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RECOVERY POTENTIAL ASSESSMENT FOR CUSK (*BROSME BROSME*)

Artist: Jeff Domm

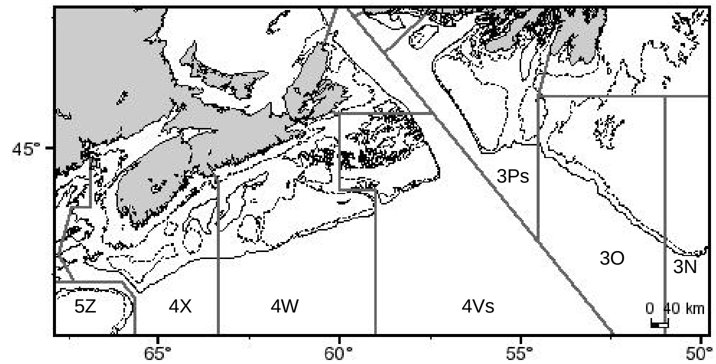

Figure 1: Main area of cusk distribution in Canada.

Context

In 2003 cusk (Brosme brosme) was designated as threatened by the Committee on the Status of Endangered Wildlife Species in Canada (COSEWIC), largely on the basis of declines in the Fisheries and Oceans Canada (DFO) research vessel (RV) survey. An Allowable Harm Assessment was conducted by DFO in 2004. Following consultation with the Provinces, Aboriginal peoples, stakeholders, and the public, Governor in Council referred the assessment back to COSEWIC for further information and consideration. COSEWIC reaffirmed the original assessment in 2006. Thus, cusk is once again under consideration for addition to Schedule 1 of the Species at Risk Act (SARA)*. A Recovery Potential Assessment was undertaken November 27-29, 2007, to provide information and advice on current status and trends, the impact of human activities on the species, possible alternatives and management measures to mitigate these impacts, and the potential for recovery.*

SUMMARY

- In May 2003, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed cusk as threatened. They are currently being considered for listing on Schedule 1 of the *Species at Risk Act (SARA)*.
- Cusk abundance has declined since the 1970s; however, there is insufficient data to determine the degree of decline and there is conflicting evidence on whether cusk abundance has continued to decline since the late 1990s.
- There has been no reduction in the range of cusk in Canadian waters. Cusk do not seem to have disappeared from any areas where they have been caught historically.
- Adult cusk prefer structured, hard bottom habitat and a depth range of 400 to 600m. The preferred habitat of juvenile cusk is not known.
- Given uncertainties associated with available abundance indicators, a recovery target for the abundance of cusk could not be precisely determined. With current information, a recovery target for cusk would likely be a stock of the size observed in the mid to late 1980s, prior to the large and abrupt decline in the indices of stock status available from that period. However, a reliable measure of the current magnitude of stock size relative to that period is

not available. Accordingly, a practical interim strategy would be to promote measures that result in an increasing trend in cusk abundance.
- A reasonable spatial target would be to maintain the current distribution of cusk.
- According to the population models used in this assessment and assuming that unreported bycatch and discards remain constant, commercial landings in 4X of about 200 mt would result in a 75% chance of observing at least a 50% increase in biomass after 15 years (1 generation), while 4X landings of about 600 mt would result in only about a 54% chance of observing at least a 50% increase in biomass after 15 years. These landings would have to be increased by 1.43 times to be applicable to the entire management area (4VWX + 5Zc).
- Fishing is the only known major source of human-induced mortality for cusk. Canadian cusk landings from 4VWX and 5Zc have ranged from 790 metric tonnes (mt) to 1490 mt between 1999 and 2006. The vast majority of these landings are from the groundfish longline fishery in 4X and 5Zc. Cusk are also known to be caught as bycatch in some lobster fisheries. Cusk mortalities in 2005/2006 lobster fisheries were estimated to be a minimum of 226 mt in Lobster Fishing Area (LFA) 34 and 22 mt in LFA 41.
- Habitat does not appear to be, nor is likely to become, a limiting factor to cusk survival and recovery. There are no known threats that have reduced cusk habitat quantity or quality.
- There are a number of uncertainties associated with this assessment. For example, survival of released cusk may be overestimated in the bycatch analysis for lobster fisheries in LFAs 34 and 41 as it only considers immediate condition and not long-term survival. In addition, not all sources of cusk fishing mortality have been accounted for, i.e., potential bycatch in lobster fisheries outside of LFAs 34 and 41, and other trap fisheries.

