CONSERVATION BIOLOGY

The sturgeons' plight

William E. Bemis and Eric K. Findeis

STURGEONS and paddlefishes — 27 Recent species in two families, Order Acipenseriformes — have an especial claim on the attention of biologists and the public. For biologists, acipenseriforms are a group that has been extant for a quarter of a billion years; for the public, they are prize exhibits in aquaria and, of course, are the source of caviar.

But the message last month from an international gathering* of researchers was unhappily familiar: wherever they occur in the wild, in North America, Europe and Asia, these fishes are in trouble. At one time so numerous in North America that they posed hazards to navigation, all species now face extinction[1] because of over-fishing, poaching, pollution, habitat destruction and dams barring access to spawning sites.

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Diminishing resource: a large kaluga sturgeon from the Amur River, near Khabarovsk, Siberia. Kaluga are endemic to the Amur, but are fast becoming depleted in numbers not least because they yield high-quality caviar. (Photograph by V. Svirsky.)

Habitat destruction in the Aral Sea basin threatens the only surviving species of *Pseudoscaphirhynchus* (V. Birstein & B. Goncharov, Inst. Developmental Biology, Moscow). Uncontrolled exploitation of beluga (*Huso huso*) in the Caspian Sea also endangers this, the largest species, for Russia's continuing annual release of 100 million sturgeon larvae into the Volga cannot keep pace. In the Amur River, shared by Russia and China, kaluga (*H. dauricus*) were largely unmolested until a warming of relations brought intense commercial fishing.

In North America, Atlantic sturgeon (*Acipenser oxyrhynchus*) never recovered from over-fishing a century ago, while others such as pallid sturgeon (*Scaphirhynchus albus*) were hit by river rechannelling. In Western Europe, the Baltic sturgeon (*A. sturio*) is nearly extinct. And in China, the Gezhouba dam on the Yangtze River virtually eradicated giant Chinese paddlefish (*Psephurus gladius*) (Wei, Q., Yangtze River Fisheries Research Inst., Shashi).

One problem is the biology of sturgeon: long-lived and slow to mature, they depend on large rivers, which are under environmental pressure worldwide. Their size and predictable spawning runs make them easy to catch even with simple gear. Only in remote areas (northern Ontario; M. Ferguson, Univ. Guelph), small, well-managed fisheries or under strict protection (*A. brevirostrum*; J. Boreman, Univ. Massachusetts, Amherst) have sturgeon avoided decimation.

Although we know something of the generic relationships within the acipenseriforms, the group's vast range and great variation complicate analyses at the α taxonomic level. The resulting disputes are not merely academic. For instance those centring on the Alabama sturgeon, *S. suttkusi*[2], generated editorials in the *Wall Street Journal*[3]. Is this a distinct species? Is it extinct? If not, should development of the Alabama River proceed given the sturgeon's warranted protection under the Endangered Species Act?

There are however rays of light in this gloomy picture. We finally have some basic life-history data on sturgeon, thanks to telemetry (B. Kynard, Univ. Massachusetts, Amherst), and international awareness of their plight is growing. Moreover, gourmets can do their bit by insisting on caviar from fish farms. Elimination of the wild harvest of this delicacy would help to ensure the survival of these ancient and remarkable fishes. □

William E. Bemis and Eric K. Findeis are in the Graduate Program in Organismic and Evolutionary Biology, University of Massachusetts, Amherst, Massachusetts, 01003, USA.

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1. Birstein, V. J. *Conserv. Biol.* **7**, 773–787 (1993).
2. Williams, J. E. & Clemmer, G. H. *Bull. Alabama Mus. nat. Hist.* **10**, 17–31 (1991).
3. *Wall Street J.* A14, 22 Nov. 1993; A14, 26 Jan. 1994.

DAEDALUS

Deep heat

IF you let a water drop fall on a red-hot plate, it does not touch the plate. Instead, it flies vigorously around on a cushion of steam. The steam seems to be generated preferentially towards the rear of the moving droplet, and pushes it along.

Daedalus once invented a red-hot boat based on this principle. Its hull, separated from the water by a film of steam, experienced almost no viscous drag. As it moved through the water the generated steam exerted an asymmetric thrust which helped it along, ramjet fashion. The principle might apply even better to a red-hot submarine. With no wave losses and no drag it might reach enormous speeds. Furthermore, below 2,200 metres the hydrostatic pressure exceeds the critical pressure of water. The vessel would be surrounded not by steam but by supercritical fluid of even lower viscosity. This would merge into the surrounding ocean, without the instability and rapid heat transfer of a discrete steam–water boundary.

At first, Daedalus feared that only a nuclear source could keep his submarine hot enough. But he then recalled that the ocean is in equilibrium with the atmosphere, and must be fully saturated with air. To be saturated at the local high pressure, the deeps must contain a vast amount of dissolved oxygen. Oxygen-saturated supercritical water, of course, supports combustion strongly. It is even used to burn up oily organic waste.

So Daedalus's red-hot submarine will take the form of an unmanned oil tanker. Its shape will be optimized for ram-steam propulsion; it will have a porous surface sealed with nitrocellulose lacquer. It will be towed out into the ocean by a tug, and allowed to sink. At the correct depth the lacquer will be fired, igniting the oil as it exudes from the uncovered pores. The resulting sheath of superheated steam and combustion products will stream back along the shaped hull, building up its thrust as a high-pressure external combustion supercritical ramjet. Eddies will not be shed from the smooth, compressible supercritical boundary layer. The only viscous drag will come from a small navigation package towed safely on a long cable behind the red-hot craft, which may reach speeds of hundreds of metres per second. Near its destination, the navigation package will steer it up towards the surface. Its propulsion will falter; the package will deploy floats and emit a homing signal for the collecting tug. Deep sea oil transport should be very clean. Leaks or even major spillages will never reach the surface, but will burn up in the oxygenated depths. David Jones