Haddock, *Melanogrammus aeglefinus*

**Background**
Haddock is a temperate species inhabiting both sides of the North Atlantic. In North America the range extends from near the northern tip of Labrador, based on fishery records ([http://marvdc.bio.dfo.ca/pls/vdc/mwmfdweb.auth](http://marvdc.bio.dfo.ca/pls/vdc/mwmfdweb.auth)), south to New Jersey, and sometimes to Cape Hatteras in deep water in winter (Froese and Pauly 2006, Scott and Scott 1988). Complete species accounts for haddock were given by Klein-MacPhee (2002) and Scott and Scott (1988). The species is demersal on hard, smooth bottom other than rocks or mud, from inshore waters to the edge of continental shelf. Haddock occupy depths of greater than 20 m to perhaps 135 m and a maximum of 380 m. They feed on a wide range of bottom invertebrates and fishes. Haddock tend to occupy deeper water in winter and move into warmer, shallower shelf and coastal water in summer. Spawning migrations vary in direction and intensity with locality, with concentrations forming on major banks from Grand to Georges. Spawning depth and time vary by population. In Canadian waters the season extends from January to July, and from February to May off New England. Eggs, larvae, and early juveniles are planktonic in surface waters, the latter often associated with jellyfish. Planktonic durations are about one week to one month for eggs and 5-6 months for larvae and juveniles. Haddock form distinct populations in Newfoundland, Nova Scotia, and New England waters.

Haddock has been an important commercial species for many decades, with fishing from 73ºN off the Greenland coast, and 59º15’N off Canada in the 1960s and ’70s, south to 35º54’N. In the past fishing occurred off Labrador, but in more recent years has been focussed in waters from off Newfoundland to Massachusetts, with very low landings off New York ([http://marvdc.bio.dfo.ca/pls/vdc/mwmfdweb.auth](http://www.st.nmfs.gov/st1/com mercial/landings/ds_8850_bystate.html)). Catches are much reduced from the past ([http://marvdc.bio.dfo.ca/pls/vdc/mwmfdweb.auth](http://marvdc.bio.dfo.ca/pls/vdc/mwmfdweb.auth), Brown 1998 in Klein-MacPhee 2002).

**Temperature limits, critical thresholds, vulnerability, and barriers to adaptation**

Sea surface temperatures in the current distribution of haddock range from a February minimum of -2.1ºC to an August maximum of 26.55ºC.

Haddock is a temperate species. Adults have been recorded from 1ºC (Scott and Scott 1988) to 16ºC (Klein-MacPhee 2002), but prefer 3-8ºC in Canadian waters (McCracken 1965, in Hardy 1978) and 2-10ºC in U.S. waters (Brown 1998, in Klein-MacPhee 2002). Temperatures of less than 1ºC are lethal (Templeman 1961, in Klein-MacPhee 2002). Haddock have been reported to survive experimentally at 20ºC (North American Council on fishery Investigations 1939, in Hardy 1978), though this should be regarded as an extreme. The preferred
temperature for spawning in North America is 2.5-6.5°C (Svetovidov 1962). The temperature limits of eggs in the wild are 0°C and 19°C, represented by specimens in collections of the Atlantic Reference Centre (ARC) (Van Guelpen pers. comm.), though eggs usually are found at less than 10°C (Anonymous 1998). In the laboratory hatching was best from 4 - 10°C (Laurence and Rogers 1976). Larvae are found from 1°C (ARC collection, Van Guelpen, pers. comm.) to 14°C (Anonymous 1998), though lethal limits of 4°C and 10°C have been reported (Laurence 1978). Small planktonic juveniles have been collected from surface waters of 2-19°C (ARC collection, Van Guelpen pers. comm.) though they likely do best at temperatures above 4°C and less than 10°C like the larvae. Demersal juveniles have been recorded from 6.5-15.7°C, prefer temperatures below 10-11°C, but have survived experimentally at 20°C (Hardy 1978 and references therein), an extreme value.

In our sensitivity analysis haddock was one of the less vulnerable fishes and one of the least vulnerable species overall. The most sensitive stages of haddock are hatching eggs and pelagic larvae, for which temperatures above 10°C appear to be detrimental and perhaps lethal.

**Impacts**

A 4°C rise in global temperature will impact the distribution of haddock in the western North Atlantic. Results of most models and scenarios are similar, showing potential loss of haddock habitat from the southernmost waters of its distribution. Loss generally will be from marginal waters south of approximately New Jersey, though perhaps as far north as Cape Cod. Model CCSR also shows habitat loss from waters off southern (scenario A2) to most (scenario B2) of Labrador. No northward gain of habitat was predicted by the models. Since fishing is concentrated between Newfoundland and Georges Bank it should be little affected by the loss of haddock habitat.

Individuals of this species may be adaptable to increasing water temperatures resulting from global warming by slowly shifting their distribution to remain in suitable temperatures. This appears possible because of their life history, mobility, and presence of suitable water temperatures, but may be influenced by the availability of appropriate spawning areas and substrate (Colton 1972, in Frank et al. 1990). Predicting inter-population dynamics and consequences resulting from shifting distributions in response to global warming is beyond the scope of this project.

If haddock successfully shift their distribution to maintain environmental temperature while accommodating other ecosystem factors, they will see no increase in growth rate and will reproduce successfully. But if haddock experience water temperatures which are warmer than normal but below the critical maximum of approximately 10-11°C then spawning may begin earlier and last longer (Marak and Livingstone 1970, in Frank et al. 1990). Growth rate may
increase due not only to increased metabolic rate, but also to earlier warming leading to earlier coastward migration from deeper wintering grounds, providing better feeding in the spring (Hodder 1965). However, if summer SSTs of southern Canadian waters exceed the critical maximum for planktonic haddock eggs and early larvae of approximately 10-11ºC, their survival will be impacted in a negative manner.

Free-living larvae of the nematode *Anisakis simplex*, a parasite of haddock (Margolis and Arthur 1979), are pelagic and widespread in Canadian Atlantic waters (Brattey and Clark 1992). These larvae experience declining survival at 10ºC, and cannot survive 13ºC or higher (Hojgaard 1998). Therefore, surface waters from Newfoundland southward will become less hospitable to this parasite during summer and fall with global warming.

References: