Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 6 months or issues of general interest. They can be submitted by e-mail (science_letters@aaas.org), the Web (www.letter2science.org), or regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.

Counting Whales in the North Atlantic

IN THEIR REPORT "WHALES BEFORE WHALING in the North Atlantic" (25 July, p. 508), J. Roman and S. R. Palumbi conclude, using genetic markers, that humpback, minke, and fin whale populations in the North Atlantic were once much larger than previously thought, which goes against the current "wisdom" in International Whaling Commission (IWC) circles. This discrepancy may have several explanations.

The conventional estimates of the original population sizes—i.e., before the onset of industrial whaling—have mostly been obtained by adding the cumulative catches recorded in logbooks to recent direct estimates from sighting surveys. This gives notional upper limits to the original numbers, which are corrected downward to account for the difference between reproduction and natural mortality—net reproduction rate (NRR)—during the exploited period. The process of correction involves application of a simple "classical" model of population dynamics in which the difference is assumed to be density dependent with the NRR declining continuously—but not necessarily linearly—from a relatively high value in very small populations to zero when the population is at carrying capacity. Such assessments may be conditioned by data, such as the "catch per unit effort" (CPUE) index commonly used in fisheries' stock assessments as indicating the declining trend of an unsustainably exploited population (*1*).

Roman and Palumbi recognize that such assessments can have substantial bias if more whales were killed as a result of whaling operations than are recorded as catches, but IWC scientists have gone to great lengths to try to take reasonable account of these. However, the simple assumptions of density dependence could be misleading if, for example, depensation (the Allee effect) were manifest at very low population levels (*2*, *3*). More importantly, Lars Witting has argued, from theoretical considerations in population genetics, that the fundamental assumption that the "intrinsic" population growth rate, when the population is very small, is exponential—an idea going back to Thomas Malthus—is not valid (*4*). Witting's revised population model predicts long cycles of considerable amplitude in population rather than stable asymptotic population size. He has shown that this can explain the fact that the recovered population of gray whales in the northeastern Pacific is now several times larger than the estimates of the mid-19th-century population obtained by the traditional back-extrapolation (*5*).

Roman and Palumbi conclude that the original population of minke whales in the north Atlantic was double the present number. But this is entirely in accord with the conclusion that the IWC Scientific Committee reached in 1985, the present depletion being the direct consequence of Norwegian whaling, which began on this species only in 1930 (*6*).

Lastly, it is perhaps worth mentioning that the IWC's management objective that "catches should not be allowed on stocks below 54% of the estimated carrying capacity" comes from the New Management Procedure (NMP) that was adopted in 1974 in the wake of the first call by the United Nations for a 10-year moratorium on commercial whaling; the Revised Management Procedure (RMP) developed involves more subtle rules not dependent critically on a particular population model (*7*).

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IN THEIR REPORT "WHALES BEFORE WHALING in the North Atlantic" (25 July, p. 508), J. Roman and S. R. Palumbi use genetic diversity data to estimate preexploitation population abundance of North Atlantic humpbacks. They are one of an allopatric population pair, the second population being in the Southern Hemisphere. Latitudinal migrations for each population occur concurrently in the same direction during different hemisphere seasons, and their chronologically separate presence in low latitudes facilitates transequatorial migration between and dispersal within North Atlantic and Southern Hemisphere populations even absent significant changes in oceanic and climatic regimes (*1*, *2*). Migrating farthest to the equator, humpbacks are unlikely to have genetically discrete antitropical (i.e., North Atlantic and Southern Hemisphere) populations (*3*). Population identity in the east equatorial Atlantic region from sightings and catch records is inconclusive (*4*, *5*), and populations are not recognized as allopatric vicariants at the subspecies pair level (the North Atlantic and Southern Hemisphere population) (*6*). Repetitive Pleistocene glacial maxima drove multiple humpback dispersal events across the equatorial region, resulting in mixing of the North Atlantic and Southern Hemisphere populations followed by separation, exacerbated in the North Atlantic, where the polar front moved farther south than in the North Pacific. Probable mixing in the equatorial region now and repetitive equatorial transgressions and subsequent isolation in the Pleistocene would have injected outside variation and affected humpback population structure, violating the authors' assumptions of a nearly closed population.

There is debate about the size of early whale populations in the North Atlantic. A humpback whale is shown here.

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Response

WE APPRECIATE HOLT'S HISTORICAL COM-mentary on the discrepancy between genetic and logbook estimates of whale abundance. His suggestions about issues of concern should be heeded. However, few of the numerical methods that Holt mentions have been successfully applied to whales in the North Atlantic. He is correct that whale log kills have been added up and this number used as the historic population size for North Atlantic humpbacks (*1*). Attempts at more detailed modeling fail to fit current data and conclude "it is possible that removals from earlier periods [19th century] have been significantly underestimated." [(*2*), p. 295, brackets inserted]. No estimate of the number of logbooks that have been lost has been folded into these summations, and the sophisticated impact of Allee effects has been completely missing from methods of whale logbook analysis from the North Atlantic (*1*). Holt is thus completely correct in suggesting that numerous opportunities exist to revisit and improve these analyses.