BACKGROUND

Rationale for Assessment

In 2003, cusk was designated as threatened by COSEWIC, largely on the basis of declines in the Fisheries and Oceans Canada (DFO) summer Research Vessel (RV) survey. Cusk are now being considered for addition to Schedule 1 of *SARA*. Should cusk be listed, the prohibitions of *SARA* would apply to cusk in Canadian waters. Activities that would harm individuals or jeopardize the recovery of the species would be prohibited and a recovery strategy and action plan would be required. Until a recovery strategy is available, Section 73(2) of *SARA* authorizes competent Ministers to permit otherwise prohibited activities affecting a listed wildlife species, any part of its critical habitat, or the residence of its individuals. Under Section 73(2) of *SARA*, authorizations may only be issued if:

(a) the activity is scientific research relating to the conservation of the species and conducted by qualified persons;
(b) the activity benefits the species or is required to enhance its chance of survival in the wild; or
(c) affecting the species is incidental to the carrying out of the activity.

Section 73(3) establishes that authorizations may be issued only if the competent minister is of the opinion that:

(a) all reasonable alternatives to the activity that would reduce the impacts on the species have been considered and the best solution has been adopted;
(b) all feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and
(c) the activity will not jeopardize the survival or recovery of the species.

Decisions made on permitting of incidental harm and in support of recovery planning need to be informed by the impact of human activities on the species, alternatives and mitigation measures to these activities, and the potential for recovery. An evaluation framework, consisting of three phases (species status, scope for human-induced harm, and mitigation) has been established by DFO to allow determination of whether or not *SARA* incidental harm permits can be issued. The analysis provided here will support decisions related to the listing of cusk and its recovery planning. In the context of this report, “harm” refers to all prohibitions as defined in *SARA*.

Species Biology and Ecology

Cusk is a solitary, sedentary, bottom-dwelling species found across the North Atlantic from the United States, north to Greenland, across to Iceland, Svalbard, along the Murmansk Coast, and south in the Northeast Atlantic to Ireland. It has also been found along the mid-Atlantic Ridge. In the northwest Atlantic, it has been caught from Cape Cod to Labrador though it is most common in the Gulf of Maine, Western Scotian Shelf, and northward along the edge of the Scotian Shelf to Banquereau Bank. It is rare in the Gulf of St. Lawrence and the inner Bay of Fundy.

Ichthyoplankton data and maturity studies indicate that spawning on the Scotian Shelf occurs from May to August and peaks in June, though port samplers have observed cusk in spawning condition as early as March. Cusk are considered to be quite fecund, with reports of 100,000 to 3,927,000 eggs from 56- and 90-cm fish, respectively. Eggs are buoyant, pelagic larvae are about 4 mm in length when hatched, and larvae migrate to the bottom when they reach approximately 50 mm in length.

Cusk otoliths, particularly those of larger specimens, are difficult to read. The oldest fish aged previously was estimated to be 20 years old. Recently, radiocarbon bomb dating methods have been used to estimate the age of cusk from Canadian waters. This ageing effort has returned older age estimates, including an 82 cm fish aged at 39 years (the longest reported cusk from Canadian waters is 118 cm). These new ageing data also suggest that cusk may reach maturity at 10 years, in contrast to previous estimates of 5-6 years. In 1966, length at 50% maturity was reported to be 43.5 cm for males and 50.7 cm for females. Studies are currently underway to determine if the length at maturity has changed.

