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Amur Fish: Wealth and Crisis

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Amur Fish: Wealth and Crisis
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Contents

Introduction

The Amur River is one of the biggest free-flowing rivers of the world – it is the ninth longest (almost four thousand kilometers long) and has the tenth biggest watershed (about two million square kilometers). The Amur River is formed by the confluence of its uppermost tributaries Shilka and Argun and flows through its estuary bay into the Tatar Strait of the Sea of Okhotsk. The other biggest tributaries of Amur River are: Onon (Mongolia, Russia), Kerlen (Mongolia, China), Zeya (Russia), Bureya (Russia), Songhua (China), and Ussury (China, Russia). The basin lies in three countries encompassing three Chinese provinces: Jilin Province, Heilongjiang Province, and Inner-Mongolia Autonomous Region; five Russian administrative units: Primorsky Kray, Khabarovsky Kray, Amur Oblast, Chitayskaya Oblast, and Evreiskaya Autonomous Oblast; and three Mongolian regions (aimag): Tov, Khentii, and Dornod. The border between China and Russia stretches for over 3,000 km on the Amur River, making it one of the world's major border rivers. The population of the basin exceeds 80 million people, of which over 90% belong to China.

The fish resources of Amur River have tremendously decreased during the past century due to excessive catch, pollution, habitat degradation, and hydropower development. In this one of the richest salmon rivers of the world in 1910 the total catch of salmon according to Russian sources was over 100,000 tons. The total catch of valuable sturgeons was 1.2 thousand tons. By now these numbers decreased more than tenfold, illustrating the critical condition of Amur fishery.

Considering this the release of the book "Amur Fish" written by G. V. Novomodnyi, S. F. Zolotukhin, and P.O. Sharov is very timely. The authors managed to produce a concise and amazingly informative piece. The book starts with description of the history of studying of Amur fish by famous scientists such as Pallas, Middendorf, Schrenk, Nikolskyi, and others. The authors then provided the latest description of the existing diversity of Amur fish that includes both native and invasive species. Special attention was paid to fish species listed in the Red Data Book of Russian Federation with description of biology and current status of populations of each species. The richly illustrated book with grayscale illustrations in the text and true color images in the middle contains description of salmonids and sturgeons of Amur providing thorough analysis of the existing threats to these most valuable resources of the great river, uncovering causes of the drastic decrease of abundance, and proposing feasible solutions to current problems.

This is almost scientific publication, but one could hardly call it overloaded with information and special terminology. It is very easy to read and will be interesting to both specialists and wider circle of readers who are concerned about the biological resources of Amur and conservation of this world treasure. The book is certainly very useful for government agencies and environmental nongovernmental organizations concerned with nature protection, as it reveals information about such problems as illegal fishing and trade of valuable species, issues of habitat degradation and water quality, main threats to biological diversity and sustainability of Amur ecosystem as well as many other problems of the basin. Many fishermen would find it useful as a plentiful source of information on fish species and their place in the giant freshwater ecosystem of Amur River watershed. Some data is provided on impacts of marine driftnet fishing and forest fires on condition of salmonids stocks of Amur and its tributaries.

The authors are absolutely right writing that: "Solving problems of Amur fish means solving problems common for the whole basin, which demands taking into account all aspects of the socioeconomic development and use on natural resources of the South of Russian Far East, Northern China, and Eastern Mongolia." The book should attract attention of the global community as it highlights issues of one of the most unique and globally important ecosystems of the planet.

K. A. Zgurovsky

Coordinator of Marine Program of the Far Eastern Branch of WWF Russia, PhD.

Amur Fish Diversity and Research History

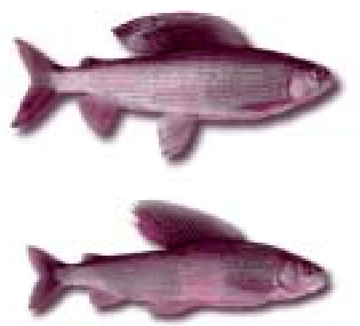


Figure 1. Anyui Graylings: *Thymallus* sp.1 (top), yellow-spotted *Thymallus* sp.2 (bottom)

European bitterling — *Rhodeus sericeus* (Pallas, 1776)

Barbel steed — *Hemibarbus labeo* (Pallas, 1776)

Amur asp — *Pseudaspius leptocephalus* (Pallas, 1776)

Figure 2. Amur species described by Pallas

Before Europeans came to the Amur River, indigenous people were quite familiar with local fish as fishing was one of the main subsistence activities. Soldatov catfish (*Silurus Soldatovi*) is one example. By the time this species was described and given a Latin name, it had already been given a name by the Nanai indigenous people. Another example is grayling. Fish biologists have only recently discovered additional grayling species in the Amur. In Anyui River, a tributary of the Amur River, two types of grayling differ significantly from each other both in appearance and migration patterns (Figure 1). That was no secret for Nanai people, who already had names for both species.

Nonetheless, it is widely accepted that the study of Amur fish began in 1772 when Petr-Simon Pallas visited the Onon River. In that year he collected various Amur fish and in 1776 published the first list of Amur fish including 15 species, including three new species (Figure 2).

The most recent lists of Amur fish retain eight species and subspecies described by Pallas. This includes: taimen – *Hucho taimen* (Pallas, 1773), lenok - *Brachymystax lenok* (Pallas, 1773), river smelt – *Hypomesus olidus* (Pallas, 1814), flathead sculpin – *Megalocottus platycephalus* (Pallas, *1814)*, lake minnow – *Phoxinus perenurus* (Pallas, 1814), starry flounder – *Platichthys stellatus* (Pallas, 1787), white-spotted char – *Salvelinus leucomaenis (*Pallas, 1814), resident Dolly V*arden – Salvelinus malma curilus* (Pallas, 1814).

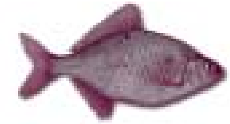
Pall*as* was followed by Johan Gotlib Georgi, an ethnographer, traveler, and professor of mineralogy of the Imperial Academy of Science. After a comparison of his and Pallas' collections, Georgi counted 20 species. He was the first to describe the biggest Amur fish, the kaluga, which was quite numerous at that time.

After the middle of the 19th century, scientific expeditions were conducted on a regular basis, with participation by famous scientists such as Middendorf, Maak, Shrenk, and Radde. In those years, Shrenk discovered the Amur sturgeon, which was described scientifically by Brandt in 1869.

The greatest Amur fish biologist of the second half of 19th century was undoubtedly Benedict Ivanovich Dybovsky. Dybovsky was a doctor of zoology and professor of the Warsaw Main School, who was sent to Eastern Siberia in 1864 for his part in the Polish

Ussurian sawbelly — *Hemiculter lucidus* (Dybowski, 1872)

Upper Amur grayling — *Thymallus grubii* (Dybowski, 1869)



Russian bitterling — *Acanthorhodeus asmussii* (Dybowski, 1872)

Vladislavia — *Vladislavia taczanowskii* (Dybowski, 1869)

Amur pike — *Esox reichertii* (Dybowski, 1869)

Chinese sleeper — *Perccottus glenii* (Dybowski, 1877)

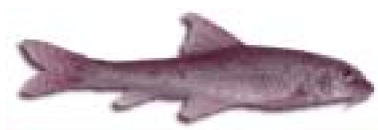
uprising. Studying Amur ichthyofauna was only a small portion of his scientific work among zoogeography; the collection of plants, insects, crustaceans, and mollusks; hydrology; ethnography and other pursuits. Dybovsky was actually unable to study the whole Amur Basin. In 1865 he lived near Chita in the Inogda River Valley (Shilka River watershed). Then in 1868, he accompanied general Skolkov in visit to the Amur and Ussuri, and in 1872-74 he organized several expeditions to Argun and Ussuri watersheds. Dybovsky's list of Amur fish included 53 species. The latest list retains 19 species described by Dybovsky.

