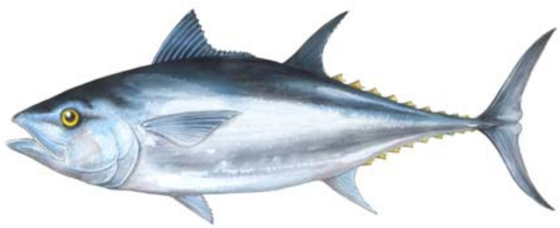
RECOVERY POTENTIAL ASSESSMENT FOR WESTERN ATLANTIC BLUEFIN TUNA (*THUNNUS THYNNUS*) IN CANADIAN WATERS



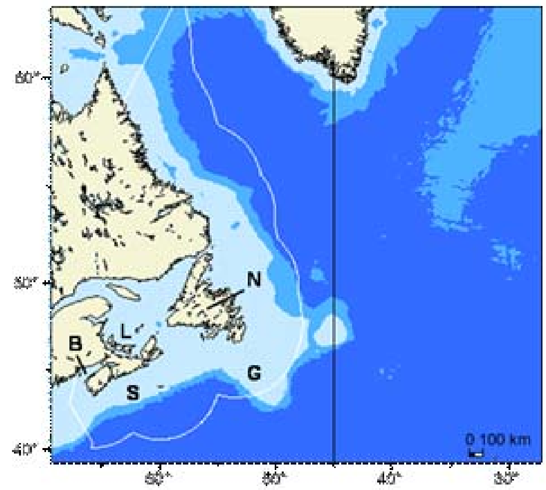


Figure 1: Areas mentioned in text. Black line represents the International Commission for the Conservation of Atlantic Tunas management unit boundary between eastern and western Atlantic stocks (45º W), white line represents boundary of Canada's Exclusive Economic Zone and L= Gulf of St. Lawrence, N= Newfoundland, G=Grand Banks, S=Scotian Shelf, and B=Bay of Fundy.

Context:

When the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designates an aquatic species as Threatened or Endangered, Fisheries and Oceans Canada (DFO), as the responsible jurisdiction under the Species at Risk Act (SARA), is required to undertake a number of actions. Many of these actions require scientific information on the current status of the species, population or designable unit, threats to its survival and recovery, and the feasibility of its recovery. Formulation of this scientific advice has typically been developed through a Recovery Potential Assessment (RPA) that is conducted shortly after the COSEWIC assessment. This timing allows for the consideration of peer-reviewed scientific analyses into SARA processes including recovery planning.

In May 2011, COSEWIC determined that Atlantic bluefin tuna in the western Atlantic (Figure 1) was Endangered. The reason for the designation is that the current abundance of spawning individuals is the lowest observed and the abundance of spawning fish has declined by 69% over the past 2.7 generations. COSEWIC concluded that the cause of the decline, overfishing, has not ceased and that it is not clearly reversible. This RPA provides information and scientific advice required to meet various requirements of the SARA*, including public consultations, decisions regarding the listing of western Atlantic bluefin tuna in Canadian waters under the Act, and developing a recovery strategy should the species be legally listed.*

SUMMARY

- Atlantic bluefin tuna migrate seasonally to Canadian waters between July and December with occurrences on the Scotian Shelf, in the Gulf of St. Lawrence, in the Bay of Fundy, and off Newfoundland with considerable variation from one year to the next as a result of interactions between biological factors and environmental variations.
- Atlantic bluefin tuna migration and aggregation are related to oceanographic fronts and to the distribution of their prey.
- Spawning stock biomass (SSB) shows an initial steep and steady decline from 1970 to the mid-1980s and relative stability since then; with indications of a possible slight increase in recent years.
- Under the International Commission for the Conservation of Atlantic Tunas (ICCAT) low recruitment scenario, western Atlantic bluefin tuna is not overfished; under the ICCAT high recruitment scenario western Atlantic bluefin tuna is overfished.
- Fishery catch per unit of effort (CPUE) information indicates that local abundance of Atlantic bluefin tuna off southwestern Nova Scotia and in the southern Gulf of St. Lawrence is high in recent years.
- The proposed recovery target for abundance is to increase spawning stock biomass compared to 2012. ICCAT projections suggest that the 2025 SSB would be equal to or larger than the 2012 SSB for total allowable catches (TACs) of 2,250 metric tonnes (mt) or less.
- The proposed distribution target for recovery is to maintain habitat conditions allowing for a broad distribution in Canadian waters.
- The National Marine Fisheries Service (NMFS) of the USA concluded that there is a low probability of extinction at the TAC agreed for 2011 and 2012 (1,750 mt).
- Fishing is the only documented source of human induced mortality. Other potential sources are anthropogenic noise and oil and gas exploration and exploitation.
- Potential threats to habitat include overfishing of prey species, global climate change, and anthropogenic noise.
- Feasible mitigation measures to minimize the threat posed from fishing could include a reduction or elimination of landings of Atlantic bluefin tuna in directed fisheries or as a bycatch in other fisheries, and measures to increase the post-release survival of any Atlantic bluefin tuna released.
- Given that the proposed recovery target is an increase in SSB compared to 2012, maximum allowable harm was agreed to be the maximum removals by the fishery that would still result in the SSB in 2025 being greater than the SSB in 2012.

BACKGROUND

Rationale for Assessment

In May 2011, Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determined that Atlantic bluefin tuna (*Thunnus thynnus*) in Canadian waters was Endangered. The reason for the designation is that the current abundance of spawning individuals is the lowest observed and the abundance of spawning fish has declined by 69% over the past 2.7 generations (about 40 years). COSEWIC concluded that the cause of the decline, overfishing, has not ceased and that it is not clearly reversible.

As part of the Recovery Potential Assessment (RPA) process, scientific information is needed to support the development and assessment of social and economic cost and benefits of potential management scenarios for recovery to better inform public consultations and to support other entities involved in the decision of whether to add the species to Schedule 1 of the *Species at Risk Act* (*SARA)*. If it is legally listed, the information will be used to develop a recovery strategy.

