Transgenic Fish: A Boon or Threat?

ERIK STOKSTAD'S ARTICLE "ENGINEERED FISH: friend or foe of the environment?" (News Focus, 13 Sept., p. 1797) entertains the premise that the culture of transgenic fish, which grow two to six times faster than conventional fish, "might alleviate pressure on wild stocks." Two key points not addressed by Stokstad challenge this premise.

First, the culture of carnivorous species, such as salmon and trout, already represents a net drain on wild fish populations. Over 2 kg of wild fish are required to produce 1 kg of aquacultured conventional carnivorous fish (*1*). In North America and Europe, fish are usually reared in high densities and therefore rely completely on manufactured feeds for sustenance. Manufactured feeds for carnivorous species are typically composed of 35 to 50% fish meal and up to 20% fish oil (*1*). The accelerated growth rate of transgenic fish will necessitate an enormous increase in the usage of feeds and their constituent marine feedstuffs. Fish meal and fish oil are typically made from menhaden and anchoveta harvested from the wild. As these species are already being exploited near their maximum sustainable levels (*2*), using more of them to create even more feed for transgenic fish can hardly be considered an easing of pressure.

Second, on the basis of the Law of Conservation of Matter, increased feed inputs will result in more outputs of waste in aquaculture effluents [e.g., (*3*)]. Reclamation of aquaculture waste is already problematic. In net-pen culture, for example, untreated wastes are expelled directly into the surrounding waters and commonly cause local eutrophication, buildup in sediments of feed-borne antibiotics, and benthic anoxia (*4*). Although the degree of these impacts depends on husbandry practices and the hydrodynamics of the site, the potential for serious environmental damage will increase with the increased feed usage required by transgenic fish culture. Add the potential effects of interbreeding between transgenic escapees and wild fish discussed by Stokstad, and transgenic fish culture appears more threat than boon to the wild fishery.

LAUREL J. RAMSEYER
281 Park Avenue, Arlington, MA 02476, USA. E-mail: laureljr@attbi.com

References
1. R. L. Naylor *et al.*, *Nature* **405**, 1917 (2000).
2. Food and Agricultural Organization (FAO), *The State of World Fisheries and Aquaculture 2000* (FAO, Rome, 2000).
3. H. Ackefors, M. Enell, *Ambio* **19**, 28 (1990).
4. British Columbia Environmental Assessment Office, *Salmon Aquaculture Review*, vol. 3 (British Columbia Environmental Assessment Office, Victoria, Canada, 1997).

Dealing with the Risks of Transgenic Fish

ERIK STOKSTAD'S ARTICLE "ENGINEERED FISH: friend or foe of the environment?" (News Focus, 13 Sept., p. 1797) correctly points out the risk to the environment associated with potential releases of genetically modified aquatic animals. This risk is a function of the specific genes, specific species and strain, and environment, and is independent of whether the genes came from genetic engineering, conventional breeding, or inadvertent selection.

The scientific research community must remain attentive to the details of how these very complex problems are being addressed. Researchers can become "collateral damage" to groups with agendas ranging from real environmental concern, to antitechnology, anti–genetically modified organism activists, to crass commercial interests.

In California, State Senator Byron Sher introduced legislation (*1*) SB 1525 that would have made it "unlawful to import, transport, possess... any live transgenic fish." When it was clear that this legislation would shut down many zebra fish researchers in California, it was amended to allow researchers to get a permit for noncommercial purposes only. This could still affect researchers by impacting zebra fish suppliers like Scientific Hatcheries and Exelixis, along with the added burden of another layer of permits. This bill with its amended variations and reincarnations posed a real risk to scientific research in California, before it was finally stopped for this year.

The proponents of a ban on transgenic fish (*2*) submitted a petition to the California Fish and Game Commission to adopt a moratorium on "transgenic" fish and stated that the moratorium would "specifically apply... [to] ornamental aquatic species, such as transgenic zebra fish." Senator Sher's letter of support (*3*) specified plans for "mass producing a transgenic form of these zebra fish" as "wrong." When the zebra fish research community heard about these plans and showed up at the Fish and Game Commission meeting on 29 August 2002, the proposal was defeated. Efforts are under way to find a solution to the real problem of unwanted gene movement in the environment, without impacting scientific research and other insignificant environmental risk situations.

DALLAS WEAVER
Scientific Hatcheries, 5542 Engineer Drive, Huntington Beach, CA 92649, USA. E-mail: deweaver@gte.net

References and Notes
1. See info.sen.ca.gov/pub/bill/sen/sb_1501-1550/sb_1525_bill_20020220_introduced.html.
2. Letter to R. Treanor, California Fish and Game Commission by the Natural Resources Defense Council (NRDC), Institute for Fisheries Resources, Pacific Coast Federation of Fishermen's Associations (PCFFA) and The Ocean Conservancy, 23 July 2002.
3. Letter to M. Flores, California Fish and Game Commission, by State Senator Byron Sher, 30 July 2002.

Encouraging Academic Competition in Europe

THERE HAS BEEN CONSIDERABLE DEBATE ON what are seen to be unfair academic recruitment practices in European countries such as Italy and Spain ("Academic recruitment in Spain and Italy," D. Gui *et al.*, Letters, 2 Aug., p. 770; "Reforms spark more jobs—and protests," X. Bosch, News of the Week, 1 Feb., p. 781). A substantial problem lies in the fact that there is a lack of direct competition for funding among the universities of a specific country based on indicators of scientific performance.

