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Characterization of Aquaculture in the Western U.S.

STURGEON FARMING

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Photo: Sturgeon, Tsar Nicoulai Farm, California.

Sturgeon populations worldwide have declined for centuries as a result of overharvest for their highly valued caviar and meat, pollution, and construction of dams. The global wild harvest of sturgeon peaked in 1977 at approximately 71 million lb of sturgeon, following which natural stocks have experienced a continuous decline (Bronzi, 2011; 2023). Natural populations of sturgeon historically have included 27 species distributed north of the 30th parallel throughout North America, Europe, and Asia.

Declining populations of sturgeon in the 1950s prompted the Soviet Union to develop sturgeon hatcheries to support a stock enhancement program as mitigation for the construction of dams on tributaries of the Caspian Sea that are critical to the anadromous spawning life cycles of sturgeon. The Soviet stock enhancement program included effective management of wild sturgeon harvests and successfully sustained a large commercial harvest of sturgeon through the 1980s that supplied approximately 80% of the worldwide supply of sturgeon caviar and meat (Bronzi et al., 2019). The collapse of the Soviet stock enhancement program in the 1990's led to subsequent declines in the Caspian Sea sturgeon population (Bronzi and Rosenthal, 2014) that triggered 1997 regulation of the international trade of sturgeon products worldwide under the Convention on International Trade in Endangered Species (CITES, 2024).

In North America, various populations of sturgeons on the East Coast (Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, and shortnose sturgeon, *Acipenser brevirostrum*), the Midwest (lake sturgeon, *Acipenser fulvescens*), and the West Coast (white sturgeon, *Acipenser transmontanus*; green sturgeon, *Acipenser medirostris*) supported major commercial fisheries from about 1890 to 1910, followed by their collapse. The North American populations largely have remained in a precarious status with some listed as threatened or endangered with

Photo: Idaho Springs Caviar Caviar.

little to no commercial harvest. In the late 1970s, the U.S. Fish & Wildlife Service sponsored research to develop hatchery methods for artificial spawning of sturgeon, and by 1981 had successfully spawned white, lake, and Atlantic sturgeon. Detailed methodologies for successful spawning of sturgeon were established and published in the 1980s (Conte et al., 1988) with the first permits granted to collect wild white sturgeon from the Columbia, Sacramento, and later the Snake River for spawning. The offspring raised from these early collections were raised on farms and in hatcheries to serve as future domestic broodstock (Logan et al., 1995). Farmed production of sturgeon began in California and was followed by Idaho. In Idaho, farmers developed the Sturgeon Cooperative to capture sturgeon broodstock to support private farms but also for conservation efforts in support of wild populations (Idaho Springs Foods, 2024). Subsequent research funded by the Western Regional Aquaculture Center contributed to the domestication of white sturgeon that eliminated the reliance on annual collection of wild white sturgeon. A number of private aquaculture companies emerged over the next decade in California, Oregon, and Idaho to raise white sturgeon to market size (Doroshov et al., 1997).

Sturgeon spawning and farming techniques have since spread worldwide, with sturgeon farms now established throughout Europe, Russia, and China, North and South America, and Madagascar. Many species of sturgeon are farmed, including the historic traditional species from the Caspian Sea (Beluga, *Huso huso*, Russian, *Acipenser gueldenstaedtii*, stellate/sevruga, *Acipenser stellatus*, Persian, *Acipenser persicus*, and Siberian, *Acipenser baerii*), the Asian species (Kaluga, *Huso dauricus*), the white sturgeon, and numerous hybrids. Sturgeon meat and caviar production from sturgeon farms reached 1.7 million lb of caviar and 2.5 million lb of meat by 2022 (Bronzi, 2023). China has emerged as the dominant producer of caviar and sturgeon meat, with the North American sturgeon farms that were the first producers of farmed caviar and meat, ranking 8th in the world, but supplying only 2% of world caviar production (Figure 1).

Sturgeon farming poses several challenges that are distinct from those of major U.S. aquaculture species. Chief among these is that sturgeon do not reach maturity for 6 to 8 years in states such as California and 10 to 13 years in states with cooler temperatures. Research funded by the Western Regional Aquaculture Center from 1993 to 2018 was instrumental in addressing several of the key bottlenecks to commercial seed production of white sturgeon (NAA, 2024). Sturgeon fingerlings became more readily available as domesticated broodstock reached maturity and the supply of fingerlings led to growout production and market development. In California, weekly sales of farmed sturgeon date back to 1985, with rapid growth of the U.S. sturgeon sector occurring since