Species Biology and Ecology

Atlantic bluefin tuna is a very large species (the all-tackle angling record is a 679 kg fish of 304 cm fork length taken off Aulds Cove, Nova Scotia in 1979). Atlantic bluefin tuna in the western Atlantic ranges from Newfoundland to the Caribbean, Venezuela and Brazil. In the eastern Atlantic, Atlantic bluefin tuna occurs from the Lofoten Islands, off northern Norway, south to the Canary Islands and into the Mediterranean and Black seas.

Atlantic bluefin tuna are pelagic, highly migratory, and they have a broad diet. They migrate seasonally to Canadian waters between July and December to feed. Fisheries occur on the Scotian Shelf, in the Gulf of St. Lawrence, in the Bay of Fundy, and off Newfoundland (Figures 1, 2). The occurrence and abundance of Atlantic bluefin tuna in any one of these locations have varied considerably in the past and continue to do so for a combination of reasons including the size of the stock, oceanographic conditions, and prey distribution, all of which influence the location of catches. The perception of distribution and range is measured primarily by the distribution of fishing effort (Figure 2), but some information is also available from electronic tagging experiments in recent years (Figure 3).

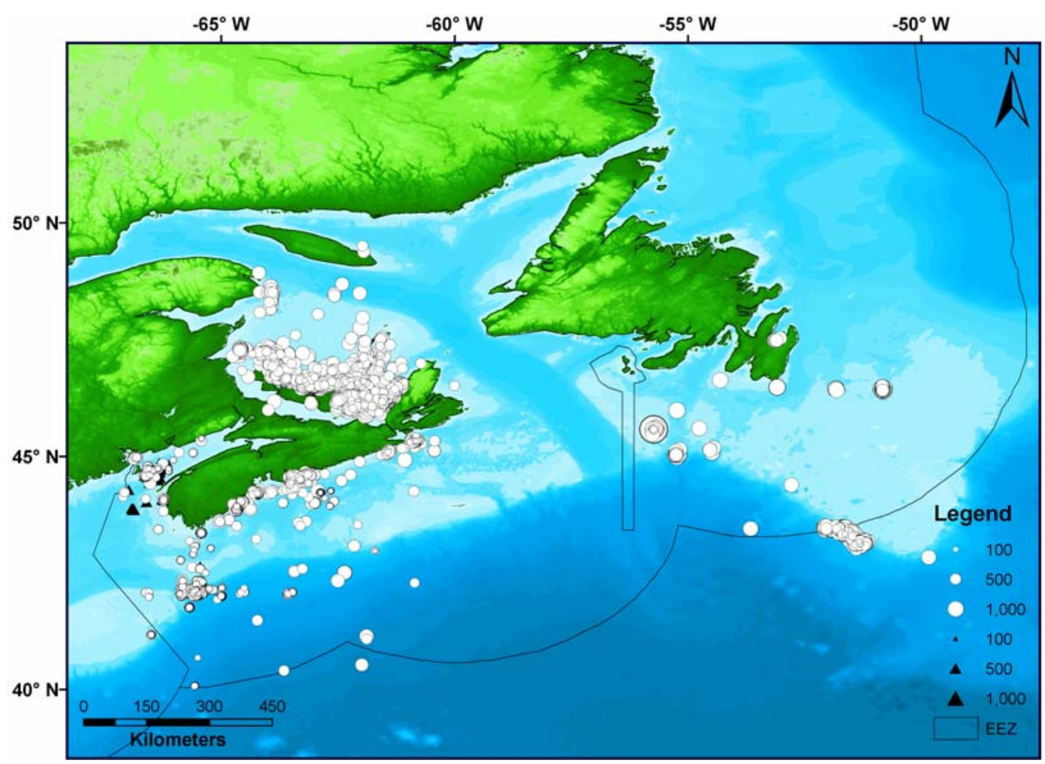


Figure 2: Location and landed weight (lbs) of Canadian Atlantic bluefin tuna catches by gear from logbook records from 2000-2009. White circles represent hook and line and black triangles represent electric harpoon. The size of the circles/triangles is proportional to the landed weight. The black line represents the boundaries of the Exclusive Economic Zones (EEZ).