It would be possible to call 20th century in the history of Russian fish systematics zoogeography the century of Lev Semenovich Berg. Berg had never been to the Amur, but he had ample opportunity to analyze collections that were brought to him. He described many new taxa and produced a list of Amur fish that includes 85 species and subspecies.

The level of communication among scientists of that time

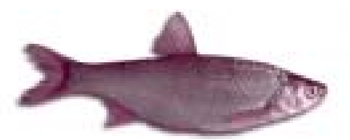
Far Eastern brook lamprey — *Lethenteron reissneri* (Dybowski, 1869)

Siberian stone loach — *Barbatula toni* (Dybowski, 1869)

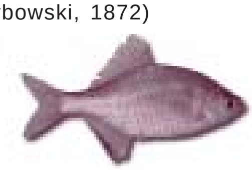


Amur gudgeon — *Gobio cynocephalus* (Dybowski, 1869)

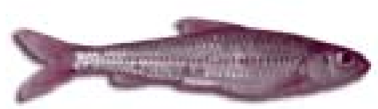
Pseudobagrus ussuriensis (Dybowski, 1872)



Amur ide — *Leuciscus waleckii* (Dybowski, 1869)



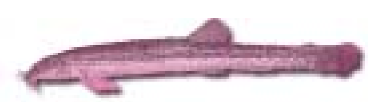
Khanka bitterling — *Acanthorhodeus chankaensis* (Dybowski, 1872)



Slenderhead shiner — *Squalidus chankaensis* (Dybowski, 1872)

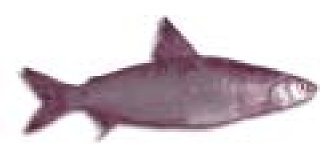
Amur sculpin — *Mesocottus haitej* (Dybowski, 1869)

Lagowsky minnow — *Phoxinus lagowskii* (Dybowski, 1869)



Mohoity weatherfish — *Misgurnus mohoity* (Dybowski, 1869)

Chekanowsky minnow — *Phoxinus czekanowskii* (Dybowski, 1869)

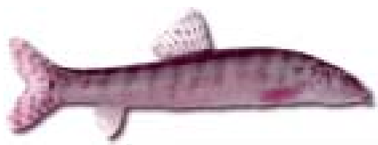


Khadary whitefish — *Coregonus chadary* (Dybowski, 1869)

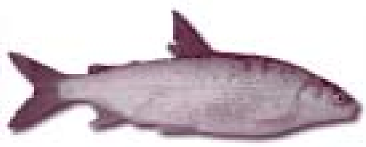
Figure 3. Amur species discovered and described by Dybovsky

Oily shiner — *Sarcocheilichthys nigripinnis czerskii* (Berg, 1914)

Soldatov gudgeon – *Gobio soldatovi* (Berg, 1914)



Leptobotia – *Leptobotia mantschurica* (Berg, 1907)



Amur whitefish — *Coregonus ussuriensis* (Berg, 1906)

Figure 4. Amur species, described by Berg

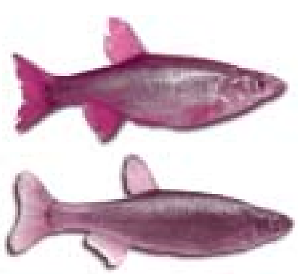


Figure 5. Top — Sakhalin minnow — *Phoxinus sahalinensis* (Berg, 1906), bottom — lake minnow —*Phoxinus perenurus* (Pallas, 1814)

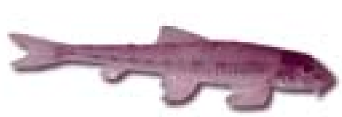


Figure 6. Amur beak gudgeon — *Rostrogobio amurensis* (Taranetz, 1937)

did not permit Berg's given names to last until today, many of his fish names turned out to be "younger synonyms" for older fish names of species living in the Amur and other Asian rivers. In the most recent list of Amur fish, only five species have names given by Berg. In this list, *Leptobotia mantschurica* could be a younger synonym of the Chinese species *Parabotia fasciata*. Another Berg species – *Leiocassis herzensteini* was never caught again after the beginning of the 20th century and could be an unusual form of other known species.

Recently, another species described by Berg was added to the list of Amur fish – Sakhalin minnow – *Phoxinus sahalinensis* (Berg, 1906).

Anatoly Yakovlevich Taranets, a promising Far Eastern fish biologist, conducted several expeditions on Amur and described a new species – *Rostrogobio amurensis*. Unfortunately, he died in World War II. In the late 1940s, the rapid decrease of freshwater fish harvest in the Amur (Figure 8) was caused by increased fishing during the war. These circumstances led the government to send a big ichthyologic expedition to Amur. The leader of the expedition was Georgii Vasilievich Nikolsky, professor of the Moscow State University.

In addition to biologists' applied fish research, the expedition continued to study the biological diversity of the Amur. Nikolsky and Soin described a new species – the Soldatov catfish. Kryzhanovsky et al. (1951) discovered barbel chub, previously known only in China, and also discovered a new Amur bitterling species, which was rediscovered in the 1960s by Vronsky. After studying the fish embryos, these same researchers developed the hypothesis that more than one species of eight-whiskered gudgeon exists in the Amur. Adult fish of the other species have still not been found.

The results of the "Amur Expedition of 1945-1949" were published in a monograph by Nikolsky, entitled "Amur Basin Fishes" (1956), which included a list of 103 species and subspecies found in Amur. The Amur was later studied by the Amur Branch of TINRO (which later became the KhoTINRO-center - Khabarovsk Division of TINRO-center). It was believed that it would be impossible find a new species in Amur after Berg and Nikolsky.

In the 1967 Boris Borisovich Vronsky discovered the *Pseudoperilampus lighti* (Wu, 1931) in the Amur and classified it as an Amur subspecies (*P.lighti amurensis*). Just recently, this turned out to be a younger synonym of Chinese species *Rhodeus fangi.* It is also known that this very attractive fish (named *Rhodeus uyekii*) lives in Korea, where it is considered to be an endemic species. This fish is very unusual, but it is numerous in the Amur, Ussuri, and in Khanka Lake. Therefore, it could not go unnoticed by Berg or Dybovsky, so we believe it is a second exotic species in the Amur. The first exotic species was bass, introduced to the region in 1919. Fangi bitterling probably came to the Amur at a later time, perhaps during the 1930-1940s. It most likely came from the southern Chinese rivers, as a result of fish farming.

Also in the early 1960s, another TINRO scientist Igor Arkadievich Gromov discovered bighead in the Amur. This species was introduced to the Amur from Chinese fish farms in 1952. It had reached Russian waters by the beginning of 1960s. This fish today is not very abundant, probably because of suboptimal conditions in the natural environment. Krychtin (1999) even listed this species in the Red Data Book of Khabarovsky Krai, perhaps with the hopes that that this fish would be permitted to become an abundant species[1]. In 1970 Gromov found a species, that he described as a new species Mystus mica. Previously, that fish had been considered to be an immature fingerling of another species[2]. Chinese fish biologists discovered this species in the Amur only in 1982 and identified it as *Leiocassis argentivittatus.* They may have been correct as *L. argentivittatus* is a common species in Yangtze River and very well known in China.

