



LETTERS: TO THE EDITOR

PERSPECTIVE: FISHERIES MANAGEMENT

The North Atlantic Ocean: Need for Proactive Management

ABSTRACT: Among the major oceans of the world, the North Atlantic presents a unique problem in regard to the management of its commercial and recreational fisheries. Almost all of the populations of large-sized, predatory fishes have collapsed to the extent that they no longer play an effective role in the ecosystem. There is a fundamental difference in the biodiversity and present state of the fisheries between the North Atlantic and the North Pacific. Much of the difference is attributable to their contrasting geological and climatic histories. The two oceans had been effectively separated until about 3.5 million years ago, when the Bering Strait was formed permitting the Great Trans-Arctic Biotic Interchange. During the interchange, hundreds of Pacific species migrated to the Atlantic but only a few in the opposite direction. Although the Atlantic benefited from the interchange, its species diversity remained relatively low. Today, the North Atlantic, in comparison to the North Pacific, possesses only about half the number of molluscan species, about one third in many fish species, and many fewer species of crabs, shrimp, and shellfish. The low biodiversity of the North Atlantic ecosystem has apparently made it more vulnerable to fishing pressure resulting in a series of population collapses. Many of the overfished populations have become so depleted that their recovery has become questionable. In the marine environment, species invasions and introductions evidently have not caused extinctions of native species or loss of biodiversity. Rather than deriving all our efforts toward the restoration of depleted fisheries, it is suggested that we undertake a proactive management program. Proactive management means the addition of species to low diversity ecosystems in order to decrease annual variation, to increase biodiversity, and to augment overall production.

El Atlántico Norte: Necesidad de un Manejo Proactivo

RESUMEN: Dentro de los océanos más grandes del mundo, el Atlántico representa un problema único en cuanto al manejo de pesquerías comerciales y deportivas recreativas. Casi todas las poblaciones de grandes depredadores en el Atlántico han colapsado hasta el punto en el que ya no juegan un papel efectivo en el ecosistema. Existe una diferencia fundamental entre el Atlántico norte y el Pacífico norte en cuanto a biodiversidad y estado actual de las pesquerías. Esta diferencia es atribuible a su contrastante historia geológica y climática. Ambos océanos fueron separados hace cerca de 3.5 millones de años, cuando la formación del estrecho de Bering permitió el gran intercambio biótico trans-ártico. Durante el intercambio, cientos de especies del Pacífico migraron al Atlántico, pero solo unas pocas se trasladaron en sentido opuesto. Si bien el Atlántico se benefició con este intercambio, su diversidad específica se mantuvo comparativamente baja. En la actualidad el Atlántico norte, en relación al Pacífico norte, posee apenas la mitad del número de especies de moluscos, un tercio de las especies de peces y muchas menos especies de cangrejos, camarones y otros mariscos. La baja biodiversidad del ecosistema del Atlántico norte aparentemente lo ha vuelto más vulnerable a la presión de pesca, dando como resultado el colapso de una serie de poblaciones explotadas. Muchas de las poblaciones se han agotado tanto que su recuperación resulta muy cuestionable. En el ambiente marino, la invasión e introducción de especies exóticas no ha precipitado la extinción de especies nativas o la pérdida de biodiversidad. Más que enfocarse todos los esfuerzos hacia la recuperación de las poblaciones agotadas, se sugiere que se adopte un programa de manejo proactivo. El manejo proactivo implica la adición de especies a ecosistemas de baja diversidad con el fin de reducir la variación anual, incrementar la biodiversidad y aumentar la producción.

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INTRODUCTION

Recently, it has been observed that the ongoing erosion of marine biodiversity trends a trend that predicts the global collapse of all currently fished taxa by the year 2040 (Worm et al. 2006). This extrapolation has been considered inappropriate (Hilber et al. 2007) so the threat of global collapse was downgraded to an exaggeration. However, that prediction may be more applicable to the North Atlantic. There is a significant difference between the North Atlantic and the other major oceans. It is only in the North Atlantic that the populations of almost all of the large-sized predatory fishes have collapsed (Eaton et al. 2006). A collapsed state means that the population has become so low that the species no longer play an effective role in the ecosystem. Compared to the North Pacific, the North Atlantic communities have a low species diversity. A considerable part of the diversity difference is attributable to the contrasting geological and climatic histories of the two oceans.