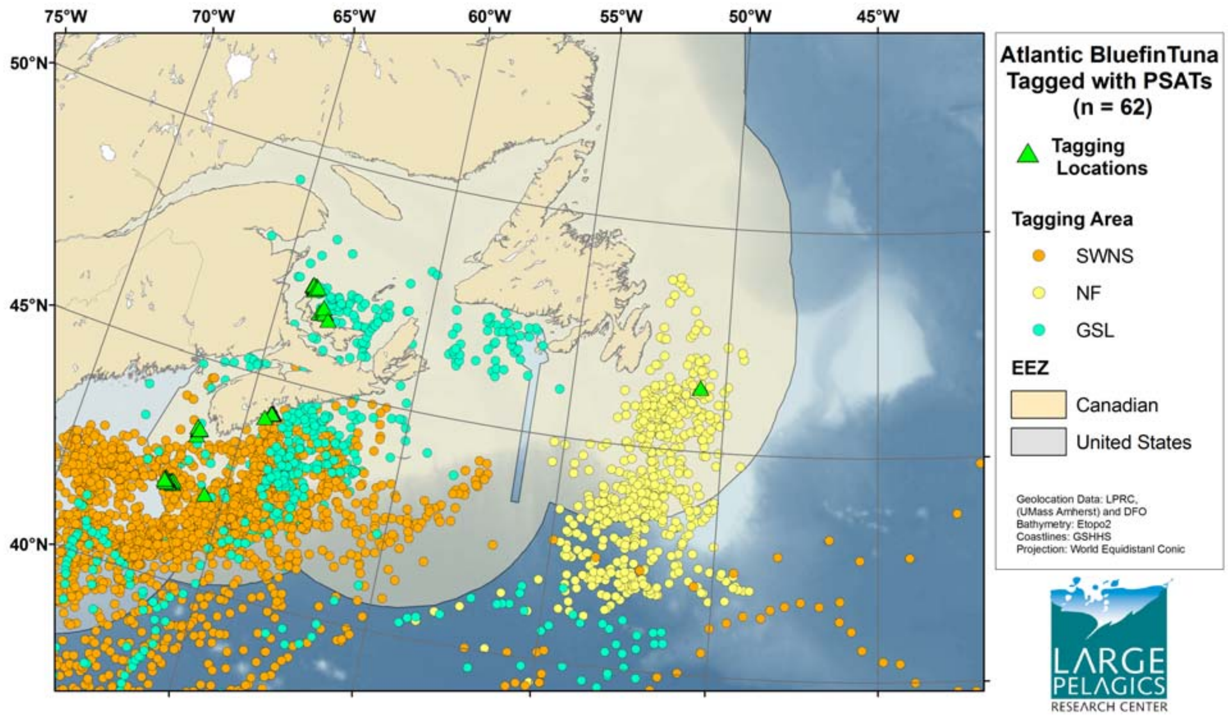


Figure 3: Daily geolocation estimates of 62 Atlantic bluefin tuna tagged off the Canadian Atlantic provinces from 2005 to 2009. Tagging areas were southwestern Nova Scotia (SWNS), the Gulf of St. Lawrence (GSL) and the Grand Banks of Newfoundland (NF). Position information was estimated using sea surface temperature inclusive of Kalman filtering and bathymetric correction. Exclusive Economic Zone (EEZ) boundaries show residency and cross boundary movements of tagged Atlantic bluefin tuna. (Lutcavage et al. unpublished data; permission for use outside the context of this RPA requires the permission of the authors.)

At least two main spawning groups exist: a considerably larger component in the Mediterranean and a smaller one in the Gulf of Mexico. Spawning may occur elsewhere in the western Atlantic as larvae and mature individuals have also been found in the Bahamas and Straits of Florida in suitable water temperatures at the time of spawning.

Fisheries on Atlantic bluefin tuna are managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT) on the basis of a two-stock hypothesis, separated by 45°W, but fish of western origin are caught east of 45°W and *vice versa*. Canadian fisheries harvest mainly large fish (>150 cm fork length) which are primarily western origin Atlantic bluefin tuna. There is no information suggesting that Atlantic bluefin tuna in Canadian waters should be divided into substocks or subpopulations.

ICCAT assumes that western origin Atlantic bluefin tuna are mature at 9 yrs of age. Age at maturity in the eastern stock is estimated to be 4 to 5 years of age. No new information was available to compare changes in growth rates or size at age over time. Natural mortality rate is estimated at 0.14 and generation time is estimated to be 15 years. Recent studies documented decreases in the somatic condition of Atlantic bluefin tuna from the late 1990s through 2005 in the Gulf of St. Lawrence (it increased in 2006 and has varied slightly though 2007, 2008, and 2009) (Paul *et al.* 2011) and Gulf of Maine (Golet *et al.* 2007). The 14-year period of decline in Atlantic bluefin tuna condition observed in the Gulf of Maine was mirrored in large herring size classes (Golet *et al*. unpublished data; Golet 2010). The reasons for the decline in condition are unknown, but the trend has reversed.

ASSESSMENT

Trends and Current Status

The Standing Committee on Research and Statistics (SCRS) of ICCAT conducts Atlantic bluefin tuna stock assessments every second year, and two stocks are assumed – eastern and western Atlantic (Figure 1). The most recent assessment was completed in 2010 (Anon 2011a, b) and the next one is planned for 2012.

Spawning stock biomass (SSB) shows an initial steep and steady decline from 1970 to the mid-1980s and relative stability since then; with indications of a possible slight increase in recent years (Figure 4, upper panel). SSB is estimated to have peaked at 51,500 mt in 1973, declined to about 15,000 mt in 1985 and remained relatively stable since then with the 2009 SSB estimated at 14,000 mt. Total abundance (age 1 and older) estimated in the most recent assessment was at its maximum in 1970 (1.3 million individuals) and the most recent estimate (2009) is slightly above 300,000 individuals (Figure 4, lower panel).

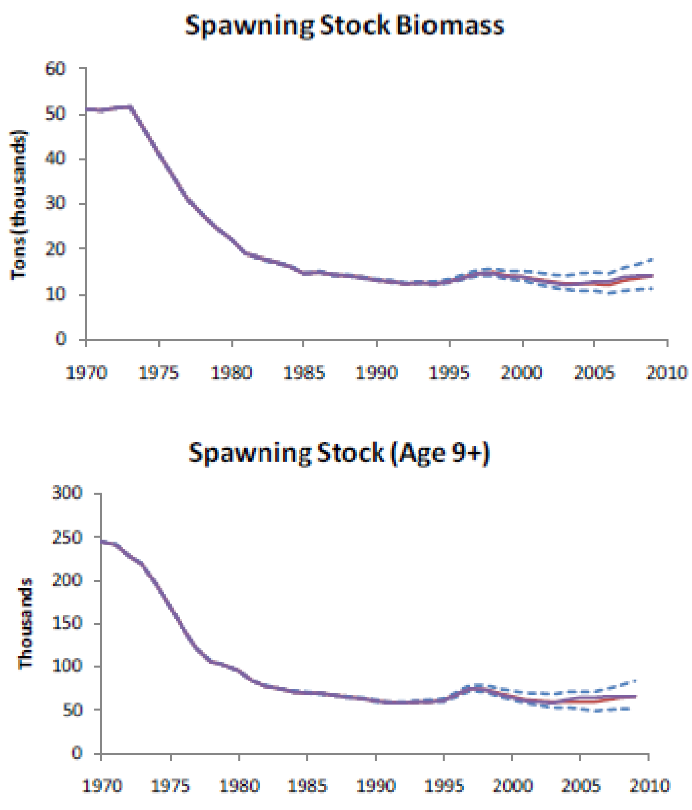


Figure 4: Median estimates of western Atlantic bluefin tuna spawning stock biomass (upper panel) and spawning stock numbers (age 9+) (lower panel) for the ICCAT base case virtual population analysis (VPA). The 80% confidence intervals are indicated with dashed lines. The recruitment estimates for the last three years have been replaced by the median (red line). (*Figure 53 from Anon. 2011b.)*

ICCAT has consistently used 1970 to the present as the assessment period on the basis that more data were available for that period. Fewer data are available for earlier years. In 2008, as a sensitivity analysis to the base case, ICCAT made a run starting in 1960; the results (Figure 5) show that biomass was lower in the early 1960s compared to 1970 (Anon. 2009).