The diet of cusk is not well known as their stomachs generally evert when they are brought to the surface. Limited sampling indicates a diet of crabs, shrimp, and other invertebrates. A variety of fish species have also been found in cusk stomachs. Cusk have been found in the diets of cod (*Gadus morhua*) and halibut (*Hippoglossus hippoglossus*).

ASSESSMENT

Current Status and Trends

At present, there is insufficient data to determine if there are **distinct populations** of cusk within Atlantic Canada. There are no discontinuities in the spatial distribution of cusk, and no studies have been undertaken to compare cusk life history throughout Canadian waters. In addition, data on egg and larval distributions from the Scotian Shelf Ichthyoplankton Program (SSIP) undertaken from 1976-1982 do not indicate recruitment pulses of multiple spawning components. Given a lack of information to suggest otherwise, cusk are assessed as a single unit in this report.

There are no estimates of absolute cusk **abundance** in Canadian waters. Indices of abundance from DFO and the autumn National Marine Fisheries Service (NMFS) bottom trawl surveys, commercial fishery catch rates, and industry surveys (halibut fixed station survey and 4VsW sentinel survey) are available (Figure 2). The bottom trawl survey indices show a substantial decline from the early 1970s to the early 1990s and subsequently fluctuated at low abundance without trend. While the decline shown by the bottom trawl surveys is considered to reflect a decline in population abundance, it is not thought to be proportional to total population abundance because the surveys do not sample the preferred habitat or depths of cusk. The industry surveys fluctuate without trend since they started in the mid to late 1990s. The industry surveys are considered to be proportional to total population biomass; however, concerns have been raised about the consistency of protocols during their conduct, including bait type and sample coverage. These abundance indices were not used in projecting population trajectory because they are short time series and lack contrast. The commercial fishery catch rates show a declining trend since 1986. While the catch rates are also considered proportional to total abundance, it is thought that management measures (e.g., trip limits, overall caps, and bycatch percentages) may have caused a reduction in catch rates. In summary, there was consensus that cusk abundance has declined since the 1970s; however, there is conflicting evidence regarding whether cusk abundance has continued to decline since the late 1990s. Considering all the caveats for the various indices of abundance, it was considered appropriate to base recovery potential on projections that use the intrinsic rate of growth for the cusk population estimated from the July – September 4X commercial groundfish longline fishery catch rate, which is only a small portion of the total longline fishery.

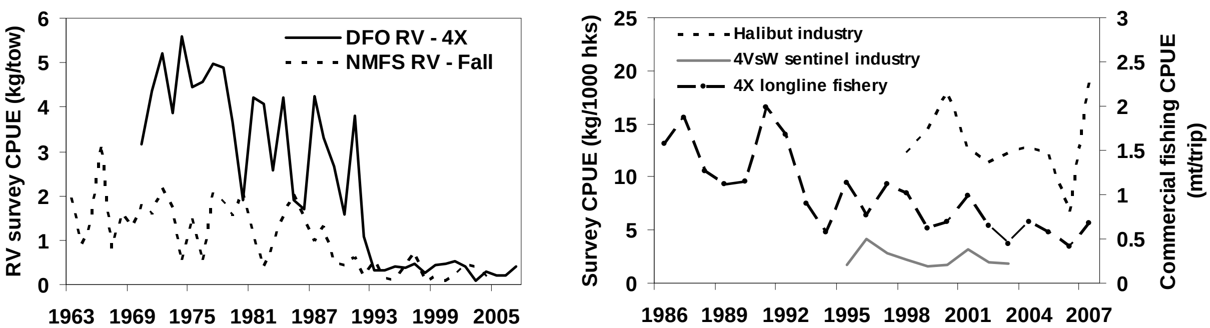

Figure 2. Catch rates in the research vessel (RV) surveys, industry surveys and the commercial groundfish longline fishery in 4X. DFO summer RV survey (for 4X only) and the NMFS Fall RV survey are plotted in the left panel. In the right panel, the halibut industry and 4VsW sentinel surveys are plotted against the left axis and the commercial longline index (July-September) is plotted against the right axis.