In the 1970s, the Far Eastern State University Department of Ichthyology published results of their research in Khanka Basin, which mentioned a new exotic species, the ochetobius. That species is no longer likely to inhabit the Amur. It is necessary to study the present diversity of Khanka species as there may be additional species to those described by Rozov (1934), Berg (1949), Nikolsky (1956), Samuilov and Svirsky (1976), and Bogutskaya and Naseka (1996). Even today new native and introduced species can also be found. For instance, resident Dolly Varden char was found in Ilistaya River (a tributary of Lake Khanka) as recently as 2002.

In the 1970s, the Academies of Sciences of the USSR and of Mongolia conducted a comprehensive biological expedition in Mongolia, which also involved studying Amur fish. At the same

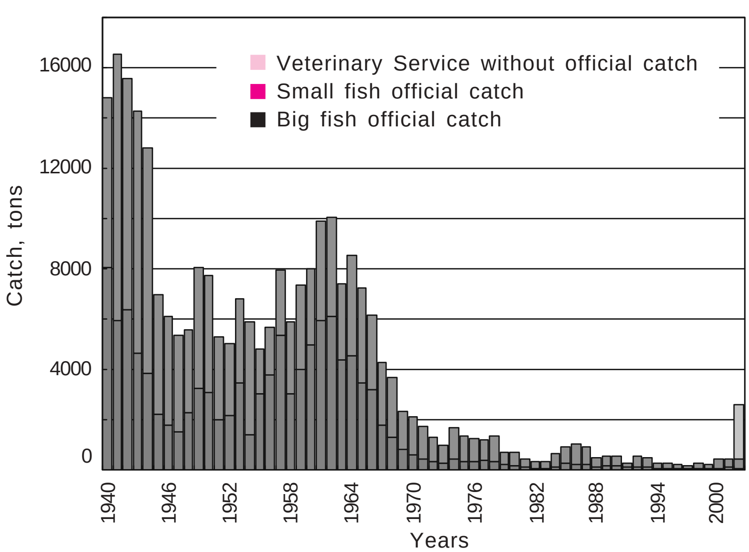


Figure 8. Dynamics of Amur freshwater fish catches

Figure 7. Eight-whickered gudgeon — *Gobiobotia pappenheimi (*Kreyenberg, 1937)

Fangi bitterling — *Rhodeus fangi* (Miao, 1934)

Leiocassis argentivittatus (Regan, 1905)

Bighead carp — *Aristichthys nobilis* (Richardson, 1845)

Figure 9. New Amur species found in 1960s

[1] We believe it is good that pestrolob did not significantly affect any existing native species.

[2] We consider *Mystus mica* like *Rhodeus fangi* to be exotic species for Amur.

Figure 10. *Abbottina lalinensis* (Huang et Li, 1995) (museum of Heilongjiang Fish Institute)

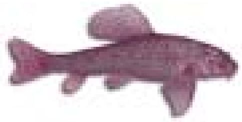


Figure 11. Rounded gudgeon — *Abbottina rivularis* (Basilewsky, 1855)

Figure 12. Catching small Amur fish by TINRO scientists (on the picture one of the authors — German Novomodny)

time, the Institute of Limnology of the Siberian Branch of the Academy of Sciences studied fish diversity of Amur and Zabaikalye. Judging by the book "Description of Species of Heilongjiang Province" (1995), Chinese fish biologists have not studied Amur fish diversity recently. The book is a mediocre compilation of different Chinese publications and monographs by Berg and Nikolsky. There are some interesting data on recent Chinese studies of Songhua, including a new species Abbottina lalinensis Huang et Li; however, this appears to be an ordinary Abbottina rivularis. In October of 2003, the Khabarovsk Branch of TINRO and Heilogjiang Institute of Fish Research agreed to conduct joint studies of Amur fish diversity.

The Berg epoch of studying Amur fish ended with a number of publications at the end of 20^{th} and the beginning of the 21^{st} century ("Catalog…"1998, "Atlas of Russian Freshwater Fish 2002, Primorye Fishes 2002, etc.) Regretfully, new literature from China, Japan, and Korea had not been consistently available to the authors of the above mentioned publications. Also, over the last 50 years, leading Russian museums only received Amur samples on an occasional basis. At the same time, the scientific potential of the old Moscow and St-Petersburg collections still allows researchers to find some interesting samples. Revisions made to these collections introduced changes to the number of species of Amur sawbellies, loaches and Asian weatherfish. Those collections would also determine which species recently found in the Amur are exotic and which are native.

The present research of Amur fish diversity was begun when one of the authors acquired a digital camera in 2000. The first goal was to make a collection of pictures of Amur fish, especially poorly known species which were not fished commercially. After a month of work, we discovered a new Amur species in the Kiya River near the town Pereyaslavka – rosy bitterling. This is an invasive species. Its origin is considered to be Taiwan, and it has also been introduced from this country to the Yangtze, then from there to Korean rivers. In the 1940s *R.ocellatus ocellatus* was introduced from the Yangtze to Japan, where it now coexists with native subspecies *R. ocellatus kurumeus*. In 1961 *R. ocellatus* was accidentally introduced from China to Uzbekistan, and in 1984 from Japan to Fiji. The Japanese Freshwater Fish Catalogue (1996) contains a good picture of this fish spawning, which allowed for the correct identification of this fish.

More and more species were found. Abundant populations of vladislavia were discovered in the Iman, Khor, Kiya, Anyui, Khingan, Middle Amur, and Bureya rivers. Eight-whiskered loach was found throughout Amur, not just in Mongolia and Khanka Lake as was previously thought. A number of new species, found just outside Khabarovsk, were previously known to be only in Songhua: eleotris, Darby loach, Chinese bleek, Chinese macropodus. Aquarium collection of spiny loaches helped in finding a new species. Its correct name is most likely Chinese spiny loach Cobitis sinensis (Figure 17).

These interesting results led to an international conference "First International Symposium on Fish Biodiversity of the Amur River