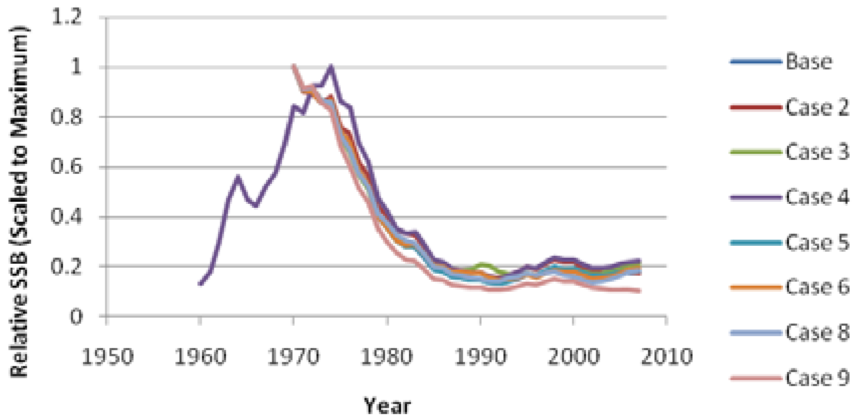


Figure 5: Trends in western Atlantic bluefin tuna relative spawning stock biomass shown for various scenarios explored by the ICCAT SCRS during their 2008 assessment (Figure 35 from Anon 2009), along with the base case. Case 4 extended the time series back to 1960.

Fishery catch per unit of effort (CPUE) information indicates that local abundance of Atlantic bluefin tuna off southwestern Nova Scotia and in the southern Gulf of St. Lawrence is high in recent years (Figure 6).

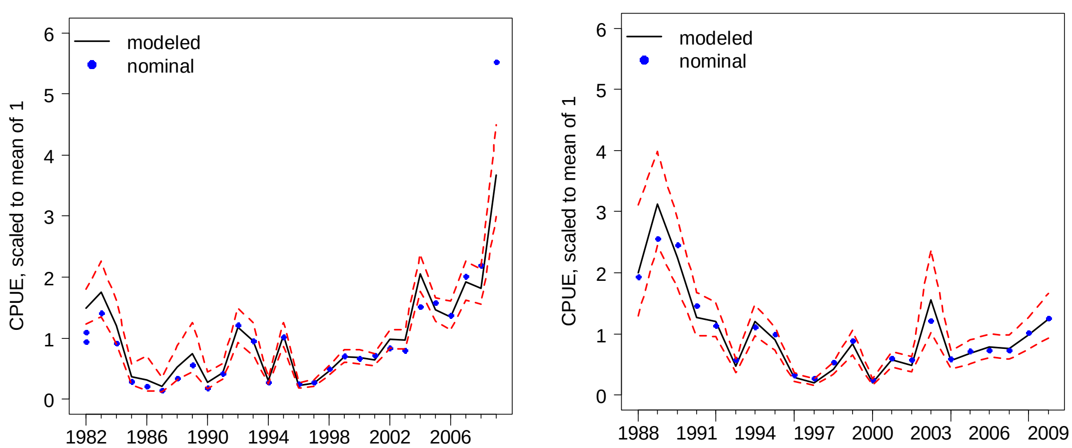


Figure 6: The standardized and nominal catch per unit effort (CPUE) (fish/h) for the southwestern Nova Scotia bluefin tuna fishery (right) and the Gulf of St. Lawrence bluefin tuna fishery (left) with 95% confidence intervals (Figures 21 and 31 from Paul et al. 2011).

In Canadian waters the range of Atlantic bluefin tuna extends from Georges Bank, into the Bay of Fundy, along the Scotian Shelf, in the Gulf of St. Lawrence, and to the Grand Banks of Newfoundland and extends from coastal waters to the boundary of Canada's Exclusive Economic Zone. There is no evidence that range has been reduced.

The objective of ICCAT is to maintain or restore species/stocks to biomasses that can produce the maximum sustainable yield (MSY) (Anon. 2007). For western Atlantic bluefin tuna, ICCAT's objective is to recover the stock to the biomass at MSY with at least a 50% probability by 2018 (Anon 2011b). The 2010 SCRS assessment estimates recent exploitation rates as the average of the fishing mortality rate (F) from 2006 to 2008 relative to F_{MSY}. MSY reference points were calculated assuming two recruitment scenarios reflecting different productivity. F_{MSY} = 0.16 under the low recruitment scenario and F_{MSY} = 0.06 under the high recruitment scenario. Under the low recruitment scenario, where lower productivity due to unknown changes in the ecosystem is assumed since 1975, $F_{2006\text{-}2008}/F_{MSY}$ is 0.73 (80% confidence interval (CI) is 0.59-

0.91). Thus, under the low recruitment scenario, western Atlantic bluefin tuna is not overfished. Under the high recruitment scenario, where productivity is assumed not to have changed, $F_{2006-2008}/F_{MSY}$ is 1.88 (80% CI is 1.49-2.35) implying western Atlantic bluefin tuna is overfished. $F_{2006-2008}$ is the same under both recruitment scenarios.

SSB_{MSY} estimated under the high recruitment scenario (92,000 mt), is considerably higher than the maximum observed SSB (1973) of approximately 51,500 mt; on the other hand under the low recruitment scenario current SSB is above B_{MSY}.

While the ICCAT SCRS considers the 2 recruitment scenarios to be equally likely, ICCAT has made its management decisions assuming the low recruitment scenario since 1999.

