been made in implementing certain aspects of the precautionary approach (PA) for lobster stocks in Canada. In Quebec, a PA was developed and implemented in 2012 for the lobster fishery in the Magdalen Islands (Lobster Fishing Area, LFA 22) (Gendron and Savard 2012; Integrated Fishery Management Plan, Lobster Fishing Area 22, 2010-2014, updated May 2013). This PA was developed based on "A Decision-making Framework (DMF) for implementing a Harvest Strategy that Includes the PA" (DFO 2009), The DMF consists of three components: 1) Reference points and stock status zones, 2) Harvest strategy and harvest decision rules, and 3) Assessment of uncertainty and risk. For LFA 22, the first two components were developed. The first component of the DMF was developed taking also into account discussions held at a workshop on applying the PA to effort-controlled fisheries (DFO 2010) and a study that a consultant conducted for DFO on implementing the PA (DFO 2011). In 2012, reference points were also developed for lobster in the Maritimes Region (LFAs 27 to 38) (Tremblay et al. 2012, DFO 2012). In all cases, without operational models for lobster populations, an empirical approach has been required for developing reference points (Smith et al. 2012).

The proposed approach for defining reference points for the lobster stock in the Gaspé is the same as the approach used for the Magdalen Islands (LFA 22, Gendron and Savard 2012). It follows the DFO DMF and complies with guidelines developed for the provision of scientific advice on the PA for invertebrates (Smith et al. 2012). The purpose of the PA is to provide a management action (decision rule) that sets a predetermined harvest rate for each stock status zone (Figure 1). An indicator is used to assess stock status; the stock is then placed in one of the three zones (healthy, cautious or critical) depending on the indicator's value. The limit reference point (LRP) is that threshold below which the stock's productivity is greatly compromised; this corresponds to the critical zone. The upper stock reference point (USR) is the limit beyond which the stock is known to be in the healthy zone. In this zone, we consider

that the maximal harvest rate defined should not endanger the stock's health. The cautious zone is between the LRP and the USR. In theory, when the stock is in this zone, the harvest rate is adjusted according to the level of the indicator, to promote its return to the healthy zone.

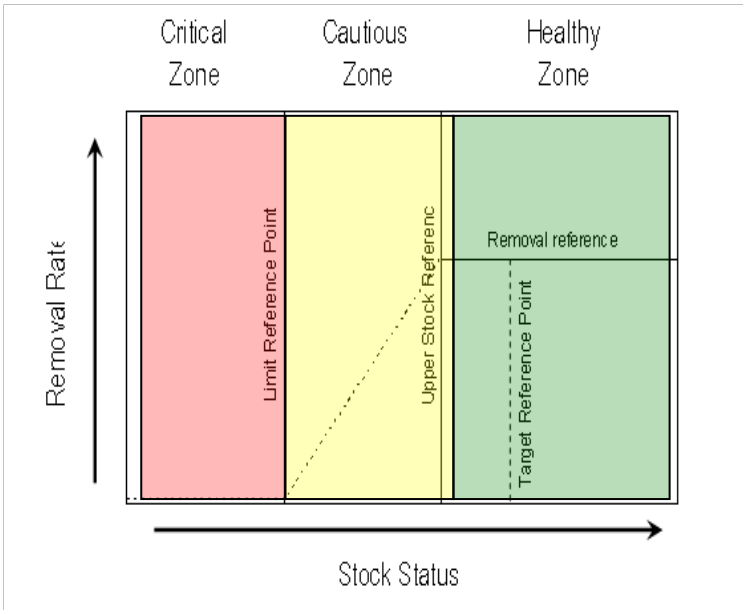

Figure 1. Reference points and stock status zones in the context of the Precautionary Approach (from DFO 2006).

Analysis and Response

Indicator of stock status

In accordance with what was established over the past few years regarding choice of a lobster stock status indicator (DFO 2010, Smith et al. 2012), and after what was done for the Magdalen Islands (Gendron and Savard 2012) and the Maritimes (Tremblay et al. 2012), landings were retained as a lobster stock status indicator in the Gaspé. As in the other cases, it is assumed that in the current context, that landings can be reasonably representative of the biomass.