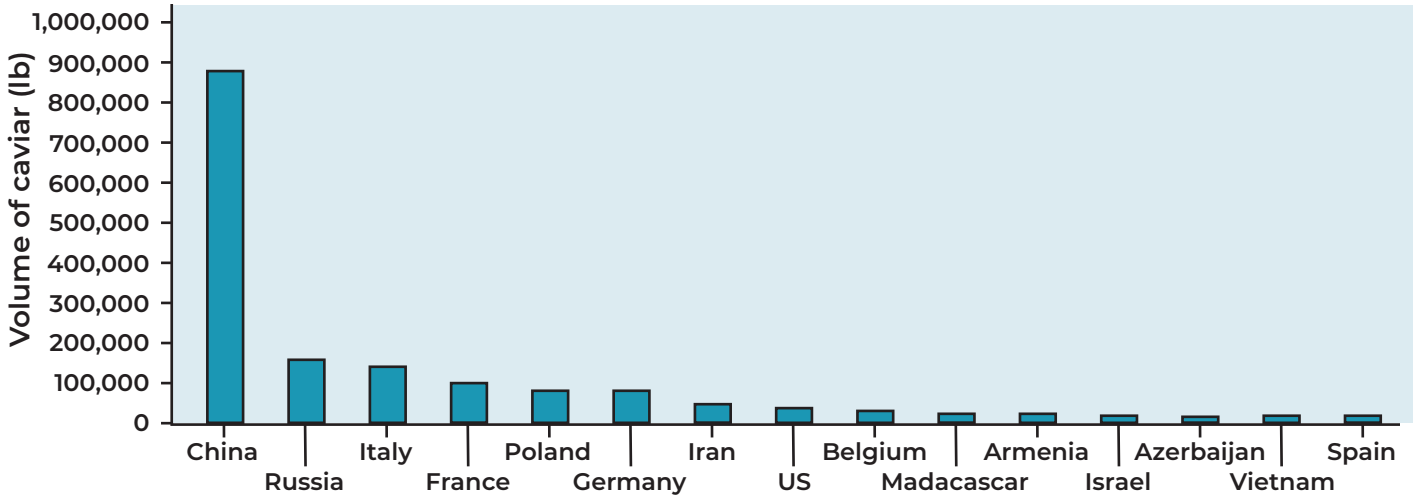

Figure 1. Top 15 caviar-producing countries (by volume), 2022. Source: Bronzi (2023)

the mid-1990s (van Eenennaam et al., 2004). Early market development in Idaho included direct sales from farms to refugees from the Soviet Union who had re-located to Idaho.

The U.S. Censuses of Aquaculture show growth in the number of farms, volumes sold, and sales increases through 2018 (Table 1). The number of farms reported in the Census of Aquaculture increased from 12 in 1998 to 18 in 2018, with total sales reaching $10.3 million from 2.6 million lb sold in 2018 (USDA-NASS 2000, 2006, 2014, 2019). Of the 18 farms that reported sales of sturgeon in 2018, 11 also reported caviar sales of $7.7 million from 60,000 lb of caviar sold. California is the largest sturgeon and caviar-producing state in the U.S. with approximately 86% of 2018 sales, followed by Idaho, with some minor production in Oregon. Other sturgeon farms have developed over time outside the Western Region in Florida, North Carolina, Georgia, and Hawai'i.

Sturgeon farms support at least 18 distinct supply chains in the Western Region (Figure 2 presents a generalized supply chain map). Some sturgeon farms purchase fingerlings from other farms for growout. Most sturgeon are sold to processors that specialize in caviar production, while some other farms have integrated vertically by incorporating caviar processing into their overall farming business. The meat remaining from the carcasses of large caviar fish and processing of the traditional sized 22-lb sturgeon reared specifically for meat production is sold into retail markets (restaurants and supermarkets).

In California, Idaho, and perhaps other states, some more limited amounts of sturgeon are sold into

Table 1. U.S. sturgeon farming, number of farms and value of sales over time. Source: USDA-NASS (2000,2006, 2014, 2019). "D" indicates data suppressed for confidentiality reasons.

Category	1998	2005	2013	2018
Sturgeon				
Number of farms	12	13	22	18
Volume sold (lb)	none reported	1,050,600	2,088,000	2,571,000
Value of sales ($)	D	D	D	$10,318,000
Caviar				
Number of farms	none reported	5	12	11
Volume sold (lb)	none reported	none reported	22,000	60,000
Value of sales ($)	none reported	D	D	$7,689,000