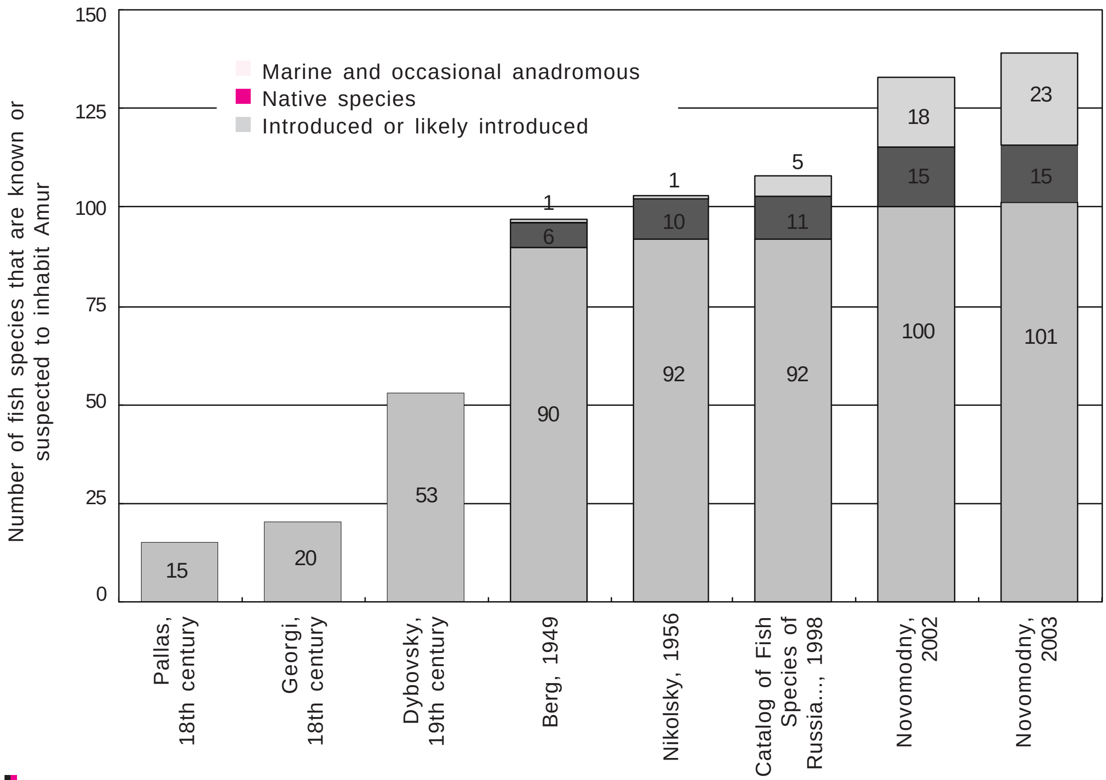


Figure 13. Stages of studying Amur fish diversity

and Adjacent Rivers Fresh Waters" in October 2002, initiated by KhoTINRO director V.A.Belyaev. Leading fish biologists studying fish diversity of the North-East Asia participated in the conference, including N.G. Bogutskaya (St.-Petersburg), E.D. Vasilieva (Moscow), I.A. Chereshnev (Magadan), S.V. Shedko (Vladivostok), Akiro Goto and Hirumi Sakai (Japan), Dun Chun-Chzhi (Harbin, China), and others.

Obviously, the study of Amur fish diversity is not yet finished. It is likely that many new species, both native and exotic, will be found. There are some species, for which it is still undetermined whether they are native or exotic. This includes the *Rhodeus fangi*, *Mystus mica*, two new for the Amur species of spine bitterling, *Cobitis sinensis*, *Squaliobarbus curriculus*, *Micropercops cinctus* and other. In the 1940s, black carp was more abundant in Lower Amur, but it then disappeared in Amur and Songhua. It is possible that Chinese fish farmers released fingerlings of this species in Songhua River. However, Chinese fish biologists consider black carp a rare, but native Amur species (Description of Heilongjiang Province Fishes, 1995).

Solving these and many other issues of systematics, taxonomy, as well as the distribution and biology of Amur fishes is an important step to achieving a modern, civilized ecosystem-based approach to conservation and rational use of Amur fish diversity. Accomplishing these tasks requires financing, which has been lacking from both Russia and China. A modern internet project to unite efforts of different researchers would be a great help.

Chinese bleak – *Aphyocypris chinensis* (Guenther, 1868)

Dabry loach – *Paramisgurnus dabrianus* (Sauvage, 1878)

Eleotris – *Micropercops cinctus* (Dabry de Thiersant, 1872)

Figure 14. Songhua species in Amur (found on Big Ussuri Island, autumn 2002)

Today it is possible to find 139 fish species in the Amur basin (including those within brackish estuaries) (Appendix). Out of 101 native freshwater and anadromous species, there are three questionable species. These are the *Pseudobagrus herzensteini* (Berg 1907), *Abbottina lalinensis* (Huang et Li 1995), and *Gobiobotia* sp.2 (Kryzhanovsky, Soin, Smirnov 1951). It is possible that these are only synonyms of other Amur species, the *Pseudobagrus ussuriensis* (Dybowski), *Gobiobotia pappenheimi* (Kreyenberg) è *Abbottina rivularis* (Basilewsky). Within this list, 15 species are marine (one lives in brackish waters), and there are the occasional anadromous species, such as Sakhalin sturgeon, redfin, chinook, coho, steelhead, white-spotted char, and so on. Most of them, except starry flounder, striped mullet, and white-spotted char, are quite rare.

At least 24 species are known to have been introduced, if the unsuccessful introduction of sockeye in 1920s is counted[3]. Only 17 species were brought on purpose, and others came in accidentally. Eight exotic species have acclimatized, but they do not live outside water bodies where they were introduced. Six species most likely disappeared. And nine species not only acclimatized, but are also very abundant and widespread – possibly interfering with the survival of native species. Combining all these numbers, it is evident that there are at least 118 relatively abundant fish species in the Amur basin.

[3] Sockeye is also an occasional species in Amur

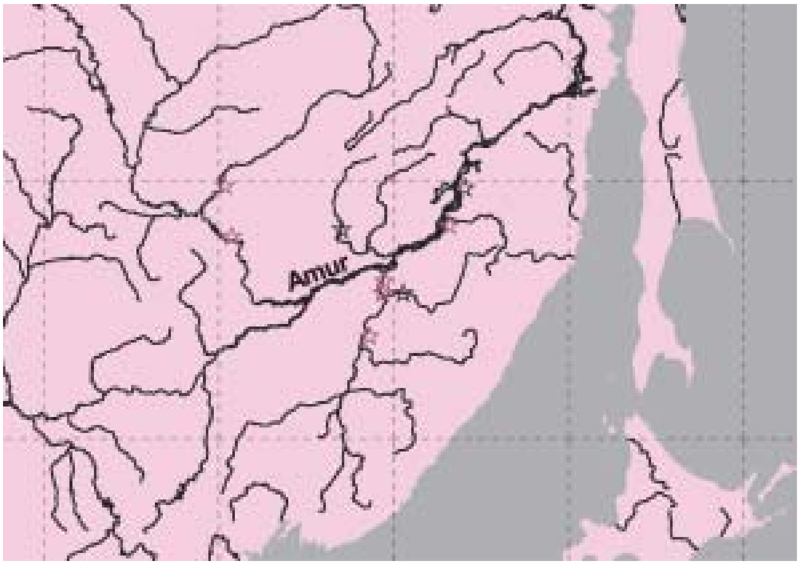


Figure 16. Populations of vladislavia(orange) and rice loach (black), 2001-2003

Freshwater goby – *Rhinogobius brunneus* (Temminck et Schlegel, 1845)

Gymnogobius – *Gymnogobius urotaenia* (Hilgendorf, 1879) (caught in South Primorye)

Rice loach – *Lefua costata* (Kessler, 1876)

Figure 15. Songhua species in Amur

Cobitis sinensis (Sauvage & Dabry de Thiersant, 1874)

Cobitis melanoleuca (Nichols, 1925)

Cobitis lutheri (Rendahl, 1935)

Cobitis choii (Kim et Son, 1984)

Figure 17. Spiny loaches of Amur

Figure 18. Rosy bitterling – *Rhodeus ocellatus* (Kner, 1867) (found in Kiya and Bira in 2001, in Sarapulsky stream in 2003)

Species Listed In Red Data Book of Russia

Eight species of Amur fish are listed in the Red Book of Russian Federation. These are the yellowcheek, black carp (amur), black Amur bream, small-scale carp, Soldatov catfish, Chinese perch (auha), Amur sturgeon (Zeya-Bureya population), and kaluga (Zeya-Bureya population).