There has been no reduction in the **range** of cusk in Canadian waters. The percentage of stations where cusk were caught (Figure 3) in the halibut fixed station survey, which covers from the Grand Banks to the Gulf of Maine, has fluctuated without trend since it started in 1998. At a smaller scale, cusk are captured in most groundfish longline trips. Cusk are also caught regularly in lobster fisheries where these fisheries overlap with cusk distribution. There has been no change in the range or prevalence of cusk in the groundfish longline fishery in 4X (Figure 3). Cusk do not seem to have disappeared from any areas where they have been caught historically.

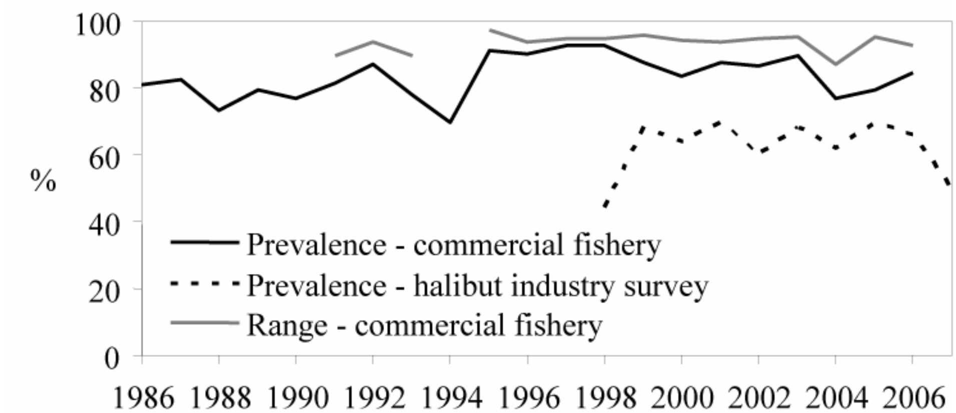

Figure 3. Percentage of commercial groundfish longline trips in 4Xnopq where cusk were caught (prevalence - commercial fishery), percentage of halibut industry survey stations which were sampled in all years where cusk were caught (prevalence - halibut industry) and percentage of 5 x 5 minute geographic blocks with groundfish longline effort in 4Xnopq where cusk were caught (range - commercial fishery).

Habitat Requirements and Residences

Adult cusk prefer structured, hard bottom **habitat**, including boulders, rocks or pebbles and coral. They are occasionally found on mud, but rarely on sand. Cusk have been reported from depths of 20 m to 1185 m. Preferred depth range is approximately 400 to 600 m based on high catch-per-unit-effort (CPUE) in the halibut fixed station survey. This type of habitat is found throughout the Scotian Shelf. The preferred habitat of juvenile cusk is not known. Habitat requirements for spawning are also unknown.

Cusk's **primary habitat** can be found in the Gulf of Maine, Western Scotian Shelf, and Slope. However, the total amount of cusk habitat in Canadian waters, including areas of low abundance, is much greater than this. The minimum amount of habitat required for cusk survival and recovery is not known.

SARA defines **residence** as:

> "A *dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating*."

Cusk do not have any known dwelling-place similar to a den or nest during any part of their life cycle.

Targets for Recovery

There are no reliable estimates for the historical or current absolute abundance of cusk. Given the uncertainties associated with all available abundance indicators, recovery targets for cusk abundance were discussed but could not be precisely described. With current information, a recovery target for cusk would likely be a stock of the size observed in the mid to late 1980s, prior to the large and abrupt decline in the indices of stock status available from that period. However, a reliable measure of the current magnitude of stock size relative to that period is not available. Accordingly, a practical interim strategy would be to promote measures that result in an increasing trend in cusk abundance (e.g., regulating relative fishing mortality). In addition, further work is required to develop and calibrate an index that would provide reliable information on the state of cusk stock status in the past, present and future. Such an index should allow comparison with stock status in the 1980s, the current standard for a recovery target.