It is readily acknowledged however that landings can be affected by several factors other than abundance, such as effort levels (nominal and effective), and accuracy with which they are declared. The nominal effort has been quite stable in the Gaspé between the mid-1980s and the mid-2000s. Before the 1980s, market demand for lobster was low as well as fishing effort. In the early 1970s, professionalization of the lobster fishery prompted a major increase in fishing effort and contributed to a significant increase in landings between the mid-1970s and mid-1980s. More recently, in the mid-2000s, measures to reduce fishing effort have been put in place. In 2006, the number of traps was reduced from 250 to 235 per license. Moreover, starting in 2003, the number of fishing licenses was reduced successively from 238 to 198, 180 and 173 in 2009, 2011 and 2013, respectively. There is nevertheless a strong correlation between landings and catches per unit effort (CPUE), which suggest that the changes in landings were not due to changes in nominal effort. For LFA 20, CPUEs by weight from commercial sampling are strongly correlated with landings from 1989 to 2011 ($r = 0.69$, $p < 0.01$). CPUEs from the lobster recruitment project conducted in the Gaspé (Bruneau and

Gendron 2012) are also strongly correlated with landings from 2007 to 2011 ($r = 0.85$, $p = 0.068$) (Gendron and Savard 2012).

Effective effort has also changed through the years, because of technological changes in fishing equipment. These changes were mainly brought between the mid-1970s and the mid-1980s (Archambault 1997). It cannot be excluded that over these years, a certain part of the increase in landings was due to an increase in fishing efficiency. Recent reductions in nominal effort resulted in a reduction of the density of traps on the fishing grounds, which may have a positive effect on the effectiveness of remaining traps. This aspect has not been quantified. However, during the last decade several management measures have been implemented to try to slow down the increase in fishing efficiency (daily fishing hours, hauling of traps limited to once a day, limits on trap size, maximum line length and minimum number of traps per line).

Landings are compiled from purchase slips. Quantities of unsold lobster are not counted. It is assumed that the resulting underestimation remains relatively low and does not affect the observed trend.

Other indicators

Although landings (or biomass more generally) were retained as an indicator of stock status, it is recognized that they constitute only one aspect of stock status. There are a number of other important indicators related to abundance, demography, productivity (reproductive potential and recruitment) and fishing pressure (see Gendron and Savard 2012); these indicators make it possible to interpret fluctuations in landings and, in some cases, predict them (e.g. recruitment indicators). It is important to continue to compile and analyze those indicators and include them in the preparation of scientific advice. Examination of all the indicators will help determine the nature and components of the stock which can account for fluctuations observed in landings. Assessment of these other indicators could lead to new analyses, research projects or monitoring projects and, if needed, expedite the application of certain management measures. For the moment, the PA developed here should be accompanied by the other indicators to provide a more complete perspective of the stock status.

Reference Points

According to the definition in the decision-making framework (DMF), a stock is considered to be in the Critical zone if the biomass, or its index, is less than or equal to 40% of maximum sustainable yield (B_{MSY}). In other words, 40% of the B_{MSY} corresponds to the LRP. Similarly, a stock is considered to be in the Healthy zone if the biomass, or its index, is greater than 80% of B_{MSY}; 80% of the B_{MSY} corresponds to the USR.

The DMF also specifies that if no stock status estimates are available from a formal model, tentative estimates of the B_{MSY} may be used. The mean biomass (or index of biomass) during a productive period is one potential substitute; 50% of the maximum historical biomass is another.

Therefore, the average biomass for 1985 to 2009 was used as a proxy for B_{MSY}, just as it was for the Magdalen Islands (Gendron and Savard 2012) and the Maritimes (Tremblay et al. 2012). This corresponds to a productive period during which two generations of lobsters were produced in large numbers. Average landings for the Gaspé (LFAs 19, 20 and 21) from 1985 to 2009 totaled 810 t (Figure 2). The LRP (40% of the average) is 325 t and the USR (80% of the average) is 650 t.

According to these values the lobster stock in the Gaspé is considered to be in the Healthy zone.

It cannot be determined with certainty whether the LRP is in fact a critical threshold according to the DMF or whether the stock can rebound from it. One should not use these reference points to infer the status of the stock of the past. From 1945 until the mid-1970s, landings were lower than the value of PRL, but the low landings were not the result of overexploitation of the stock, or of a low abundance, but rather related to the fact that at that time, lobster fishing in the Gaspé was a small-scale fishery. That being said, it is believed that the lobster stock in the Gaspé is currently more robust than it was in the past. The increase in the minimum legal size (6 mm between 1997 and 2004) has increased the reproductive capacity of the stock by reducing fishing pressure on immature lobsters.

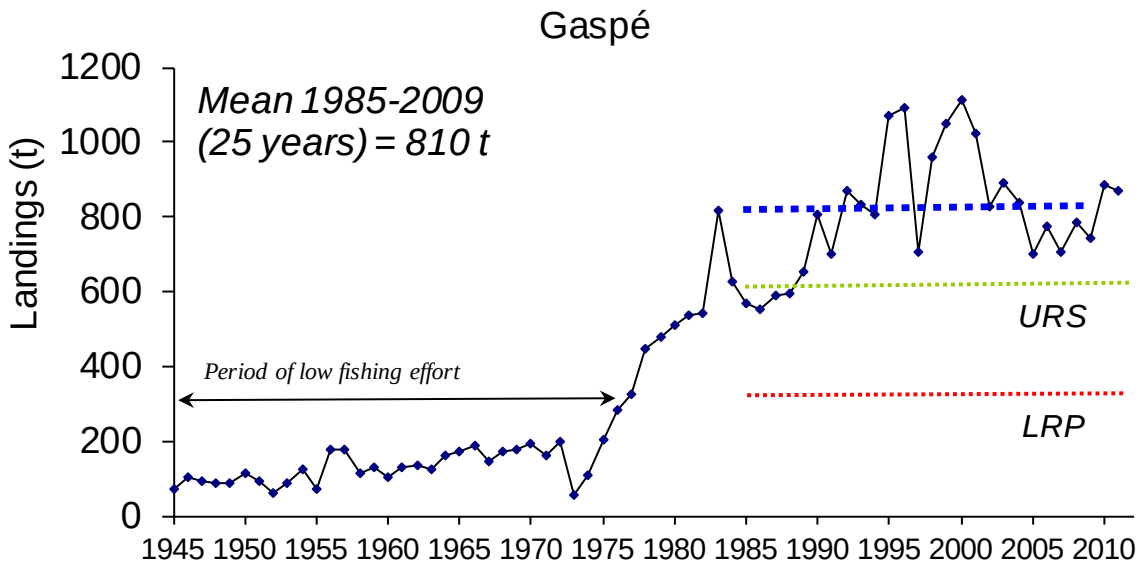

Figure 2. Lobster landings from 1945 to 2011 in the Gaspé (LFAs 19, 20 and 21). Dotted blue line : the mean landings for the reference period, from 1985 to 2009. The other dotted lines represent the upper stock reference (USR) (green line) and the limit reference point (LRP) (red line). Note: we should not infer the status of the stock from the landings for the period from 1945 until the mid 1970s when fishing effort was much lower compared to subsequent years.

Management Measures Options

Three categories of management measures apply in the lobster fishery: escapement measures, input control measures and output control measures. For each of the three categories, there is a set of tools described in the "tool box" in FRCC (1995). Escapement measures include size limits (minimum, maximum or a closed window of sizes), V-notching and discarding certain categories of lobster such as berried females. Input control measures include those designed to limit the various components of the fishing effort such as the number of fishing days allowed, the number of traps, trap dimensions, and those limiting fishing operations such as daily hours of fishing operation, the number of daily hauls, the length of trap lines and the number of traps per line. Input control measures could also include the implementation of fishing exclusion zones. Output control measures are intended to control the amount of landings; and such these measures rely on quotas.