The Atlantic was formed in the late Jurassic, c. 150 million years ago (Ma) in North Africa pulled away from North America (Hansen 1998). The history of the present cold-temperate (boreal) marine biota can be traced back only as far as the mid-Eocene, c. 40 Ma. At this time, a global cooling event began that continued through most of the Cretaceous with temperatures reaching their minimum c. 29 Ma. The severe climatic change caused extinctions that greatly reduced species diversity. Most of the species comprising the original warm-temperate biota, that had been acclimated to winter

180 *Fisheries* • VOL 35 NO 6 • APRIL 2008 • WWW.FISHERIES.ORG

North Atlantic Fisheries: A Response to Criticism of the Proactive Proposal

Editor's note: Briggs' original article (*Fisheries* 33[4]:180–185) is available online at: www.fisheries.org/afs/docs/fisheries/fisheries_3304.pdf and Courtenay et al.'s rebuttal (*Fisheries* 34[4]:181–186) is available at: www.fisheries.org/afs/docs/fisheries/fisheries_3404.pdf.

I have decided that I must write this letter for three reasons. First, the subject is exceedingly important because it is essential that something more be done in order to help revitalize the North Atlantic fisheries. Second, the critical article that Courtenay et al. (2009) published in opposition to my proposal of a transplantation program did not meet the standards of good criticism. Articles that embody criticism of controversial ideas are important to scientific progress. But those who publish the criticism bear a responsibility to make it objective and to the point. Much of the criticism of Courtenay et al. (2009) was beside the point because it dealt with transplantations and invasions that took place in highly restricted geographic areas. Third, the inclusion of erroneous or misleading statements weakened the criticism to the point where it became of questionable value.

GEOGRAPHIC RESTRICTION

Upon reading the article by Courtenay et al. (2009), one may wonder why so much of its text was devoted to small localities other than the North Atlantic? If this material was included simply to build a case against the Atlantic proposal, then the criticism was misdirected. My proposal involved the transplantation of species from one ocean to another, not to small oceanic islands or to freshwater streams and lakes. In relatively small habitats where space is at a premium, the equilibrium theory (MacArthur and Wilson 1963) comes into play. This means that introductions into small areas are likely to conflict with and cause extinctions among the native species due to limited space that is already fully occupied. There is ample evidence for this effect aside from the data used by Courtenay et al. (2009).

COMPARATIVE INFORMATION

For comparison, it is instructive to consider the results of two inter-oceanic invasions. Just as the opening of the Suez Canal permitted the largest contemporary marine invasion, the opening of the Bering Strait permitted the largest invasion of the Cenozoic. About 3.5 million years ago, the Bering Strait developed into a wide open passage that permitted the migration of thousands of species between the North Pacific and North Atlantic via the Arctic Ocean. At that time, the Arctic Ocean had little ice cover and its surface temperature was equivalent to that of the two adjoining oceans (Mudelsee and Raymo 2005). The results of this Trans-Arctic Biotic Interchange were analyzed by Vermeij (1991, 2004) through his work on fossil and recent Mollusca.

In terms of successful (colonizing) invasions, 24 species from the North Atlantic settled in the North Pacific, but invasions on the opposite direction were far more numerous. At least 143 species from the North Pacific colonized European shores, while 176 did so in eastern North America. On the eastern American rocky shores, the invaders now comprise the majority of common species (Vermeij 2004). Among the Atlantic species with Pacific ancestors, about 47% have so far evolved into distinct species. Along with the mollusks, many other marine organisms also invaded to the extent that, in the present northern biota, species of Pacific origin or their descendants outnumber those of Atlantic origin by about 10 to 1.

The fact that this enormous biotic interchange took place without any apparent extinction of native species due to competition from invaders has great biological significance. Certainly, the invaders managed to occupy many of the preferred habitats but the native species apparently accommodated the invaders by giving up parts of their ecological spaces. The general result for the North Atlantic was a substantial gain in species diversity

with no apparent losses due to transmission of diseases, parasites, or unusual predation.