There may be other demographic effects of intense harvesting. Female humpback whales with calves were the target of a sustained hunt in their nursery ground in the Caribbean. Demographic research of the North Atlantic right whale has shown that increased mortality of mother whales can cause declines in population growth rate, life expectancy, and the number of lifetime reproductive events (*3*). We would expect all of these declines to occur in a hunt focused on reproductive females. In fact, Friday and Smith (*4*) mention in their study of humpback harvests that the impact of hunting females "should be taken into account in reconstructions of historical abundance from catch records." To our knowledge, these effects have not been accounted for in estimates of preexploitation population size of humpbacks.

Although the International Whaling Commission (IWC) still lists the 54% threshold as a major management target (*5*), the new Revised Management Plan (RMP) may focus instead on managing harvest with less regard for historic population targets. Our quote that "catches should not be allowed on stocks below 54% of the estimated carrying capacity," was taken directly from the IWC's Web site. According to the RMP, this management objective should have "greater priority" than the others mentioned. Thus, available documents leave us still a little uncertain about current IWC management objectives. We hope our genetic estimates revive interest in the use of historic data to gauge management policy.

Mitchell explains why humpback whale populations might occasionally cross the equator, and his Letter may give the impression that this movement is recognized as widespread. However, his reconstruction of present and past population movements is very speculative and requires documentation by careful data sets (*6*) before being accepted. Current data suggest that humpback populations in different hemispheres have remained largely separate and that transhemisphere movement is rare.

Whales that move from the Southern to Northern Hemisphere must spend two consecutive seasons in the tropics, where they do not feed, before moving to the northern feeding grounds. Such long deprivations are possible, but difficult, and in the first worldwide survey of humpback whale mtDNA genetics, Baker *et al.* (*7*) found evidence of only a handful of transequatorial migrations of humpback whales worldwide during the past 2 to 3 million years. Larger data sets now available do not challenge the conclusion that migrations across the equator are rare (except for a population near Colombia, which winters just across the equator, but returns to the Southern Hemisphere to feed). In their review of genetic diversity in worldwide humpbacks, Baker and Medrano-González (*8*) support this conclusion, noting that "maternally directed fidelity following colonization of new feeding grounds has persisted for thousands of years, despite the nearly unlimited mobility of humpback whales and the absence of obvious geographic boundaries."

In accordance with Mitchell's comments about Pleistocene history, there is some speculation that the Last Glacial Maximum may have enhanced population exchange between the Southern Hemisphere and the North Atlantic (*7*). One currently common mitochondrial genetic haplotype in the North Atlantic may have colonized from the South Atlantic during Pleistocene glacial maxima. To account for this in our Report, we removed this lineage from our analysis of the North Atlantic and still found comparable estimates of genetic diversity in this basin.

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Research and the Bayh-Dole Act

IN THEIR RECENT POLICY FORUM, J. G. Thursby and M. C. Thursby discuss the Bayh-Dole Act and its effects on university licensing ("University licensing and the Bayh-Dole Act," 22 Aug., p. 1052). There is no doubt that the passage of the Bayh-Dole act in 1980 changed the face of university-industry relations and resulted in a dramatic increase in the number of patent filings and commercial revenues to universities and research institutions. What is less clear concerns the impact of this newfound revenue on the conduct of research.

As Thursby and Thursby point out, all objective measures indicate that there has been no real effect on the way research is conducted, despite dramatic increases in patent filings and other commercialization activities. What is not covered in the Policy Forum is the increasing pressure that our industrial partners are feeling concerning proprietary technologies. In recent years, mainly because of economic forces, our industrial partners have become reluctant to license any technology whose ownership is not clearly delineated and whose intellectual property is not strongly patented.

As researchers, we are often motivated to seek out new technologies that promote the common good. Patent protection is frequently the single most effective way to translate laboratory findings to the public, where they can benefit us all.

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CORRECTIONS AND CLARIFICATIONS

News Focus: "Proton guns set their sights on taming radioactive wastes," by D. Normile (17 Oct., p. 379). It was incorrectly stated that schemes similar to the accelerator-driven systems described in the article were studied in the 1950s to turn thorium into uranium-235 to fuel nuclear reactors. The correct isotope is uranium-233.

Cover image: 12 April 2002. The image of Narcissus, a detail of a painting by Michelangelo Merisi da Caravaggio, was printed backwards. The slide used to generate the image was backwards, which led to the error.