Yellowcheek

The species was listed under category 1 as disappearing on the recommendation of M.L.Krykhtin.

Range. Yellowcheek is widely spread in the Eastern China, with the Amur being the northern border of the range. It is a relatively warm water species, so it avoids mountain streams and is completely absent in the Upper Amur.

Biology. Matures at the age of six years and length not less than 60 cm. Spawns instream from the beginning of June to midAugust. Eggs and fry are pelagic, and carried out to sea by streams. Main spawning grounds in the Middle Amur, Songhua, and Ussuri. Fry and young fish feed in the Lower Amur. Adult fish do not migrate far and live near the spawning grounds or slightly downstream. Fry stay near shore and feed on the fry of other fish. After spawning, adult fish travel to the offchannel floodplains with slow current. Yellowcheek winters in the main river. Its main food is small, pelagic fish, though yellowcheek does not eat carp even when hungry. Maximum size is two meters length and over 40 kg in weight.

Commercial fishing. Valuable commercial fishing target. It is relatively cheap in Chinese markets. This large predator is never overly abundant. According to Kryukov (1894), the 1891 catch in the Lower Amur was 9.5 tons. According to Nikolsky (1956) 1941-1950 catches varied from 5.6 to 43 tons a year. By the end of 1950, the abundance significantly decreased. According to Krykhtin, catch decreased to 2.5 tons a year in the 1970s. In China catches were considerably higher, 28.5 tons in 1940 and 41.5 in 1941 (Nikolsky 1956).

Conservation. Besides the ban on fishing for endangered fish, there has been an annual ban on freshwater fish catch during spawning period in spring-summer since 1981, and fishing limits have been put in place in border waters of Amur and Ussury according to Russian-Chinese 1994 fishing regulations.

Effectiveness of protections. We believe that all these bans have zero efficiency. First, it is easier to catch yellowcheek in the fall when it leaves floodplain waters. Second, when the fish was really scarce (up to the mid-1990s), no fishermen did release yellowfish. In the Soviet time it was difficult to sell it, so fishermen just took it for their families. Today, it is easy to sell a Red Book species. Current fish inspections on the river are not really efficient, and Russian-Chinese agreements do not actually have an impact on the situation.

Abundance. In the recent years yellowcheek has increased in abundance due to low water levels in the Amur, the increase of water temperature, and abundant organic matter in the river. Between Khabarovsk and Komsomolsk-on-Amur, yellowcheek is even more abundant than pike. (And this is the same for Russian and Chinese markets).

Conservation. Today no special measures of protection are necessary as there is no real threat to this species.

Black Carp (Amur)

The species was listed under category 1 as disappearing on the recommendation of M.L. Krykhtin.

Distribution and Abundance. Black carp (also called black amur) is widespread in China. It is believed that the Amur basin is the northern border of the range (Nikolsky 1956). It is possible that this species was introduced to Amur, because it is one of the four main cultured species in China. These are white carp (amur), carp, and bighead carp. In the Russian portion of the Amur in the 1940s-and 1950s, the species occurred from the mouth of Songhua to the Amur estuary, in the Ussuri River, and in Lake Khanka. In the many years since that time, there has been no demonstrated catch of this fish. It was said to have been caught in 1990s in the Middle Amur near the towns of Vladimirovka and Nizhnespasskoe, not far from Khabarovsk. Chinese fish biologists have also not encountered this fish in Songhua for many years. It is possible that the toxic chemicals polluting the Amur have had a negative impact on this fish. It is also difficult to collect data on this fish because it looks very similar to white carp (amur).

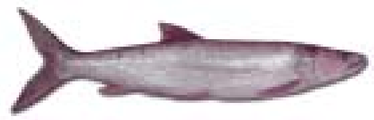


Figure 19. Yellowcheek – *Elopichthys bambusa* (Richardson, 1844)

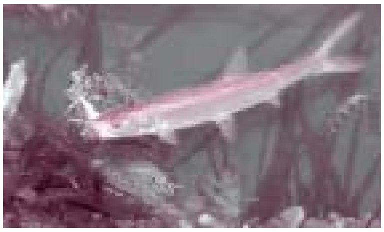


Figure 20. Young yellowcheek in KhoTINRO

Biology. In the summer black carp remains in slow streams. Matures at the age of 7-10 years at a length of 66-80 cm. It spawns in the second half of June to the beginning of July in river, when the water level rises. Main spawning grounds in 1940s-1950s were in the lower reaches of Songhua. Eggs and fry are pelagic. Fecundity is about 700-800 thousand eggs. The fish reaches maximum length over 100 cm and weight 35 kg. It lives over 13 years. Its main food is mollusks.

Effectiveness of protections. Besides the ban on fishing for endangered fish, there has been an annual ban on freshwater fish catch during spawning period in spring-summer since 1981, and fishing limits have been put in place in border waters of Amur and Ussury according to Russian - Chinese 1994 fishing regulations. It is not clear how to distinguish native and aboriginal fish.

Conservation. It is likely that this species is absent from Russian waters. Possible conservation measures include a decrease in fishing or the granting of protected status to the areas formerly known as spawning grounds.

Black Amur Bream

After revision of genus *Megalobrama* the correct Latin name is now *Megalobrama mantschuricus* (Basilewsky, 1855). The species was listed under category 1 as disappearing on the recommendation of M.L. Krykhtin.

Range Widespread in China. The Amur is the northern border of its natural range. It is a relatively warm-water fish, so it avoids mountain streams and is absent in the Upper Amur basin.

Biology. In the summer it travels to floodplain lakes, shallows, and streams for spawning and feeding. Matures at the age 6-8 years and length of 30-37 cm. Spawning is annual, usually in July during water level increase. Eggs are attached to water plants. Fecundity is about 250 thousand eggs. Maximum length is 60 cm and weight 3 kg. Life expectancy is at least 10 years. Main food is mollusks, insects, fish, and to a lesser extent plants and algae.

Abundance. Used to be less abundant in 1970s-1980s. Today it is a fairly abundant fish. In June 2003 in the Khabarovsk market, the amount of black bream was comparable to the amount of white bream. Present conditions of natural environment favor abundance of this species.

Relative species. As black Amur bream is protected it is necessary to know that recently in Songhua and Khanka Chinese fish farmers introduced another bream from Southern China – *Megalobrama amblicephala.* So far it was not caught in Russian waters but it is likely in the near future.

Effectiveness of protections. Besides the ban on fishing for endangered fish, there has been an annual ban on freshwater fish catch during spawning period in spring-summer since 1981, and fishing limits have been put in place in border waters of Amur and Ussury according to Russian-Chinese 1994 fishing regulations.

Conservation. No special measures are necessary at the moment because of high abundance. This is a phytophilic species so it is necessary for hydro power stations to maintain similar to natural flooding regime. It is recommended to discontinue listing this species as endangered.