There is no evidence of a reduction in cusk area occupied. A reasonable target would be to maintain current distribution.

Population Trajectory Under Varying Conditions

Population projections are based upon a surplus production model fit to the 4X commercial longline CPUE from 1986 to 2007, during the July-September fishing period only. Fishing mortality was incorporated in the model using all commercial landings of cusk within 4X. The influence of different levels of exploitation on the probability of an increase in population biomass is explored using the median estimate of the intrinsic rate of population growth (r = 0.154) from the model. This assumes that the discard mortality rate remains constant.

Projections are inherently uncertain due to the stochastic nature of many population and environmental processes; however, projections can provide probabilistic outcomes under different harvest scenarios. For example, assuming that unreported bycatch and discards remain constant over the period, commercial landings in 4X of about 200 mt would result in a 75% chance of observing at least a 50% increase in biomass after 15 years (1 generation), while landings of about 600 mt would result in only about a 54% chance of observing at least a 50% increase in biomass after 15 years (Figure 4). From 2003-2006, cusk landings in 4X accounted for an average of 70% (60-79%) of the total reported cusk landings. If we assume that mortality and growth are similar across the entire management area, then cusk landings in 4VWX and 5Zc would have to be in the order of 1.43 times the value extracted from Figure 4.

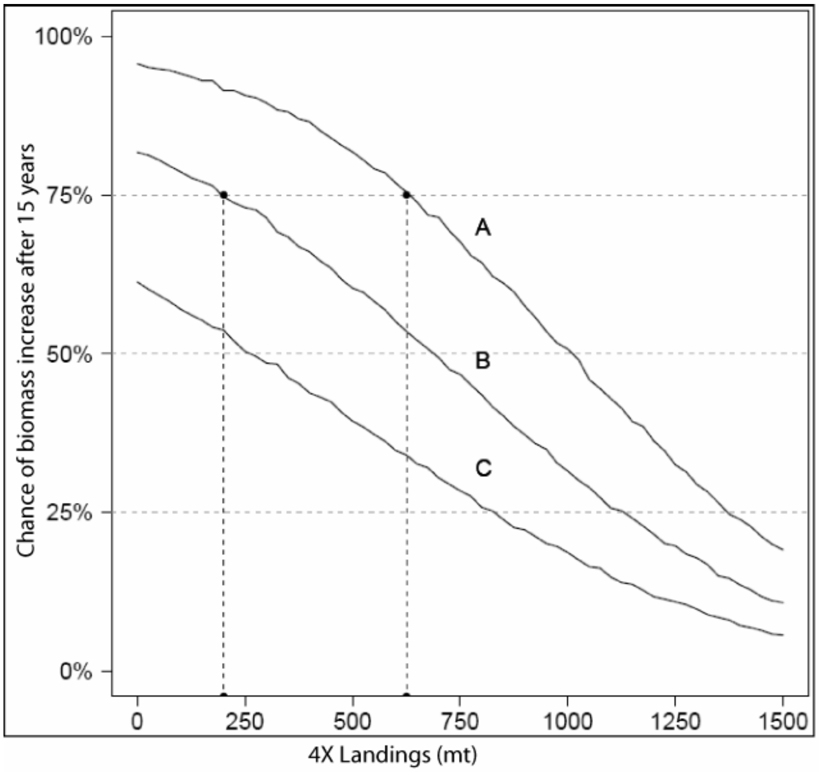

Figure 4. Forecasts of cusk recovery scenarios after 15 years (1 generation). Forecast results are presented as the probability of (A) no further decline in biomass, (B) at least a 50% increase in biomass and (C) at least a 100% increase in biomass. For example, to obtain a 75% chance of obtaining at least a 50% increase in biomass, 4X landings would have to be ~200mt. These forecasts assume that unreported bycatch and discards remain constant over the 15 year period.

Sources of Mortality

Fishing is the only known major source of human-induced mortality on cusk. In the COSEWIC report, bycatch in the cod, haddock, pollock, and halibut longline fisheries is mentioned specifically for Canadian waters. Some individual harvesters target cusk.