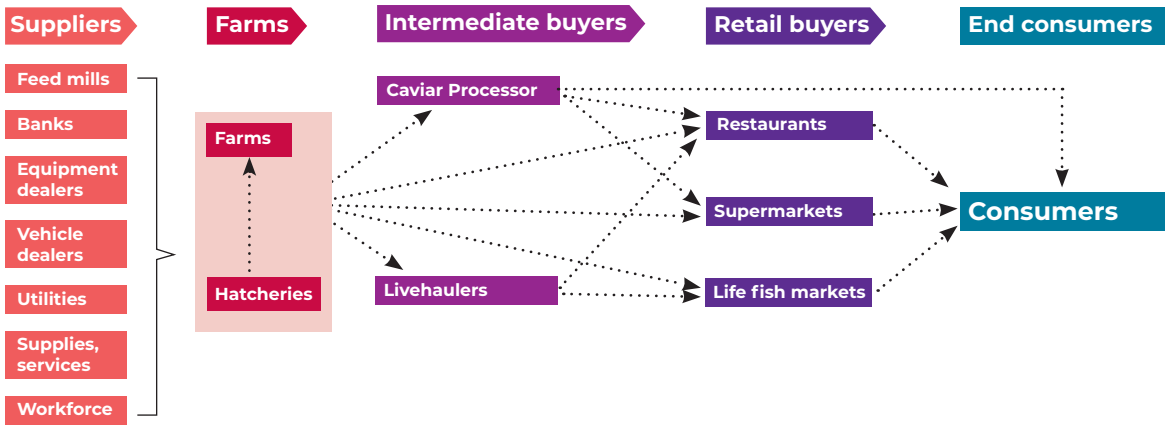

Figure 2. Supply chains supported by sturgeon farms in the Western Region.

live fish markets, either through sales to a livehauler or transported by the farm to live fish markets in the region. Live fish markets are unique retail outlets that have installed the tanks, pumps, and filters necessary to hold and display fish until selected and purchased by their patrons. In California, the majority of foodfish such as tilapia, catfish, and largemouth bass raised on farms are sold to such live fish markets (Engle et al., 2024).

The growth of sturgeon farming in the U.S. is a major success story of U.S. aquaculture. Nationally, sturgeon farming was reported to contribute to 1,711 jobs and economic output of $517 million in 2022 (NAA, 2024). Moreover, U.S. sturgeon farms in California and Idaho are rated as a Best Choice by the Monterey Bay Aquarium Seafood Watch program (Seafood Watch, 2020). Nevertheless, legislation designed to protect wild populations of sturgeon, of which some species are listed as critically endangered, could inadvertently be used to prohibit sturgeon farming in the U.S. Given that sturgeon raised on U.S. farms have domesticated broodstock, sturgeon farming does not rely on supplies of fish from the wild. Not only that, but conservation aquaculture in Idaho has helped considerably with sustaining the population and opening up new recreational fishing areas above the native range of white sturgeon on the Snake River. In northern Idaho, conservation efforts that include aquaculture have also assisted with recovery efforts of the Kootenai River white sturgeon population. Thus, farmed sturgeon represents an agricultural alternative to wild harvests that directly supports conservation of critically endangered wild stocks of sturgeon and also eliminates pressure on wild populations by meeting consumer demand for caviar and sturgeon from domesticated, farmed production.

Photo: Keri Rouse for Virginia Tech

Sturgeon caviar.

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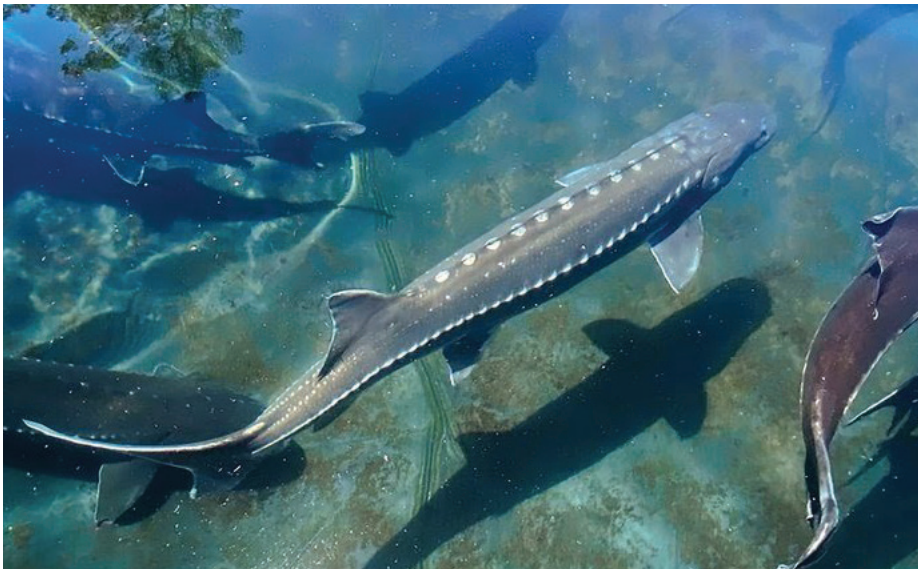

Photo: Courtesy of Tsar Nicoula Farm, California

Sturgeon, Tsar Nicoula Farm, California

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This project was supported by the Western Regional Aquaculture Center award number 2020-38500-32561 from the United States Department of Agriculture National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

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