Figure 21. Black carp (amur) – *Mylopharyngodon piceus* (Richardson, 1845) (picture taken in Harbin, China, fish grown in the pond)

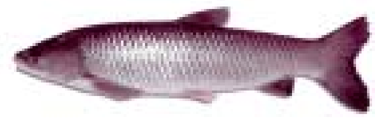


Figure 22. White carp (amur) – *Ctenopharyngodon idella* (Valenciennes, 1844)

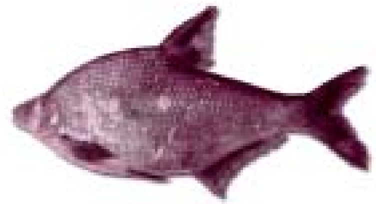


Figure 23. Black Amur bream – *Megalobrama terminalis* (Richardson, 1846)

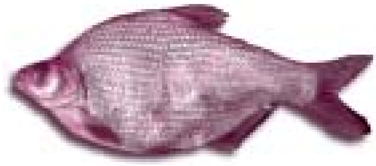


Figure 24. Introduced bream *Megalobrama amblicephala* (Yuh, 1955)

Smallscale Carp (Yellowfin)

The species was listed under category 1 as disappearing on the recommendation of M.L.Krykhtin.

Distribution and Abundance. Widespread species in China. One of the most warm water-loving species of Amur, so it was always rare in the Middle and Lower Amur. In the basin this species is abundant only in Songhua and Khanka Lake, just like *Chanodichthys dabryi Bleeker*. It is a usual Khanka species, though not very abundant. In the 1980s-1990s there were no reliable data on its existence in Amur.

Biology. It inhabits big lakes and slow running rivers, where it prefers water near shore with lots of plants. In the summer it travels to the floodplain, to the main river in the fall. Matures at the age of 4-5 years at body length about 35 cm and weight 700-800 grams. The spawning season is at the end of June and beginning of July. It was believed that its eggs are pelagic, but recent data show that the fish develops while attached to substrate. Maximum length is 70 cm, weight 2 kg, and it lives over 6 years. Main food is detritus and water plants. It looks very similar to abundant blackbelly, but is easily distinguished by bright yellow fins.

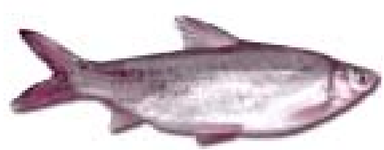


Figure 25. Small-scale carp – *Plagiognathops microlepis* (Bleeker, 1871) (from Khanka Lake)

Conservation. As for all other species in Amur, protection has not improved since its listing in the Red Book. At present, this species is quite effectively protected in Khanka State Reserve. Also, in recent years TINRO has recommended a ban on fishing in the Khanka, which is currently in effect. Right now there is no threat of disappearance of this species in Khanka, and a change to listing this species could be brought forward under category 3 (IUCN).

Figure 26. Soldatov catfish – *Silurus soldatovi* (Nikolsky et Soin, 1948)

Soldatov Catfish

The species was listed under category 1 as disappearing on the recommendation of N.S.Probatov and M.L. Krykhtin.

Biology. Unlike Amur catfish, this species spends most of its life in the main channel of the Amur and goes to the floodplain only for spawning. Females mature at the age of 4-6 years and length 90-100 cm, males mature at the age of 4-5 years and length 85-90 cm, weight 6-7 kg. They lay eggs on water plants. Fecundity is 87-350 thousand eggs. This is an active predator feeding on large prey. The prey of one year old Soldatov catfish may constitute 25-43 % of predator length, for adults usually 15-35 %. Sometimes they swallow waterfowl. Life span is 18-20 years. It grows very fast and may reach 4 meters length. According to A.N. Voronets, he personally measured a catfish weighing over 260 kg.

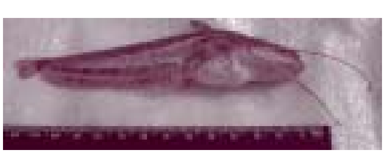


Figure 27. One-year-old Soldatov catfish on Big Ussuri Island

Catch and Abundance. As for many other Amur fish, exact abundance is unknown. In commercial fishing statistics it was recorded together with Amur catfish. We estimate it to be five times less abundant than Amur catfish. In 1960s-1970s catches of Soldatov catfich in Amur were one ton per year, and three to four tons in Khanka Lake. In the Lower Amur, this species is most abundant from the mouth of Songhua to Bolon Lake. It is quite rare elsewhere in the Lower Amur and Khanka. In 1970s-1980s this species was “steadily decreasing”. Because of that, it was listed in the Red Book. Today, the species has recovered, and fishermen generally encounter as much Soldatov catfish as a smaller-sized Amur catfish in Amur harvests.

Protection. This is a phytophilic species, so it is necessary for hydro power stations to maintain similar to natural flooding regime.

Figure 28. Auha – *Siniperca chuatsi* (Basilewsky, 1855)

Chinese Perch (Auha)

The species was listed under category 2 as endangered species on recommendation of M.L.Krykhtin.

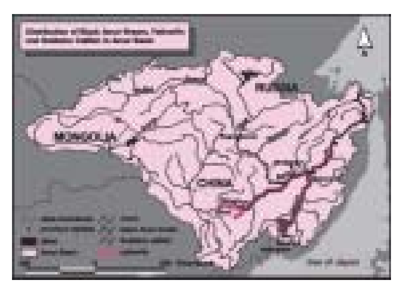
Range. Relatively warm water fish, so it avoids mountain streams and does not inhabit the Upper Amur basin.

Biology. Big bottom predator that reaches a length of 70 cm and weight 8.6 kg. In the summer, stays both in the river and travels to the floodplain. Age of maturity is five years and length 32-34 cm. Spawning occurs in June-July. Eggs are pelagic. Fecundity is 48 to 380 thousand eggs. Spawning temperature is 20-26° C. Fingerlings start feeding very early on other fish and grow very fast. Aquarium observation showed that fingerlings prey on fish of equal or even 1.5 times greater in length. They catching their prey in the middle, breaking it in half and then swallow. Usual food: gudgeons, sawbellies, blackbelly, etc. It is capable of swallowing some bagrids even with protruding spines.

Figure 29. Young auha are abundant in Amur and Ussuri in the last four years

Abundance. This species was never abundant in the Amur. After the war, the annual catch did not exceed 25 tons total, with the Russian portion being 17 tons. In the 1970s to 1980s, it was scarce in Amur, though this estimate could be disputed. After its listing in the Red Book this species was not recorded in commercial fishing statistics, and fishermen simply brought it home with them. It is surprising that today there is even less fry of this fish than 20-30 years ago. Young and adult fish are very abundant, especially compared to 1970s and 1980s. It is possible that Chinese fish farmers are responsible for the recent increase of this species’ abundance, while its natural reproduction rates are low.

Conservation. An annual ban on fishing was instituted during spawning season and is considered a sufficient conservation measure.



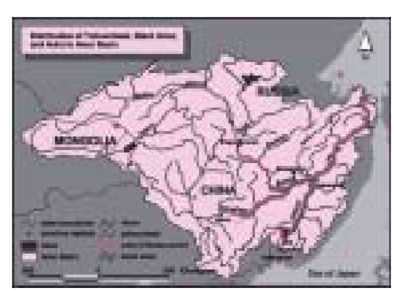


Figure 30. Red Data Book Species Distribution in Amur Basin (please, see full color map in the middle)

Sturgeons

Biology and Distribution of Amur Sturgeon

Amur sturgeon are a freshwater species, endemic to the basin, and they are a valuable commercial fishing target. The Zeya-Bureya population is listed in the Red Book of Russia under category 1 as "disappearing population of endemic species." The species is included in the IUCN list of 1996 and in CITES, Appendix 2.

Range. The length of spawning migration (or at least the first migration in its lifetime) may be 1000 km or more. Its range stretches from the brackish Amur Bay and coastal waters of Sakhalin to the most upper reaches of the Amur basin. The range also includes the rivers Shilka, Argun, Zeya, Bureya, Songhua, Ussuri (with Khanka Lake), and Amgun. At the current time within the Songhua and Ussuri, Amur sturgeon is virtually extinct due to fishing pressure.

