Letter from the Desk of David Challinor
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In the 1930's before WWII Dwight Fiske, a popular pianist, sang one of his songs, then considered rather risqué. As I remember, it went:

"The virgin sturgeon needs no urgin',
That's why caviar is my dish…"

I had not thought much about this fish or its roe (eggs) since then, because I am indifferent to caviar's taste. However, a recent article in the New York Times (9/30/05) on the U.S. ban of beluga caviar imports caught my attention and stimulated my interest in this enormous prehistoric-looking fish. This month's letter will discuss this fish and consider the reasons for the ban and what, if anything, can be done to lift it.

People have been enjoying caviar—the salty (added as a preservative) tasting sturgeon roe—for 2,500 years and until 1900 the supply was so plentiful that American caviar was served in our bars the way salted peanuts and potato chips are today. At the beginning of the last century conditions changed, and these boney-plated fish were harvested for both their flesh (firm, white and often eaten smoked) and their roe. There are 25 species in the world and virtually all are heavily fished wherever they still survive.

Perhaps the best known species is the beluga (*Huso huso*); the largest known specimen, caught in the Volga in 1736, was 8.5m (28ft.) long and weighed 4,500 lbs. Another two-tonner was netted by poachers in the Caspian in 1997. Today beluga are basically confined to the Black and Caspian seas. When the ice melts they swim up river to spawn. Belugas have been a principal source of caviar; although all sturgeon species produce it, connoisseurs generally favor beluga caviar.

Until the breakup of the Soviet Union, its government kept tight control over sturgeon fisheries in the northern half of the Caspian. They enforced catch limits and operated hatcheries to replenish the beluga populations. Now, competition between Azerbaijan, Kazakhstan and Russia has led to a free-for-all harvest of sturgeon. Since 1997, the species has been subject to the terms of the Convention on International Trade in Endangered Species (CITES). The U.S. and other signatories to the convention intend to enforce an import ban into their nations until the three countries bordering the Caspian Sea develop satisfactory plans to manage and conserve beluga. The U.S. consumes about 60% of the world's caviar production; therefore, it has a direct interest in seeing that new management plans are reviewed and ultimately approved so that the ban can be lifted.

The Smithsonian was involved in studying the sturgeon's decline in the 1970's when the late Shah of Iran was still enthroned. About six years before his fall (1979) he made a state visit to Washington. After such visits, the State Department tries to show some concrete results, so to that end Secretary Ripley and I called on the Shah to express

our interest in an Iran-U.S. science cooperation agreement. This was later signed and the two countries agreed to set up a joint project with Iranian fishery scientists to study the effect of nutrient and pesticide runoff from the farms on the north slopes of the Elburz Mountains. The runoff drains into the shallow waters of the Caspian's south shore, a prime sturgeon feeding area. We sought to learn the effect of this runoff on invertebrates fed on by sturgeon. Despite endless appeals to Congress for modest funds ($25,000) to implement the agreement, no money was appropriated and the project died.

The Caspian Sea, long the major source of caviar, is a remnant of the Tethys Sea that millions of years ago covered much of Eurasia. It is salty, but has only about half the saltiness of the Black Sea. About 300 rivers empty into it, with more than three quarters of its fresh water coming from the Volga, whose large delta at the north end has been the site of the principal beluga fishery. Besides sturgeon, the northern Caspian also has a population of endemic seals, now isolated like their freshwater relatives in Lake Baikal by the vast shrinkage of the Tethys.

Sturgeon live globally in the northern hemisphere—giant individuals abound in North American rivers on both coasts as well as in the temperate zone rivers of Europe and China. Until recently they were the dominant fish species in all these rivers. Their present morphology (structure and form) is virtually unchanged from the Cretaceous era (100 million years ago) and their ancestral forms can be traced back more than 300 million years. They are mostly bottom feeders, but are agile enough to catch fish and an occasional duckling, squirrel or even a seal pup. Despite their size, sturgeon have an odd and still not understood habit of leaping out of the water and falling back with a big splash, like humpback whales.

It would be tragic to witness the demise of this ancient fish that has successfully endured the tectonic upheavals, meteor collisions and wild climate swings of the past hundreds of millions of years. In an evolutionary sense it has been a remarkable survivor. Although current attention is focused on the struggle to save the Caspian sturgeon fisheries, the state of U.S. sturgeon fisheries is equally dismal. On both coasts sturgeon have been fished out or decimated by pollution, dams and other human-caused assaults. As an example of overfishing, Delaware Bay's sturgeon fishery was gone in only one decade (1890-00). Although the smaller males will breed every year, the larger females spawn only at three- or four-year intervals or longer and they must be five or six years old before they do so.