Habitat and Residence Requirements

As indicated above, Atlantic bluefin tuna migrate seasonally to Canadian waters between July and December with occurrences on the Scotian Shelf, in the Gulf of St. Lawrence, in the Bay of Fundy, and off Newfoundland with considerable variation from one year to the next as a result of interactions between biological factors and environmental variations (Figures 1, 2, 3). They mainly live in the pelagic ecosystem of the entire North Atlantic and its adjacent seas and is one of the only large pelagic fish living permanently in temperate Atlantic waters. Atlantic bluefin tuna can sustain cold as well as warm temperatures while maintaining a stable internal body temperature and they frequently dive to depths of 500 m to 1,000 m. The distribution of Atlantic bluefin tuna is expected to be closely related to that of its prey. Both juveniles and adults are opportunistic feeders. On the northwestern Atlantic shelf, adult Atlantic bluefin tuna target high-lipid content prey, primarily Atlantic herring, mackerel, saury, and capelin, but their diet also includes squid, sandlance, haddock, krill, whiting, butterfish, and spiny dogfish (Chase 2002; Estrada *et al*. 2005; Golet *et al*. 2007; Logan *et al.* 2011). In Canadian waters, herring and mackerel are believed to be the primary prey of Atlantic bluefin tuna. The estimated recent declines in some prey species, notably Atlantic mackerel, do not seem to have influenced the distribution, range and availability of Atlantic bluefin tuna in Canadian waters.

Tuna migration and aggregation are related to oceanographic fronts (Nakamura 1969) and to the distribution of their prey. In coastal areas, aerial surveys have shown that Atlantic bluefin tuna schools are more abundant within 10 to 25 km of sea surface temperature fronts (Royer *et al.* 2004; Schick *et al*. 2004), but the presence of prey had a higher explanatory value (Schick and Lutcavage 2009).

If the distribution of Atlantic bluefin tuna is closely associated with prey distribution, as suggested above, prey could be considered a component of habitat.

The *Species at Risk Act* 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".*

As such, the concept of residence does not apply to Atlantic bluefin tuna whilst in Canadian Atlantic waters.

Recovery Targets and Time Frame for Recovery

The results of ICCAT's 2010 assessment show an initial steep and steady decline SSB from 1970 to the mid-1980s and relative stability since then; with indications of a possible slight increase in recent years (Figure 4).

The proposed recovery target for abundance is to increase spawning stock biomass compared to 2012. ICCAT's medium term projections are provided (Figure 7) for various catch scenarios. These suggest that the 2025 SSB would be equal to or larger than the 2012 SSB for catches of 2,250 mt or less. Fishing at F_{MSY} would result in decreasing SSB towards SSB_{MSY}.

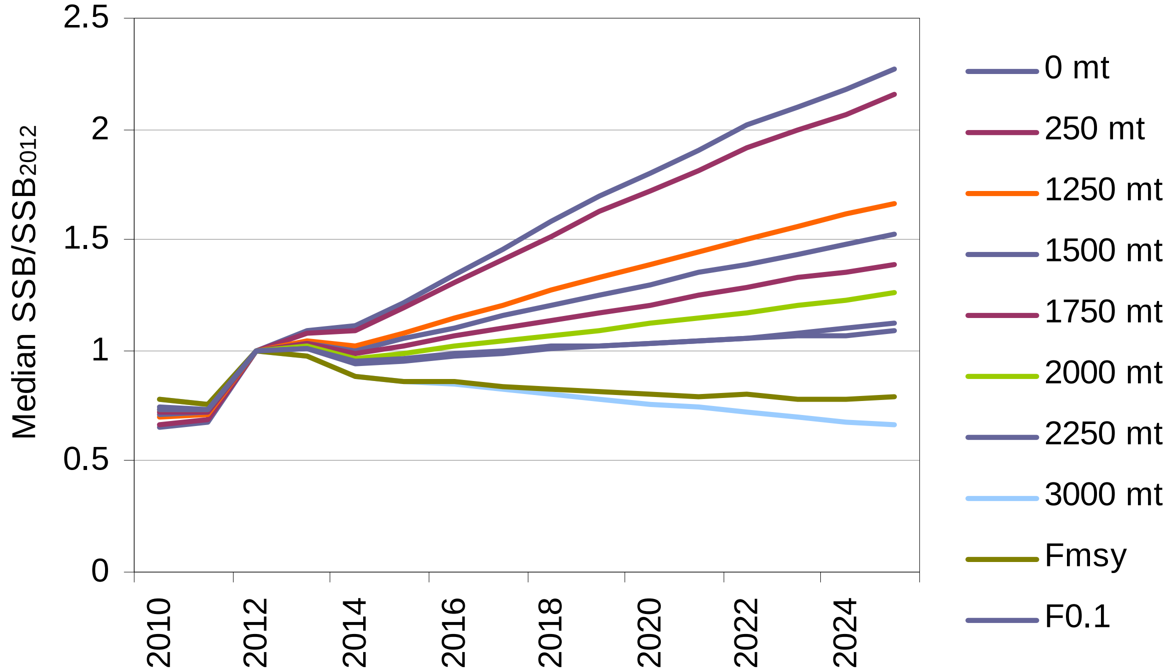


Figure 7: Western Atlantic bluefin tuna projection results relative to 2012 under various catch scenarios, low recruitment hypothesis (from Anon. 2011b). These approximate the following mitigation scenarios: 0 mt - no catch in the western Atlantic; 250 mt - bycatch only by all in the western Atlantic; 1,250 mt - no Canadian catch, others status quo catches in the western Atlantic; 1,500 mt - ½ Canadian catch, others status quo catches in the western Atlantic; 1,750 mt - current western Atlantic total allowable catch; 2,250 mt - 2010 ICCAT scientific advice.

The National Marine Fisheries Service (NMFS) of the USA has recently reviewed the status of Atlantic bluefin tuna (Atlantic Bluefin Tuna Status Review Team 2011) and made longer term projections looking at the probability of extinction (where the number of spawners is reduced to less than two fish) under various catch scenarios. The results show a low probability of extinction at the total allowable catch (TAC) agreed for 2011 and 2012 (1,750 mt).