Cusk **landings** from 4VWX and 5Zc have ranged from 790 mt to 1490 mt between 1999 and 2006 (Table 1). Landings have been below 1000 mt since 2004. For years in which cusk closures were implemented (2003 and 2007), unreported fishing mortality of cusk due to discarding is considered to be very likely.

Table 1. Cusk reported landings in metric tonnes by gear type from 4VWX and 5Zc. A bycatch cap of 1000 mt for NAFO divisions 4VWX was first implemented in 1999 for fixed gear. In 2003 this cap was reduced to 750 mt for 4VWX and 5Zc for fixed gear where it has remained since. Data are to November 2007 only.

Quota Yr	Longline	Bottom Trawl	Gillnet	Handline	Total
1999	1117	39	16	5	1177
2000	977	29	16	9	1031
2001	1431	39	17	4	1490
2002	1225	38	13	3	1279
2003*	1019	28	13	3	1063
2004	779	32	6	1	818
2005	773	24	6	1	804
2006	761	22	5	3	790
2007**	899	12	6	0	918

** -- December 1, 2003, cusk closures for certain verssel classes of longliner*
*** --September 26, 2007, cusk closures for certain vessel classes of longliner*

Discarded bycatch in invertebrate fisheries is not routinely reported. Since the 2003 COSEWIC report, cusk **mortality in the LFA 34 and LFA 41 lobster fisheries** has been estimated based on observations of commercial fishing trips. Discard mortality rate was estimated to be 49% in LFA 34 and 86% in LFA 41. Minimum cusk mortality in 2005/2006 was estimated to be 226 mt in LFA 34 and 22 mt in LFA 41 (Table 2).

Table 2. Estimated bycatch and immediate mortality of cusk in the lobster fisheries of LFAs 34 and 41 in metric tonnes.

	LFA 34		LFA 41	
	Bycatch	Mortality	Bycatch	Mortality
2005/2006	461	226	25	22[1]
2006/2007	344	169	-	-

The fishing mortality of cusk in other lobster fishing areas and other invertebrate fisheries is not known at this time. However, it is expected that some mortality of cusk does occur in other fisheries that overlap spatially with areas occupied by cusk and that use gear types to which cusk are susceptible, including baited hooks and traps.

The southern range for the population extends into US waters, thus US fishing removals represent a potential source of mortality.

Habitat-Related Threats

Habitat does not appear to be, nor is likely to become, a limiting factor to cusk survival and recovery. There are no known threats that have reduced cusk habitat quantity or quality.

Measures to Increase Productivity or Survivorship

Given current knowledge, there are no technically feasible activities that would be expected to increase cusk productivity.

[1] *ERRATUM*: The original Science Advisory Report (July 2008) listed this number as 25. This was incorrect.

Mitigation Measures and Alternatives

Examples of mitigation measures that could be implemented to improve the likelihood of survival and recovery of cusk include:

- closed areas
- gear modifications
- effort reductions
- quotas
- reductions in bycatch and trip limits
- increased observer coverage
- changes in bait type
- education and stewardship

This is not considered to be an exhaustive list of possible mitigation measures and no alternatives to activities have been considered. The effectiveness of these measures was not evaluated.

Sources of Uncertainty

The preferred habitat of juvenile cusk is not known. Human impacts on the quality of preferred cusk habitat are unknown.

Survival of released fish may be overestimated in the bycatch analysis for lobster fisheries in LFAs 34 and 41 because it only considers condition upon their release and not their long-term survival.

Not all sources of fishing mortality have been accounted for, i.e., lobster fisheries outside of LFAs 34 and 41, and other trap fisheries.