Besides being overfished, the Caspian sturgeon took another hit from a most unusual source—an accidentally introduced American jellyfish. About six years ago a comb jellyfish (*Mnemiopsis leidyi*) invaded the Caspian from the Black Sea via the Don/Volga canal. A native to our east coast, it is easily ingested as ballast water in oceangoing ships (a primary method of alien species introduction), and in that way entered the Black Sea via the Mediterranean in 1989. The population of these elongated jellies (about 5" x 3") exploded and they voraciously consumed zooplankton, fish eggs and even small fish. This assault on the food chain almost wiped out Black Sea fisheries, but miraculously they began to recover in 1997 when another comb jelly from a different

biological order, *Beroe ovata*, arrived on the scene—probably also from ship ballast. This invader, also a voracious predator, specialized in consuming *M. leidyi* so that by 2001 researchers in the Black Sea had difficulty finding any *M. leidyi* to study.

Because of the successful control of *M. leidyi* in the Black Sea by *B. ovata*, some scientists believe the specialized predator should be released in the Caspian. However, according to an article by Richard Stone in *Science* (2005) 309:1805-6, the five countries that border the Caspian cannot agree on such an introduction.

There is reason to be cautious because Caspian salinity is considerably lower than the Black Sea's. Experiments are underway to see if *B. ovata* could establish a propagule (survive and breed successfully) in the Caspian. So far it seems this species does not eat zooplankton and feeds almost exclusively on the killer jelly, whose maximum growth in the Caspian is but a fraction of its normal size elsewhere. Attempts at laboratory propagation of *B. ovata* in Caspian seawater has not been very successful; proponents for introduction claim that the only way to know is to release them into the Caspian and see whether they find a niche to breed. Thus today, further introduction efforts of the "good" jelly are on hold as long as Kazakhstan (one of the five Caspian countries) objects.

Meanwhile, many endemic Caspian fauna continue to decline precipitously. The zooplankton consumed by the killer jelly has deprived a local schooling fish (kilka) of its food, and the once active Iranian kilka harvest declined from 85,000 tons in 1999 to only 15,000 tons last year. Kilka is a favored food of not only the Beluga, but also of the Caspian seal whose population has plummeted 85% in the past 50 years (from 1.5 million to 225,000).

Worldwide the legal harvest of the 25 sturgeon species has declined to only 14% of their peak harvest in 1975, so that today aquaculture is the primary legal source of caviar. Fortunately, sturgeon lend themselves to aquaculture. The Soviets had several large successful hatcheries, which private entrepreneurs are trying to revive. The Iranians maintain the International Sturgeon Research Institute in Rasht on the Caspian coast, where they also raise the local Persian sturgeon native to the southern Caspian. The hatchery releases sturgeon to increase the wild population, which is currently protected and monitored by the government so successfully that Iran produces about half of the legal quota of caviar presently imported by the U.S.

The high price of quality caviar (up to $200 an ounce) has stimulated sturgeon aquaculture in California, Florida, Germany, China and elsewhere. The facilities for farming these fish require a substantial investment as well as patience and surgical skill. As previously mentioned, females take years to mature, and they breed at relatively long intervals. Because a breeding female is so valuable, hatchery technicians now perform caesarian sections on gravid (pregnant) females. Once laid, eggs have a sticky coating enabling them to adhere to the substrate (rocks, pebbles, etc.) until hatching; therefore, in aquaculture the roe must be harvested just before eggs are released. This sometimes requires an exploratory operation to determine egg development—hence the need for surgical skills to stitch up the fish after sampling the roe.

In Florida, native sturgeon are being raised successfully; an experimental release of 1200 fingerlings in 1997 found they had a high survival rate. However, the Fish and Wildlife Service later banned the release of additional native hatchery-bred Atlantic sturgeon for genetic reasons. The 1200 released fingerlings were the progeny of only one female and three males and thus their progeny would be too inbred. The Florida hatchery then shifted to exotic sturgeon, not beluga, because there are only four beluga in the U.S. (two are in public aquaria) and none have yet been sexed. The hatchery thus raised Russian sturgeon (*Acipepenser gueldenstaedtii*), another good caviar producer. In the wild, these females must be 15 to 20 years old before they produce the highly prized osetra caviar, although that time may be shortened somewhat in hatchery tanks.

In Germany, United Food Technologies aims to produce 500 metric tons/year of eels, catfish, tilapia and sturgeon in a closed cycle (tank water is refiltered and only evaporative loss is added) aquaculture operation. They should now be producing about six metric tons annually of sevruga caviar—another gourmet favorite.

Fortunately, sturgeon are so economically valuable that it is unlikely they will be extirpated. The policy arguments about release of hatchery-raised sturgeon will, I am confident, be resolved someday. The principal long-range impediment to their survival is human modification of their habitat, which is detrimental to their ancestral life cycle. Once the damage has been done, it is expensive and time-consuming to reverse, but there are now enough successful examples of restocking protected habitats (condors in Arizona, puffins in Maine, wolves in Yellowstone) that there is hope for sturgeon, too.

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P.S. Much information for this letter came from Robert J. Test of Alexandria, VA and from Richard A. Carey's (2005) "*The Philosopher Fish*;" *Counterpoint*, New York, NY.