LETTERS

Disposing of Weapons-Grade Plutonium

The optimistic scenario for disposing of the stockpiles of separated weapons-grade plutonium in the United States and the Commonwealth of Independent States (CIS) proposed in the letter "Converting weapons to fuel" by Stanley G. Prussin *et al.* (30 Apr., p. 607) is impractical and uneconomic. The letter suggests that irradiating the material in the form of mixed plutonium-uranium oxide (MOX) fuel in all the nuclear power plants in the United States could "effectively eliminate" the entire inventory of roughly 200 metric tons (MT) of weapons-grade plutonium in "about 2 years."

Processing 100 MT of weapons-grade plutonium per year in all U.S. light-water reactors (LWRs), which have a total generating capacity of about 100 gigawatts-electric, would require operating them with full cores of MOX fuel enriched with nearly 5% fissile plutonium, if an average capacity factor of 70% is assumed. In order for a conventional LWR to burn a full core of MOX fuel, it must undergo structural modifications (*1*). To retrofit all U.S. reactors for this purpose would be a major and costly undertaking and would probably be unwise for older reactors.

A less ambitious alternative would be to fuel LWRs with 30% MOX cores. In this case structural changes to the reactor would not be necessary. This strategy would reduce the plutonium throughput to 30 MT per year, increasing the time required to process the entire inventory accordingly. However, this option too is problematic.

Because the United States at present has no MOX fuel fabrication capability, it would have to construct an industrial-scale MOX plant. In order to absorb 30 MT of plutonium per year, its throughput would have to be 600 MT of heavy metal (MTHM) per year, which is about five times more than that of the largest currently proposed MOX plant. In a more modest plan, a single plant with a throughput of 100 MTHM would require 40 years of operation to process the U.S. and CIS plutonium inventories.

Moreover, it is doubtful that the MOX fuel would be commercially competitive with uranium fuel. Thus, MOX-generated electricity, rather than being a "benefit to mankind," would instead mean higher bills for U.S. electricity consumers.

The wisdom of any proposal to disperse weapons-grade fissile material must also be questioned. Sending MOX fuel enriched with weapons-grade plutonium to all U.S. power reactors would enormously complicate the task of safeguarding the material against diversion and theft. Furthermore, a U.S. MOX program would be deleterious to nonproliferation efforts worldwide by legitimizing civil plutonium use.

Finally, one may wonder what would be the actual return for this investment. From a nonproliferation standpoint, reactor processing reduces the attractiveness of the material for weapons use by generating a radiation barrier and by degrading the isotopic content of the plutonium. However, weapons-grade plutonium can also be rendered highly diversion-resistant, at a lower cost, by diluting it with liquid high-level radioactive wastes now awaiting glassification or by adding high concentrations of chemical "spoilers" (such as neutron-poisoning lanthanides). Use of these methods could effect a swift conversion of fissile material inventories into a more secure form. The addition of spoilers would not preclude implementation of a MOX option in the future should the many difficulties be resolved.

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Fisheries Management

The Policy Forum "Uncertainty, resource exploitation, and conservation: Lessons from history" by Donald Ludwig *et al.* (2 Apr., p. 17) raises important questions about the ability of fisheries management to sustain harvests of fish stocks in complex biological and social environments. The impression left is that fisheries managers are incapable of estimating a sustainable yield for fish stocks and, even if they could, the demands of the fishing industry would block implementation of suitable exploitation regimes. In our view, the focus on failure ignores the substantial evidence of success.

The fisheries of the northeastern Pacific are, for the most part, healthy because of conservative management. Scientists' advice has been heeded and has been conservative in the face of the uncertainty noted by Ludwig *et al.* Management regimes are enforcing strict quotas in heavily overcapitalized fisheries and result in significant constraints on a multibillion-dollar industry. Seasonal and area restrictions are imposed for the protection of marine mammals and to account for uncertainties associated with species interactions and overall ecosystem health.

Specific examples illustrate this success. In the Bering Sea, the weight of total acceptable biological catch is about 2.5 million tons, but the fishery is restricted to no more than 2 million tons. Professionals in the fields of population dynamics, marine mammals, oceanography, economics, anthropology, and ecology participate in setting the level of harvest. Political pressures on management derive largely from economic pressures related to the allocation of quotas and not in quota setting.

Cooperative Canadian and U.S. research and management since 1937 have restored the sockeye and pink salmon stocks of the Fraser River in British Columbia. These fisheries were decimated by rockslides that blocked fish passage early in this century. Construction of fishways eliminated the major obstacles to rebuilding fish runs. Harvests have risen from about 1.5 million sockeye (1918–1921) to 12.9 million (1987–1990). This occurred despite tremendous pressure from an overcapitalized fishery to harvest more. The task of restoring runs of salmon in Washington, Oregon, and California demands serious scientific attention. The roles of habitat destruction, overfishing, hatchery production, and interdecadal shifts in ocean environment (*1*) present daunting challenges.

When halibut stocks were reduced by fishing in the 1920s, the West Coast halibut fishing industry called on Canada and the United States to initiate scientific studies of the causes and to recommend measures for conservation. Over the course of 70 years as a managed fishery, stocks of halibut have fluctuated with environmental changes and the effects of direct or indirect fishing, but they have never been in a state of distress or in danger of irreversible overexploitation. The highest yield ever from that fishery occurred in 1989 after 100 years of commercial harvests.

We may never know the precise relationships between environmental conditions and fishing pressure that led to the collapse of the Peruvian anchovy fishery or the California sardine fishery. However, there is broad scientific agreement that stocks of small pelagics fluctuate massively through time independent of fishing pressure. These fisheries pose complex problems of prediction, and management strategies have been designed and implemented that attempt to take these characteristics into account.

There is much more to learn about the management of these and other fisheries in the North Pacific, and funding for research is hardly lavish. Better databases are needed, and annual fisheries cannot wait for scientific consensus to be achieved. However, current fisheries management in this area contradicts the conclusions of Ludwig *et al.* that fisheries scientists cannot determine harvest levels to sustain stocks at abundant levels and that management institutions are incapable of resisting industry pressures.

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Determining Carcinogenicity

We write in reference to the letter "Pesticides and the Delaney amendment" by Philippe Shubik (4 June, p. 1409). For those who may be unfamiliar with the International Agency for Research on Cancer (IARC) Monographs on the Evaluation