Biology. It is a freshwater fish that reaches over three meters and over 250 kg in weight after 65 years of age. After seven years, annual growth rate is 9-11 cm a year, and 5-8 cm for older fish (Figure 32).

The Amur sturgeon has a very complex population structure and can form localized groups. Every local population stays at certain part of the river with a well-defined floodplain. At the moment we believe in existence of three local populations: the "Lower Amur," "Middle Amur," and "Zeya-Bureya populations." No distinctive biological differences have been demonstrated between fish from different localized populations, though in Lower Amur there are two morphological forms: "shortsnouted" and "long-snouted."

The spawning migration of Amur sturgeon is usually within range of its local population, usually 500 km. It has been demonstrated, however, that some so-called anadromous fish can migrate for 1000 or more kilometers, which may lead to the exchange of fish between local populations. The spawning

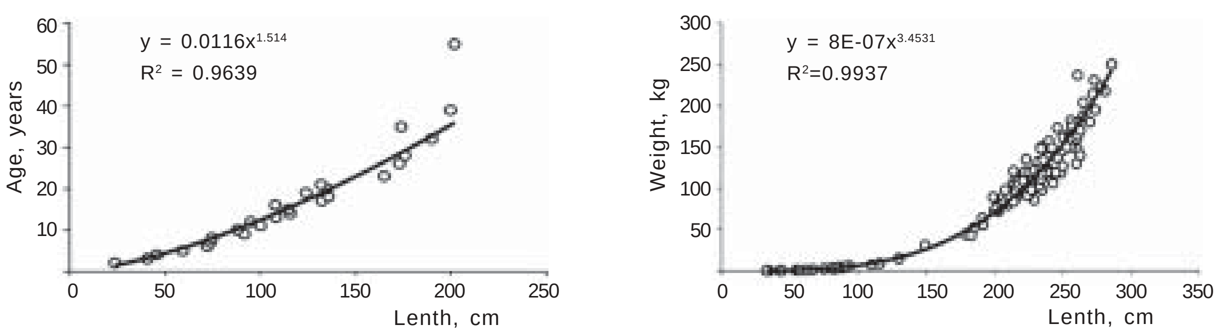


Figure 31. Dependence of length on age and weight

migration takes 4-6 months in fall-winter and spring periods. The migration ends in the spring, when spawners concentrate at the spawning grounds.

Most females mature and spawn for the first time at the age 10-14 years (11 years on average), reaching length 105-125 cm and weight 6-12 kg (10 kg on average). The period between first and second spawning is usually five years. Most males mature at the age of 7-12 years, reaching 95-110 cm in length and 4-10 kg in weight . The period between first and second spawning is four years. Gender proportion in the population is close to 1:1.

Fecundity varies depending on size from 29 to 1057 thousand eggs. Average number of eggs for females which weigh 20-40 kg who are spawning a second time is about 288 thousand eggs. Females spawning for the first time may have 135 thousand eggs.

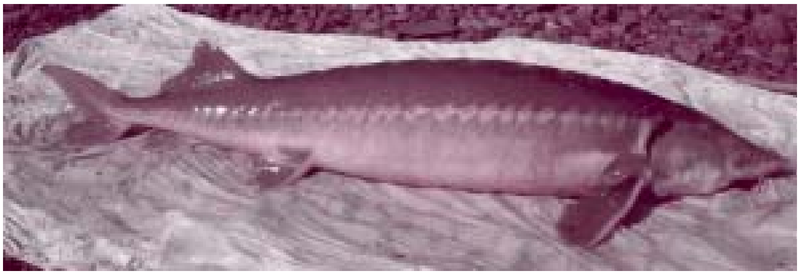


Figure 32. Amur sturgeon - *Acipenser schrenckii* (Brandt, 1869)

Spawning occurs from the end of May to early July at water temperature of 12-18^{o} C. Spawning grounds are located in river areas with a gravel substrate, fast current, and a depth of 3-6 meters. Eggs develop attached to substrate. Incubation period is 4-6 days. Fry stage is 15-18 days. When underfed, fry and fingerlings locomote in so-called "candles" through the water column to reach the surface, which allows them to travel farther downstream and to reach areas with a population rich in benthic organisms, little competition, and plenty of insects to feed on.

Adults feed mostly on benthic organisms. In the Lower Amur and nearby estuaries, they prefer corbicula. In the Middle Amur - caddis flies, chironomids, freshwater shrimp, etc. On rare occasions small fish like gudgeons are found in Amur sturgeon bellies.

Sometimes people harvest Amur sturgeon and kaluga hybrids from the Amur and especially from the Amur estuary. They may even take fish with fully developed eggs, though this is a rare occurrence and it is unknown whether these fish spawn.

Figure 33. Hybrid of Amur sturgeon and kaluga. [its appearance and mouth are similar to the kaluga, its belly is like Amur sturgeon (small and masculine), and it has bright, yellow-colored fat stores like Amur sturgeon]

Abundance. According to KhoTINRO monitoring data over the last ten years, abundance of Amur sturgeon has decreased in the Lower Amur to even 10 times less than previous numbers. The main cause for the decrease is intensive fishing pressure by the Chinese (in 1980s up to 450 tons of sturgeons were taken a year) and increasing poaching in the Lower Amur (estimated to take up to 750 tons of sturgeons a year).

The abundance of sturgeons is likely to have been influenced by the catastrophic death of many fish in Amur estuary in the fall of 1983, when numerous dead kaluga and Amur sturgeon were found on Sakhalin coast of Tatar Strait. This die-off occurred near the town Boshnyakovo and was observed by a special TINRO expedition up to of northern latitude 48° 40' M.L. Krykhtin, chief scientist for the TINRO freshwater fish laboratory at that time, believed the die-off was caused by northern winds that made the Amur estuary very saline. This issue has still not been resolved. It is possible that the event was a technogenic catastrophe.

Today, the Amur sturgeon catch in the Lower Amur is comparable to the catch 10 years ago. Rearing areas, so-called "kindergartens"[4], are filled with young fish (perhaps thanks to protections instituted during Soviet times). The population abundance in the Lower Amur is believed to be above the critical level, though it is decreasing.

