Homarus americanus, American lobster

Background

The American lobster, *Homarus americanus* H. Milne Edwards, 1837 is a clawed lobster within the family Nephropidae that includes the true lobsters, as opposed to, for example, the tropical Palinuridae which comprises spiny lobsters that lack claws. The genus *Homarus* is restricted to Atlantic waters, *Homarus americanus* being one of only three species, together with *H. gammarus* in the northeastern Atlantic and the extremely rare *H. capensis* from off southern Africa (Holthuis 1991). The American lobster is geographically restricted to the coast of the northwestern Atlantic, ranging from North Carolina to Newfoundland (Squires 1990). Within that area it is most abundant in the Gulfs of Maine and St. Lawrence (http://www.dfo-mpo.gc.ca/media/infocus/2003/20031205/lobster_e.htm).

American lobster is one of the most important commercial crustacean species and is considered by many as "King of Crustacea" (Herrick 1895). With a size of up to 64 cm in males and 61 cm in females, it is one of the largest commercial species in terms of body length (Squires 1990). While it occurs over a wide depth range, from just below shore to 700 m (Lawton and Lavalli 1995), the greatest concentrations are found in waters 4-50 m deep (Williams 1984). Consequently, most landings are from an inshore trap fishery to a depth of 40-100 m, as compared to a much smaller offshore trap and trawl fishery that may extend from 100-600m (Squires 1990). In Maine alone, lobster landings in 2005 were valued at $318 million, representing 80% of the value for all commercial fish and shellfish species of that state (http://www.st.nmfs.gov/pls/webpls/mf_8850_landings.results). In Canada lobster also ranks at the top amongst fished species. In terms of export value alone, it exceeded $1 billion in 2002 (http://www.dfo-mpo.gc.ca/media/backgrou/2003/hq-ac115a_e.htm). Total capture production of lobster has peaked at just above 80,000 tons since 1999 (http://www.fao.org/fi/website/FIRetrieveAction.do?dom=species&fid=3482).

Depending on size, female lobsters incubate 10,000 to about 100,000 eggs externally for 9-11 months, that hatch between June and September, depending on temperature (Fogarty *et al*. 1983, Ennis 1995). As for most other crustaceans, following egg hatching there is a planktonic dispersal phase, consisting of four larval stages in the lobster, the last 'postlarva' stage settling out of the plankton to a benthic existence, as do all subsequent stages. Completion of the larval phase ranges from 22 days at 22 ^{o}C to 103 days at 10 ^{o}C (Ennis 1995). American lobsters molt 20 to 25 times between hatching and sexual maturity, and generally reach commercial size after five to seven growing seasons, depending on water temperatures (http://gurukul.ucc.american.edu/ted/lobster.htm). Molting rates slow progressively with age, larger animals molting only every few years. Maximum age and weight may exceed 100 years and 20 kg, respectively (http://www.seasabres.com/%5CSafty-education%5CEducation%5Cmarinelife%5Clobster%5Clobsterfacts.htm).

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

Sea surface temperatures in the current distribution of the lobster range from a February minimum of -2.1°C to an August maximum of 28.5°C. Relevant temperature tolerance data and resulting implications were mostly derived from various sources within Ennis (1995) and Waddy *et al*. (1995) and are discussed in greater detail in the following section. In terms of thermal sensitivity compared to other species investigated here, the American lobster is not ranked as a sensitive species because of high mobility scores and above average eurythermal capacity. Given the choice, the American lobster shows a clear temperature preferendum of 17.2 ± 0.18 °C (Reynolds and Casterlin 1979).

Impact

A 4°C rise in global temperature will impact the future distribution of the American lobster in the western Atlantic. The impact is primarily in terms of its southern distribution, where all models predict a loss in thermal range. Depending on models this loss may extended as far north as the coast of New Jersey. This would affect the existing lobster fisheries of Virginia, Maryland and New Jersey. Higher-yield fisheries in more northern states could also be affected as suboptimal environmental conditions, found at the present-day southern range limit, would shift into waters at higher latitudes.

In terms of northern limits, none of the models predict an increase in range for this species under a warming scenario. However, three of the four models do indicate that the present thermal range for adult lobster extends to areas in Labrador north of Newfoundland where that species is currently not established, even though this was attempted (Boothroyd and Ennis 1992). While a number of factors may explain this, a primary consideration is temperature requirements for embryo maturation and spawning (S.L. Waddy, pers. comm.). Minimum temperatures required for spawning in summer are 10 °C or higher (Waddy *et al*. 1995, Waddy and Aiken 1995). Boothroyd and Ennis (1992) showed temperatures at the failed lobster transplantation site in St. Michaels Bay, Labrador, to just reach that level for a short time in mid-August. This appears insufficient as females seem to require 4-6 weeks exposure to 10 °C or higher for spawning to occur (Waddy and Aiken 1992). In their study of lobster in Labrador, Boothroyd and Ennis (1992) also indicate that prolonged exposure to temperatures below 0 °C may have caused the observed loss of egg clutches by females that extruded and retained their eggs. Similarly, the short time before renewed autumn cooling might not be sufficient for completion of the planktonic phase and benthic settlement within the area.

Based on this evidence a 4 °C warming would likely create appropriate thermal conditions for a sustainable lobster population in those regions of Labrador now not occupied. Disregarding other possible confounding factors, the northern range of lobster could therefore expand to the indicated areas of northern Labrador under the given warming scenario.

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