Table 1: Forecasted probability that the western Atlantic bluefin tuna distinct population segment will go extinct by year and catch level, assuming the ICCAT high and low recruitment potential scenarios are equally plausible (from Atlantic Bluefin Tuna Status Review Team 2011). Current management recommendations under ICCAT specify a TAC of 1,750 mt.

Catch Level (mt)	**Probability of Extinction**							
	2010	**2011**	**2020**	**2030**	**2040**	**2050**	**2060**	**2100**
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1250	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1500	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
1750	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02
2000	0.00	0.00	0.00	0.01	0.02	0.03	0.05	0.05
2250	0.00	0.00	0.00	0.01	0.04	0.08	0.12	0.15
2500	0.00	0.00	0.00	0.02	0.09	0.19	0.25	0.30
2750	0.00	0.00	0.00	0.04	0.20	0.34	0.42	0.54
3000	0.00	0.00	0.00	0.07	0.33	0.51	0.62	0.78
3500	0.00	0.00	0.00	0.18	0.63	0.84	0.91	0.95
4000	0.00	0.00	0.00	0.35	0.85	0.96	0.98	0.99
5000	0.00	0.00	0.00	0.73	0.99	1.00	1.00	1.00

There is no evidence that the range of Atlantic bluefin tuna in Canadian waters has decreased. Recognizing that local Atlantic bluefin tuna distribution is ephemeral as it is linked to their prey distribution and oceanographic features and that they spend only a portion of their time in Canadian waters, the proposed distribution target for recovery is to maintain habitat conditions allowing for a broad distribution in Canadian waters. However, it is notable that the main source of data to evaluate distribution is fisheries data (Figure 2). Fishing locations are influenced by factors other than fish distribution (*e.g.,* fuel prices, market demands, management regimes) and, therefore, do not reflect the entire range Atlantic bluefin tuna in Atlantic Canada.

Sources of Human Induced Mortality and Harm

COSEWIC (2011) identifies overfishing as the single largest threat to the western population of Atlantic bluefin tuna. In Canada the fishery includes commercial harvest (tended line, rod and reel, electric harpoon, and trapnet) and charter boats (rod and reel) as well as a directed harvest by one offshore longline vessel. There are also some incidental catches and mortalities in other fisheries including: pelagic longline fisheries for swordfish, sharks, and other tunas (bigeye tuna, albacore, and yellowfin tuna collectively referred to as other tunas) (approximately 30 to 40 mt per year), as well as in trap, weirs, gillnets, and purse seine fisheries for small pelagics. This incidental catch and associated mortality are presumed to be small. Since 1982, western Atlantic bluefin tuna has had strict catch limits established by ICCAT with the aim of allowing the stock to increase yet the assessment does not show increases to the extend intended. This could be due to increased mortality of western Atlantic bluefin tuna east of 45^{o}W or changes in productivity. Canada has been in compliance with these measures. Canadian catches and discards by gear for 1980 to 2009 are provided in Table 2. TACs for 2011 and 2012 have been set to allow growth in the stock under both recruitment hypotheses.

Table 2: Canadian Atlantic bluefin tuna landings and discards in metric tonnes by gear type (Anon 2011a).

Year	Gillnet	Harpoon	Longline	Purse Seine	Handline, Rod and Reel	Tended Line	Trap	Unclassi-fied	Discards	Total
1980					259		47	18		324
1981				105	279		41			425
1982						213	68	10		291
1983					71	355	7			433
1984					1	260	3			264
1985					1	121	20			142
1986			32		2	39				73
1987			33		1	32	17			83
1988			104		7	268	14			393
1989			53			579	1		14	633
1990			4		28	404	2			438
1991			6		32	447				485
1992			9		30	403	1			443
1993		33	25		88	284	29			459
1994		34	5		71	203	79			392
1995		43	4		195	262	72			576
1996		32	22		155	298	90			597
1997		55	12		245	138	59		6	509
1998		36	32		303	172	68		16	611
1999		38	31		348	125	44		11	587
2000		18	47		433	81	16		46	595
2001	<1	20	20		402	79	16		13	537
2002		13	53		508	39	28		37	641
2003		10	28		407	42	84		14	571
2004		7	43		421	49	32		15	552
2005		14	36		497	44	8			600
2006		20	48		629	35	3		2	735
2007		17	58		389	23	4			491
2008		24	30		471	24	23	4	1	576
2009		18	64		390	37	23		3	533

Anthropogenic noise such as seismic activity was identified as an additional potential threat to Atlantic bluefin tuna due to deleterious effects it may have on behaviour and physiology of Atlantic bluefin tuna and its prey (McCauley *et al.* 2003; Weilgart 2007). Anthropogenic ocean noise is mainly the result of underwater explosions, seismic exploration, naval sonar operations, and shipping. Ongoing seismic noise from oil and gas exploration exists in the Canadian range of Atlantic bluefin tuna. Imminent increases in oil and gas development and seismic testing in the Gulf of St. Lawrence may pose a threat to Atlantic bluefin tuna and their prey.

Considering the Deepwater Horizon oil spill, the potential effects on the future abundance of western Atlantic bluefin tuna was evaluated by comparing the projections made by the ICCAT SCRS (Anon. 2011a) with similar projections that assume the number of yearlings (one-year-old fish) in 2011 will be reduced by 20% (Atlantic Bluefin Tuna Status Review Team 2011). The value of 20% was based on the recent report by the European Space Agency that suggested that about 20% of the spawning habitat was oiled. The Atlantic Bluefin Tuna Status Review Team indicated that the reduction in the 2010 year-class strength will likely result in less than a

4% reduction in future spawning biomass. However, those analyses concluded that if a significant fraction of adult Atlantic bluefin tuna were killed or rendered impotent by the spill, then subsequent year-classes might also be reduced, leading to greater reductions in spawning biomass than estimated above. To date, however, there has been no evidence that any portion of adults were deleteriously affected.

Mitigation Measures and Alternatives

Feasible mitigation measures to minimize threats include a reduction or elimination of landings Atlantic bluefin tuna in directed fisheries or as a bycatch in other fisheries. If a significant reduction in harvests is required, measures to achieve this could include:

- reduced or no authorization for a directed harvest of Atlantic bluefin tuna in either a commercial or charter boat fishery;
- mandatory release of any incidentally caught Atlantic bluefin tuna in any fishery (dead or alive) to reduce the incentive to target Atlantic bluefin tuna;
- time and area closures of other directed fisheries (*e.g.*, large pelagic longline, trap, weirs, gillnets or purse seine fisheries for small pelagic fishes) to reduce Atlantic bluefin tuna bycatch;
- gear configuration changes in other directed fisheries to reduce incidental catch (*e.g*., weak hook swordfish/other tuna longline fishery, changes to reduce the entry of Atlantic bluefin tuna into traps for small pelagics, elimination of the use of kites in the shark recreational fishery);
- change in gear type to reduce incidental take of Atlantic bluefin tuna;
- identification of locations/fisheries where incidental catch of Atlantic bluefin tuna are significant and where seasonal or area closures could reduce impacts on Atlantic bluefin tuna; and
- reduction in overall fishing effort by other gear types associated with Atlantic bluefin tuna bycatch mortality (*e.g.*, pelagic longline fisheries, small pelagic traps, weirs, gillnets or purse seines, *etc.*).

Increased post-release survival of any Atlantic bluefin tuna released is another feasible mitigation measure to minimize threats. Such measures could include:

- the development and implementation of guidelines to ensure that the release of incidentally caught Atlantic bluefin tuna ensures maximum survival; and
- change in gear types in other fisheries that would facilitate the release of incidentally caught Atlantic bluefin tuna.

Other fisheries in Atlantic Canada have a bycatch of Atlantic bluefin tuna. The large pelagic fisheries can experience bycatch of Atlantic bluefin tuna when using longline gear. However, the pelagic longline fleet is also permitted to fish with harpoon and trolling gear in addition to their longline gear. Alternative fishing methods such as rod and reel or tended line for bigeye tuna, albacore, and yellowfin tuna could result in increased survivability for released incidentally caught Atlantic bluefin tuna, but may affect catch of the targeted species.

While for the most part tuna occurring in small pelagic fish traps can be released alive, other gear types for small pelagics (purse seine, gillnet) could have incidental catches of Atlantic bluefin tuna. If Atlantic bluefin tuna mortality associated with small pelagic fisheries is considered significant, alternative or reduced harvesting may be required for the small pelagic fisheries.

In recent years Canada has harvested approximately 500 mt of Atlantic bluefin tuna per year, or 28-30% of all of the reported mortalities of western Atlantic bluefin tuna on an annual basis. The majority of other mortality is associated with Japanese and USA fisheries. Total elimination of any directed fishing for western Atlantic bluefin tuna by Canadian fish harvesters could result in an approximate 24% reduction in the overall western Atlantic bluefin tuna mortality from fishing (the 4-6% difference is attributed to bycatch mortality). This reduction in mortality would only be realized if other factors including current allocations and catch levels by other contracting parties to ICCAT remain constant.

The mandatory release of any Atlantic bluefin tuna caught incidentally in any fishery in Atlantic Canada would likely result in an additional reduction in overall human induced mortality of 2-3% (based on elimination of 70 to 100 mt of bycatch in pelagic longline fisheries or from traps and seine fisheries for small pelagics with an assumed 40-60% survival of released bycatch). Seasonal or area closures, changes in gear configurations, and reduced fishing in other fisheries that catch Atlantic bluefin tuna incidentally could result in a small reduction in mortality from fishing.

Changes in gear types in other fisheries (from swordfish/other tuna longline fishery or from fish traps or seines for small pelagics) would be expected to have a small reduction in the overall mortality of western Atlantic bluefin tuna associated with these fisheries (*e.g.*, an increase in swordfish harvested by harpoon would reduce Atlantic bluefin tuna bycatch and associated mortality from the swordfish/other tuna longline fishery).

For other sources of human impacts (*e.g.*, seismic exploration), activities could be restricted to periods when Atlantic bluefin tuna are not in Canadian waters.

Threats to Habitat

Atlantic bluefin tuna migrate into Canadian waters to feed. Overfishing of prey species in Canadian waters could be a threat to their habitat.

Climate change has also been identified as a potential threat to habitat. Changes in the environment may affect prey availability, distribution, and abundance.

Anthropogenic noise was identified as an additional potential threat to Atlantic bluefin tuna habitat. Noise impact on prey species of Atlantic bluefin tuna should also be considered a threat to habitat. Reduced catch rates of 40–80% and decreased abundance have been reported near seismic surveys in species such as Atlantic cod, haddock, rockfish, herring, sandlance, and blue whiting (Weilgart 2007). Cumulative and synergistic impacts between noises should be taken into account as interactions between environmental stressors may magnify their impact (Weilgart 2007).

There are concerns about the potential impact to biota and physical environment required by Atlantic bluefin tuna life processes from hydrocarbon development in the Gulf of St. Lawrence. Environmental assessment processes are underway or proposed in Quebec and Newfoundland and Labrador to guide offshore hydrocarbon development in the Gulf of St. Lawrence. These processes should assess cumulative effects of all phases of hydrocarbon development in the context of this highly dynamic large marine ecosystem.

Allowable Harm

Given that the proposed recovery target is an increase in SSB compared to 2012, maximum allowable harm was agreed to be the maximum removals by the fishery that would still result in the SSB in 2025 being greater than the SSB in 2012. The probabilities that an increase would not occur by 2025 for catch scenarios ranging from 0 to 3,500 mt are presented in Table 3.

Table 3: Probability that SSB in each year (from 2018 to 2025) will be less than the SSB in 2012, for catch scenarios from 0 to 3,500 mt (at 250 mt increments; based on the ICCAT 2010 assessment from the low recruitment scenario and provided by the ICCAT Secretariat for this RPA); and for mitigation scenarios referred to in Figure 7.

Catch Scenario (mt)	Mitigation Scenario (corresponds approximately to)	Probability $SSB_{year} < SSB_{2012}$							
		2018	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*
0	No catch in the Western Atlantic	0	0	0	0	0	0	0	0
250	Bycatch only by all in the Western Atlantic	0	0	0	0	0	0	0	0
500		0	0	0	0	0	0	0	0
750		0	0	0	0	0	0	0	0
1000		0	0	0	0	0	0	0	0
1250	No Canadian catch, others status quo catches in the Western Atlantic	0.01	0.01	0.01	0	0	0	0	0
1500	½ Canadian catch, others status quo catches in the Western Atlantic	0.05	0.04	0.03	0.03	0.02	0.01	0.01	0.01
1750	Current Western Atlantic TAC	0.14	0.10	0.08	0.06	0.05	0.04	0.04	0.04
2000		0.26	0.25	0.22	0.18	0.17	0.14	0.13	0.10
2250	2010 ICCAT Scientific (SCRS) Advice (ICCAT 2011a)	0.48	0.46	0.41	0.41	0.39	0.36	0.32	0.29
2500		0.67	0.66	0.66	0.62	0.61	0.59	0.57	0.54
2750		0.86	0.81	0.82	0.81	0.79	0.78	0.78	0.77
3000		0.93	0.93	0.92	0.92	0.92	0.92	0.93	0.93
3250		0.96	0.97	0.97	0.97	0.98	0.98	0.98	0.98
3500		0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00

Sources of Uncertainty

The results of this recovery potential assessment are mainly based on the analysis from the 2010 ICCAT assessment of Atlantic bluefin tuna (Anon. 2011a, b). Several sources of uncertainty in the ICCAT stock assessment model were noted during discussions. These uncertainties include: the amount of mixing between the eastern and western origin Atlantic bluefin tuna stocks in the western Atlantic; the stock-recruitment relationship; the strength of the 2003 year class and the proportion that will recruit to the spawning population; uncertainties surrounding the scenario going back to the 1960s (Figure 5); and questions around the age of maturity of the fish. Concerns were also expressed in regard to the representativeness of the CPUE data as an index of abundance for the species.

The effects of large scale environmental change on species productivity and habitat suitability are unknown.

Unreported discards of Atlantic bluefin tuna are not considered to be a large source of mortality in Canadian fisheries; however, this remains to be quantified.

CONCLUSIONS AND ADVICE

Fisheries on Atlantic bluefin tuna are managed on the basis of a two stock hypothesis, separated by 45°W, but fish of western origin are caught east of 45°W and *vice versa*. Canadian fisheries harvesting larger size classes are believed to include little contribution from the eastern component, relying essentially on western origin Atlantic bluefin tunas. There is no information suggesting that Atlantic bluefin tuna in Canadian waters should be divided into substocks or subpopulations.

SSB shows an initial steep and steady decline from 1970 to the mid-1980s and relative stability since then; with indications of a possible slight increase in recent years (Figure 4). SSB is estimated to have peaked at 51,500 mt in 1973, declined to 15,000 in 1985 and remained relatively stable since then with the 2009 SSB estimated at 14,000 mt. Total abundance (age 1 and older) estimated in the most recent assessment was at its maximum in 1970 (1.3 million individuals) and the most recent estimate (2009) is slightly above 300,000 individuals.

In Canadian waters the range of Atlantic bluefin tuna extends from Georges Bank, into the Bay of Fundy, along the Scotian Shelf, in the Gulf of St. Lawrence, to the Grand Banks off Newfoundland and extends from coastal waters to the boundary of Canada's Exclusive Economic Zone. There is no evidence that range has been reduced.

As defined by the *SARA*, Atlantic bluefin tuna do not have a residence whilst in Canadian waters.

The only documented human induced mortality to Atlantic bluefin tuna in Canadian waters is fishing, both directed and incidental. Potential threats that were identified include oil and gas exploration and exploitation, anthropogenic noise, and global climate change.

Feasible mitigation measures to minimize the threat posed include a reduction or elimination of landings of western Atlantic bluefin tuna in directed fisheries or as a bycatch in other fisheries, and measures to increase the post-release survival of any Atlantic bluefin tuna released as a result of undersized fish harvests or as a mandatory requirement by fleets not authorized to retain Atlantic bluefin tuna. There are other fisheries in Atlantic Canada that may have a bycatch of Atlantic bluefin tuna that have not been identified.

The proposed recovery target for abundance is to increase spawning stock biomass compared to 2012. ICCAT medium term projections are provided (Figure 7) for various catch scenarios. These suggest that the 2025 SSB would be equal to or larger than the 2012 SSB for catches of 2,250 mt or less.

There is no evidence that the range of Atlantic bluefin tuna in Canadian waters has decreased. Recognizing that local Atlantic bluefin tuna distribution is ephemeral as it is linked to their prey distribution and oceanographic features, the proposed distribution target for recovery is to maintain habitat conditions allowing for a broad distribution in Canadian waters.

Given that the proposed recovery target is an increase in SSB compared to 2012, maximum allowable harm was agreed to be the maximum removals by the fishery that would still result in the SSB in 2025 being greater than the SSB in 2012. The probability that SSB in 2025 would be less than the SSB in 2012 with the current TAC (1,750 mt) is 0.04.

OTHER CONSIDERATIONS

In May 2011, the USA National Oceanic and Atmospheric Administration (NOAA), on the basis of their process to identify endangered species, found that an Endangered species listing for Atlantic bluefin tuna was not warranted on the basis of a low risk of extinction (see Atlantic Bluefin Tuna Status Review Team (2011) for more detailed information). NOAA intends to revisit this decision after the next ICCAT stock assessment.

SOURCES OF INFORMATION

This Science Advisory Report is from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, regional advisory meeting of July 13-15, 2011, on Recovery Potential Assessment (RPA) for western Atlantic bluefin tuna in Canadian waters. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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