Since the opening of the Suez Canal in 1869, more than 300 Red Sea organisms have invaded and become established in the eastern Mediterranean (Galil 2007). This huge number of successful migrations constitutes the largest, contemporary marine invasion. In regard to the invaded area, the relationships between invader and native species are better known in the eastern Mediterranean than anywhere else. In her review of invasive aliens and biodiversity in the Mediterranean, Galil (2007) presented information on 20 cases where the reaction between native and invader was observed. Although the reactions involved native accommodations such as niche sharing, habitat shifting, and retreat into deeper water, all of the natives managed to retain parts of their original ranges. There have been no recorded extinctions or damage due to the introduction of disease or parasites. Also, there have been no extirpations from the eastern Mediterranean. Only one native species is missing from the area and that is due to hybridization with a closely related Red Sea species.

The information about the two inter-oceanic invasions makes possible a prognosis for the proposed translocation program to enrich the North Atlantic. If we do transplant a variety of fishes and invertebrates, one can predict an outcome similar to what has taken place between invaders and native species in the eastern Mediterranean; that is, the introduced species will be accommodated by the natives and the ecosystem will benefit from the increased diversity. In regard to the long-term outcome of such relationships, one can turn to the results of the Trans-Arctic Interchange to see that the invaders will probably become permanent residents that will add to the biodiversity of the recipient region. In neither case has there been any indication of the difficulties alluded to by Courtenay et al. (2009), i.e., harm to valuable fisheries, introduction of parasites, and invasions that became "time bombs." Instead, some invaders into the eastern Mediterranean have added valuable new fisheries (Galil 2007). Examples are: the Red Sea lizardfish (*Saurida undosquamis*) was first recorded from the Levant in 1952; by the 1980s, it accounted for 2/3 of the fish landing biomass in some areas. Three species of invasive penaeid prawns are highly prized and are considered to be a boon. Several other species of Red Sea fishes, crustaceans, and mollusks have added diversity to the commercial catch of the eastern Mediterranean.

ERRONEOUS STATEMENTS

In their critical article, Courtenay et al. (2009) made some erroneous statements that need to be corrected. First, they charged (p. 182) that my proposal

did nothing to address the underlying causes for the collapse of fish stocks. Yet, in my article I clearly referred to each of the fish species in the northwestern Atlantic that was considered to be overfished by the National Marine Fisheries Service. For the eastern North Atlantic, I called attention to a similar trend of overfishing followed by population collapse. I referred to previous recommendations for restoration including the imposition of quotas, marine reserves, subsidy reduction, improved methods for dealing with illegal catches, and possibly stock enhancement. I did not suggest or imply that such measures should be abandoned in favor of transplantation.

The second erroneous statement (p. 182) was that I ignored what might be long-term ecological effects of transplantation on the native biota. On the contrary, I provided information about the long-term consequences of the Trans-Arctic Interchange in my article (Briggs 2008) as well as in a previous article (Briggs 2007) which was also part of the criticism by Courtenay et al. (2009). The Pliocene invasions of North Pacific species increased the biodiversity of the North Atlantic without causing extinctions or other apparent adverse effects.

A third erroneous or misleading statement by Courtenay et al. (2009:182) was "the idea that ecosystems with a more diverse fish fauna are more resilient to overfishing is tenuous at best and, in our opinion is unsupported by convincing research." This is a matter of opinion versus a number of articles supported by convincing research: Lehman and Tilman (2000), Finnoff and Tschirhart (2003), Hooper et al. (2005), and Ruesink et al. (2006). Furthermore, the comprehensive review by Worm et al. (2006) provided solid evidence that greater biodiversity provides tangible benefits. In that review, a comparison of records from coastal ecosystems showed that those with higher species richness demonstrated lower rates of collapse of commercially important fish and invertebrate taxa over time. And it was found that collapses in large marine ecosystems occurred at a higher rate in species-poor ecosystems, as compared to species-rich ones. A related finding by Worm et al. (2006) was that fished taxa richness was negatively related to the variation in catch from year to year and positively related to the total production of catch per year.

CONCLUSION

Compared to the North Pacific, the present North Atlantic is an impoverished ocean with only about one-third as many fish species and half as many mollusks. I have called the proposed transplantation program "proactive management" because it seeks to improve a poor ecosystem by adding species diversity instead of only preserving the status quo. The best comparable

evidence involving ocean-to-ocean invasions indicates that the program will succeed in improving biodiversity and fishery production in the North Atlantic.