Recovery projections are based upon a model that was fit to an index (July – September 4X longline CPUE that does not include all fleet components or seasons) which showed a continuing decline. This decline is uncertain given recent management measures that restrict trip catch limits. The lack of age disaggregated data made it necessary to use a model that did not include age-specific effects of natural mortality, fishing mortality, recruitment, and somatic growth. Furthermore, population projections are inherently uncertain due to the stochastic nature of many population and environmental processes. There are reasons to believe that the median estimate of intrinsic growth ($r = 0.154$) may be underestimated in the current model since not all sources of mortality have been included. If we had a better understanding of all sources of mortality and were, therefore, better able to address these sources of mortality within modeling and management, there could be improved scope for cusk recovery.

Limited biological information and concerns over the reliability of the abundance index adds uncertainty to the projections as well as to the status of the species.

CONCLUSIONS AND ADVICE

Cusk **abundance** has declined since the 1970s; however, there is insufficient data to determine the degree of decline and there is conflicting evidence on whether cusk abundance has continued to decline since the late 1990s. It is unlikely that this conflict will be resolved in the near future. The ability to detect future trends in abundance is limited by current monitoring programs. As additional biological information and a more precise biomass index become available, these should be used to revise projections.

At present, there is no evidence to suggest that there are **distinct populations** of cusk within Atlantic Canada. In addition, there has been no reduction in the range of cusk in Canadian waters. Cusk do not seem to have disappeared from any areas where they have been caught historically. Adult cusk prefer structured, hard bottom **habitat**, including boulders, rocks or pebbles, and coral. Preferred depth range is approximately 400 to 600 m. The preferred habitat of juvenile cusk is not known.

Given uncertainties associated with available abundance indicators, a **recovery target** for the abundance of cusk could not be precisely determined. With current information, a recovery target for cusk would likely be a stock of the size observed in the mid to late 1980s, prior to the large and abrupt decline in the indices of stock status available from that period. However, a reliable measure of the current magnitude of stock size relative to that period is not available. Accordingly, a practical **interim strategy** would be to promote measures that result in an increasing trend in cusk abundance. Further work is required to develop and calibrate an index that would provide reliable information on the state of cusk stock status in the past, present and future. Such an index would allow comparison with stock status in the 1980s. A reasonable **spatial target** would be to maintain the current distribution of cusk.

Population projections provide probabilistic outcomes under different harvest scenarios. Projections for cusk were based upon a surplus production model fit to the 4X commercial longline CPUE. For example, assuming that unreported bycatch and discards remain constant over the period, commercial landings in 4X of about 200 mt would result in a 75% chance of observing at least a 50% increase in biomass after 15 years (1 generation), while 4X landings of about 600 mt would result in only about a 54% chance of observing at least a 50% increase in biomass after 15 years. These landings would have to be increased by 1.43 times to be applicable to the entire management area (4VWX + 5Zc).

Fishing is the only known major source of **human-induced mortality** on cusk. Although mortality in the fisheries with the highest impact on cusk has been estimated, there are others that may result in bycatch for which there is no information, such as red crab, jonah crab, and the lobster areas outside LFAs 34 and 41. It is recommended that additional data, such as those recorded by the Observer Program, be collected in order to quantify the fishing mortality in these fisheries.

Habitat does not appear to be, nor is likely to become, a limiting factor to cusk survival and recovery. There are no known threats that have reduced cusk habitat quantity or quality. While loss of habitat has been a concern for other species, fishing mortality is considered to be the major threat for this species.

There are a number of **uncertainties** associated with this assessment. For example, survival of released cusk may be overestimated in the bycatch analysis for lobster fisheries in LFAs 34 and 41 as it only considers immediate condition and not long-term survival. In addition, not all sources of cusk fishing mortality have been accounted for, i.e., potential bycatch in lobster fisheries outside of LFAs 34 and 41, and other trap fisheries. There are reasons to believe that the median estimate of intrinsic growth (r = 0.154) may be underestimated in the current model since not all sources of mortality have been included. If we had a better understanding of all sources of mortality and were, therefore, better able to address these sources of mortality within modeling and management, there could be improved scope for cusk recovery.

SOURCES OF INFORMATION

COSEWIC, 2003. COSEWIC Assessment and Status Report on the Cusk, *Brosme brosme,* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.

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