CREDIT: KEN HAMMOND/USDA

Citation analysis, using the Institute for Scientific Information (ISI) database, could foster such competition. As a task force of the Italian Rectors' Conference (CRUI), we analyzed the subset of the ISI database encompassing the scientific production of authors affiliated with Italian institutions (*1*). We ranked Italian universities according to the number of published papers in 1995–99, their citations, and the number of citations received per paper published (impact). We then devised a productivity index (the number of papers per university researcher) and a visibility index (the number of citations per university researcher). We observed that, when data were adjusted for the number of academic researchers actually working in an institution, there were differences in rankings compared with unadjusted data (e.g., smaller universities could become higher in ranking compared with larger universities). This suggests that for comparison of scientific performance of different universities, one should also take into account the human resources available (productivity and visibility indexes). We believe that citation analysis, if endorsed at both national and local levels, may provide good opportunities for stimulating the growth of science in academic systems that are willing to increase the value of merit and genuine scientific interest.

G. A. FAVA,[1] E. BRENO,[2] V. GUARDABASSO,[3] M. STEFANELLI[4]

[1]Department of Psychology, University of Bologna, V.le Berti Pichat 5, 40127 Bologna, Italy. [2]CRUI Foundation for Italian Universities, Piazza Rondanini, 48, 00186 Rome, Italy. [3]University Hospital, University of Catania, Via S. Sofia 78, 95123 Catania, Italy. [4]Department of Computer and Systems Sciences, University of Pavia, Via Ferrata 1, 27100 Pavia, Italy.

Reference

1. E. Breno, G. A. Fava, V. Guardabasso, M. Stefanelli, La Ricerca Scientifica nelle Università Italiane. Una Prima Analisi delle Citazioni della Banca Dati ISI (CRUI, Rome, 2002).

Species Biology and Conservation Funding

IN HIS POLICY FORUM "CONSERVATION priorities for Russian mammals" (16 Aug., p. 1123), L. V. Polishchuk notes that limited government financial resources are often devoted to the conservation of only a few, high-profile flagship species. He suggests that conservation resources should be divided between species on the basis of extinction risk and proposes a mathematical model using the chance of inclusion on the IUCN Red List of Threatened Species, as predicted by annual fecundity, to provide a more uniform allocation.

The implication that the amount of funding required to conserve a species is directly related to its annual fecundity may be an oversimplification. For example, different species face different threats, from habitat loss, to overexploitation, to conflict with, and persecution by, humanity. Mitigating these different threats will incur widely differing costs (*1*). Moreover, some threatened species will generate resources for their own conservation, either through sustainable utilization such as tourism or hunting, or through their public image and marketability by fundraising nongovernmental organizations (*2*, *3*). This should relieve pressure on limited government funding sources for use on species with lower commercial potential. Finally, conservation resources are often allocated to protecting areas that conserve a range of species, rather than to individual species per se, which may be a more efficient tool for biodiversity conservation (*4*). Prioritization for funding of individual species should therefore take into account the relative costs of their conservation, the existence of alternative funding sources, and the extent to which extinction risk is averted by funding multispecies protected area networks.

The search for unifying theories and models in conservation biology to direct policy is intensifying (*5*). The model proposed by Polishchuk may be a useful tool where species face similar environmental and human pressures or where other relevant data are lacking. However, such models mask the complexity inherent in conservation, which may limit their real-world applicability (*6*).

M. J. WALPOLE, R. J. SMITH, N. LEADER-WILLIAMS

Durrell Institute of Conservation and Ecology, University of Kent, Canterbury, Kent CT2 7NS, UK.

References

1. J. K. Miller *et al.*, *Bioscience* **52**, 163 (2002).
2. M. J. Walpole, N. Leader-Williams, *Biodiv. Conserv.* **11**, 543 (2002).
3. N. Leader-Williams, R. J. Smith, M. J. Walpole, *Science* **293**, 2203 (2001).
4. D. Simberloff, *Biol. Conserv.* **83**, 247 (1998).
5. G. Caughley, *J. Anim. Ecol.* **63**, 215 (1994).
6. T. Whitten, D. Holmes, K. MacKinnon, *Conserv. Biol.* **15**, 1 (2001).

Russian mammals at risk include the Siberian tiger.

Response

I AGREE WITH WALPOLE, SMITH, AND LEAD-er-Williams that species biology is by no means the only criterion for allocation of conservation resources among species. It is equally true that allocation decisions should not ignore the species' biology and conservation status. The golden mean between underrating and overrating biology in conservation policy is yet to be developed, however.

An applied aspect of my study is that conservation resources could be divided among species in proportion to their probability of extinction. Because this quantity is known for only a handful of species, I suggest, as a first approximation, allocating resources in accordance with species' chance of being on the IUCN Red List of Threatened Species, which is determined on the basis of annual fecundity.

In fact, the points discussed by Walpole *et al.* do not undermine this proposal. It is true that "different species face different threats," and, to make the situation even worse, those having similar fecundity may well differ in other biological traits. The fact, however, is that despite these effects, which tend to blur the relationship between fecundity and chance of listing, the latter holds up well and would probably be even stronger if confounding factors were equalized. Hence, this relationship ought to be taken into account when working out a conservation strategy.

Furthermore, it's true that "some threatened species will generate resources for their own conservation." But the point is that, regardless of the source of money, be it a visitor to a national park or the state budget, it is the sum total that is allocated according to chance of listing. I realize that fundraising nongovernmental organizations cannot often follow this strategy, because the marketability of the Siberian tiger does not compare with that of the Russian desman, but a governmental agency can. Finally, it's true that "conservation resources are often allocated to protecting areas that conserve a range of species." But the question is how to divide resources among species within a protected area. Species having a higher chance of listing would require, for example, a higher frequency of monitoring, making it possible to catch the first signs of trouble. Account-

CREDIT: CORBIS