ACKNOWLEDGMENTS

I wish to thank E. A. Hanni and two anonymous reviewers for their helpful assistance.

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Courtenay et al. reply—

Briggs's letter implies that we misrepresented his position (Briggs 2008). Let us be clear here. We reject the idea that problems of overfishing marine ecosystems in the North Atlantic could be remedied by introductions of other species on a massive scale as he proposed. We know the causes of declining fisheries in the North Atlantic: over-capitalized fishing fleets that are subsidized by governments and the unresponsiveness of management agencies to reduce fishing efforts (Hilborn and Stokes 2010). Unless these problems are corrected, the prospects for long-term sustainability of these fisheries are slim.

Moreover, our position remains that it is reckless to dismiss the risks of species introductions, especially on the scale that Briggs has proposed. Introductions often fail and, more importantly, their results cannot be predicted, especially because global warming is likely to dislocate and reshuffle fish communities. Also, massive introductions of North Pacific fishes into the North Atlantic would be far more costly than any benefit to humans in the future.

In summary, we believe that the proposal by Briggs should be ignored. Nothing he proposed will cure the problem of overfishing, even should some North Pacific fishes become established in the North Atlantic.

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The author replies—

In their brief reply to my letter about the shortcomings of their criticism of my original article (Briggs 2008), Courtenay et al. continued to misread my original proposal. First, they said that I proposed the introduction of species on "a massive scale." This implies some kind of wholesale introduction. My actual words were, "Certainly, each species being considered for transplant

should be evaluated, perhaps using the steps recommended for terrestrial species (Ewel et al. 1999). However, if the life histories of the Pacific species concerned are reasonably well known and if it appears that they would fit into the North Atlantic ecosystem, the chances of a disastrous result would appear to be exceedingly slim" (Briggs 2008:184).

Courtenay et al. claim that the results of introductions cannot be predicted, but the validity of a prediction surely depends on the quality of the evidence pertaining to the circumstances. My proposal involves an ocean-to-ocean transplantation of species and there is evidence indicating that such an undertaking would be successful. First, there is historical precedence which is why I addressed the details of the Trans-Arctic invasion into the North Atlantic. Second, there is the contemporary invasion of Red Sea species into the Eastern Mediterranean. In each area, the introduced species have apparently been accommodated by their ecological equivalents. These two invasions have provided hundreds of examples of successful introductions that have taken place without native extinctions and with no apparent

damage due to the transfer of parasites or diseases.

Courtenay et al. point to global warming as a reason why the results of introductions cannot be predicted. If global warming continues on into the future, it will have an effect on the latitudinal positions of the cold-temperate zones but these changes should not affect transplantation success as long as species are transferred from one suitable habitat to another. In fact, as I indicated in my original article (Briggs 2008), the increased species diversity resulting from successful transplantations to the North Atlantic will help to stabilize that ecosystem and provide increased resistance to climatic and other disturbances. Furthermore, the increased diversity should enhance the overall biotic production including species of commercial and recreational value.

The critics claim that massive (?) introductions of North Pacific fishes into the North Atlantic would be far more costly than any benefit to humans in the future. How do they know this? No estimates have yet been made as to the costs of capture and transportation. Finally, Courtenay et al. believe that my proposal should be ignored

because it will not cure the problem of overfishing. Nowhere, have I suggested that my proactive management proposal would cure the problem of overfishing. I did pose the question as follows: "Considering that the North Atlantic has been overfished to the point where the populations of its most valuable species may not be able to recover, is there anything that can be done aside from the management actions that have already been recommended?" (Briggs 2008:182). I did not imply that such management actions should be abandoned in favor of transplantation. It is obvious that the fishery resources of the North Atlantic will continue to decline unless the overfishing is halted. In addition to that necessary action, it would be beneficial to build up the diversity by transplanting species from the North Pacific.

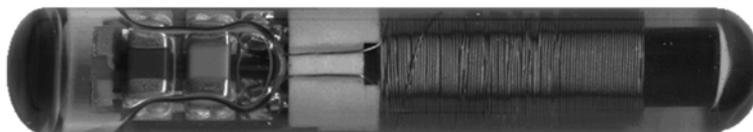
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