In the AP for lobster in the Gaspé, it will be possible, depending on stock status zones, to use these measures successively and additively. Presently, we consider that the stock is in the healthy zone. Although considered high, the current exploitation rate is acceptable and under current environmental and ecological conditions, it does not endanger the health of the stock (Gendron and Savard 2012). Management measures may remain unchanged as long as the stock remains in this area. Target reference points can still be defined if needed, based on imperatives other than biological. Escapement and input control measures can be considered when the stock will be in the cautious zone. If the stock reaches the critical zone, it may be necessary to use output controls. However, the measures mentioned above are not all equivalent in terms of their effect on reducing the removal rate. Escapement measures have an immediate impact on the stock. For example, increasing the minimum catch size has an immediate effect on reducing the removal rate because it allows a direct and complete protection of an additional fraction of the population. Measures to control fishing effort have less direct effects on reducing the removal rate, especially in situations where there is initially a fishing overcapacity.

Uncertainties

There are uncertainties in the implementation of a PA for lobster in the Gaspé:

Landings for the 1985-2009 period are proposed as a starting point for defining the stock status zones. However, the management measures to be taken when the stock enters the cautious zone will directly affect the landings. As the harvest rate decreases in this zone, the trajectory of the indicator (landings) will deviate from that of the biomass. It will therefore be difficult to interpret changes in landings as changes in biomass. New indicators of the stock status, unaffected by management measures (e.g. CPUE in a fishery-independent survey) should be developed shortly.

At this time, we do not have the analytical tools required to quantify the exact removal rate associated with a given management measure (escapement or input controls), nor are we able to precisely determine the stock's trajectory based on different removal rates. For now, harvest levels (rates) and the stock's response to a given management measure are assessed only empirically, *a posteriori*, through a review of the trends in the various indicators and the calculation of a harvest rate (Gendron and Savard 2012). Application to the Quebec (and Canadian) lobster fisheries of an analytical model such as that used currently in the United States (Chen et al. 2005) is needed in order to quantify the uncertainties and assess management risks.

The Gaspé has three different management areas that represent three geographic regions on the Peninsula. LFA 19 corresponds to Gaspé-Nord, LFA 20 to Gaspé-Sud and LFA 21 to the upper Bay of Chaleur. There is physical and ecological heterogeneity among the areas. It is uncertain whether they belong to the same production area and how they are related to adjacent production areas (see definition of lobster production areas of the FRCC, 1995). In LFAs 19 and 21, there are also fewer fishers than in LFA 20. Landings account for only 3% (LFA 19) and 5% (LFA 21) of the total for the Gaspé (2011 data, Gendron and Savard 2012). Stock status, defined by an overall indicator for the entire Gaspé, could mask changes occurring on a finer spatial scale. The various indicators used in stock assessments remain essential to quantifying this heterogeneity at the LFA scale. Their analysis could, if necessary, help introduce a spatial approach when applying decision rules.

Conclusions

Definition of reference points for the implementation of a PA for the lobster in the Gaspé is complicated by the lack of information on the key elements of the PA framework. Therefore, the reference points developed in this paper should be seen as a first step. The reference points were defined for a productive period for lobster and presently, the stock is considered to be in the healthy zone. We recognize that the landings cannot be used as an indicator in the long term and that it is necessary to begin developing other stock indicators. In this context, it is important to develop or maintain monitoring programs (especially fishery-independent) for developing reliable stock status indicators. Furthermore, the development of integrated analytical models based on probability (stock dynamics, management measures) could lead to further progress in the implementation of the PA. For now, the AP developed here should be linked with the assessment of other indicators in order to obtain a more comprehensive view of the status of the stock.

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