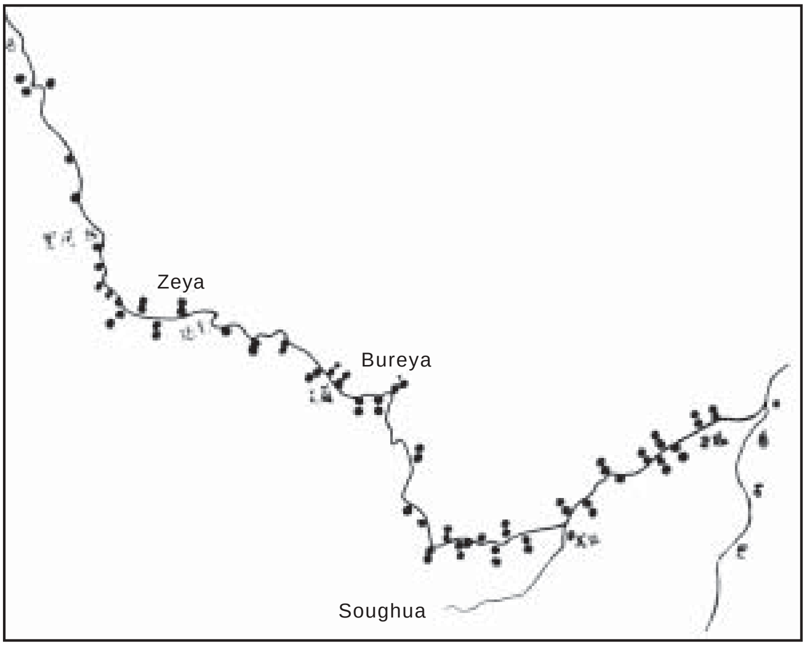


Figure 34. Spawning sites of sturgeons in the Middle Amur (Heilongjiang Province Department of Fish)

The Zeya-Bureya population is included within the greater Amur spawning population, which spawns in the uppermost part of the species range. The lower boundary is the town of Pashkovo. Because there is less food in those waters and water temperatures are low, fish grow much more slowly in this area. The exchange of fish between this local population and other sturgeon groups probably existed in the past, and this has not been sufficiently researched. At the Russian-Chinese Commission on Fishing meetings, Chinese fish biologists said that the Zeya-Bureya population is not extinct yet, though there are very few spawning fish.

[4] "Kindergartens" sites in the Lower Amur from Tsimmermanovka town to Nikolaevsk-on-Amur where young sturgeons concentrate. Usually local fishermen try to avoid fishing there.

Biology and Distribution of Kaluga Sturgeon

Kaluga, just like Amur sturgeon, is endemic to the Amur. The Zeya-Bureya population is listed in Russia's Red Book under category 1 as "disappearing population of endemic species." The species is included in the IUCN list of 1996 and in CITES, Appendix 2.

Range. It was formerly believed that kaluga was only a freshwater fish. However, today, it is known that young fish (up to 30-50 kg) are distributed across an extensive marine range from the northern parts of the Sea of Okhotsk[5] to Hokkaido Island (Okamura et al., 1997). Fishermen report catching this species in the Magadan region (Kostarev and Tyurin 1970). Kaluga is caught in the north of Khabarovsky Krai and off Sakhalin Island. Once when a fisherman was asked to take a picture of Sakhalin sturgeon within the Tumnin River, but he sent TINRO a picture of kaluga. Young kaluga are found in rivers of South Primorye.

Most kaluga stay in brackish Amur Bay and in the eastern part of the Sakhalin Gulf (Northwestern Sakhalin, especially in the Baikal and Pomr bays). Here, kaluga feeds on pink and chum salmon, spawning herring, and smelt. Other food items include marine fish, shrimps, freshwater fish, and even for young fish.

The freshwater range of kaluga is similar to Amur sturgeon and stretches for several thousand kilometers into the Amur basin, including the rivers Shilka, Argun, Zeya, Bureya, Songhua, Ussuri (with Khanka Lake), and Amgun. Today, in the Songhua and Ussuri, kaluga is virtually extinct due to fishing.

The spawning range of kaluga is also similar to Amur sturgeon, with the upper boundary being slightly lower. According to the Heilongjiang Province Department of Fish, mature kaluga do not go farther than Blagoveshensk at the current time.

Figure 35. Kaluga fry cannibalism

Figure 36. Kaluga - *Huso dauricus* (Georgi, 1775)

Biology. Kaluga is one of the world's biggest freshwater fish, reaching a length of 5.6 meters and weight of 1140 kg. Females mature at the age 16-17, and their length is over 2 meters. Males mature one or two years earlier than females. Kaluga is believed to live 48-55 years. Spawning grounds are similar to Amur sturgeon - gravel and sand bottom, depth 3 to 7 meters. Spawning season begins in May and lasts through June. Fecundity may reach 4 million eggs. Incubation period is 4-6 days. Fry is carried downstream. Kaluga are predators and may eat one another. Growth rate is much higher than for Amur sturgeon. Spawning migration (at least the first) may be 1000 km or more.

[5] According KamchatNIRO biologist B.A. Sheiko in 1997, kaluga was once found even in Palana River of the Western Kamchatka coast. (http://npacific.kamchatka.ru/np/library/publikacii/tokranov/osetr.htm)

Abundance. According to various existing data in 2000-2001, the abundance of large maturing kaluga (age over 13 years, length over 180 cm, and weight at least 50 kg) was at least 60 thousand fish with a total biomass of 5.5 thousand tons (at an average weight of 90 kg). During the past two years, a significant decrease in abundance has been noted. By some estimates, existing levels of poaching could be taking up to 95 % of the spawners annually. It is possible that by 2010 the number of mature fish would be ten times lower than in 2000. The main causes for decline are the same as for Amur sturgeon - Chinese fishing and poaching in Russia. Amur water pollution could also be negatively impacting kaluga reproduction.

Amur Sturgeons Hatcheries

There are two hatcheries in Khabarovsky Krai. One is in Amursk City (with industrial output - 200 thousand fingerlings a year), and the "Novoamursky" hatchery is near Khabarovsk (with projected output - 520 thousand fingerlings a year, and industrial output - 85 thousand). Another hatchery has been built in Vladimirovka (Evreiskaya Autonomous Oblast) as part of the federal program "Ecology and Natural Resources of Russia (2002-2010). It should begin operation in the nearest future. In the last two years, the Amursk hatchery released about 450 thousand fingerlings (45 days old) and over one million unconditioned fingerlings (10 days old). On several occasions, up to 1.5 thousand marked one-year-old sturgeons were released. The "Novoamurky" hatchery has an annual release of 85 thousand fingerlings (45 days old) and up to one million unconditioned fingerlings (10 days old). Control catches at "kindergartens" showed that artificially produced young sturgeon there are even more numerous than wild.

Table 1. Fingerling releases (in thousands) by years (TRAFFIC 2002)

Hatchery	Species	1996	1997	1998	1999	2000	2001
Amursk	Amur sturgeon	63.4	223.6		136.7	235.5	236.8
	Kaluga			0.8	385	3.5	
Novoamursky	Amur sturgeon				75	127.3	91.7
	Kaluga			1.5			

In China, there is a hatchery in Fuyuan County with an industrial output of at least 800 thousand fingerlings a year. There is another hatchery with industrial output of at least 100 thousand fingerlings a year that was recently built in the town of Zhaoxin, in Luobei county. There is no firm data on the release of fingerlings in Amur or the production of fingerlings for captive growth.

Despite frequent requests of Russia scientists, they have never been allowed to visit these Chinese hatcheries. Similarly, Chinese have never visited Russian hatcheries. This is one of the problems with the Russian-Chinese Fish Commission. Artificial reproduction of sturgeons in Amur basin is conducted, while ignoring one another, and neither side conducts any research on the influence of hatcheries on wild populations. This may be a serious threat to wild populations and could lead to a situation similar to what we see today in the Volga.

Commercial Sturgeon Fishing

Sturgeon fishing in Amur has a long history. Scientists have found sturgeon remains in neolithic settlements which existed between 2000 and 3000 BC, according to Academician Okladnikov. The first written references of sturgeon fishing in the Amur can be traced back to Georgi (1775) who mentioned the fish in respect to the Shilka, Onon, and Argun rivers. At a later time, sturgeon fishing was mentioned by de la Bruniere in 1845 (Soldatov, 1915) in the Ussuri River and by Maak (1861).

According to Kryukov (1894), 1160 tons of sturgeons were caught in the Amur basin in 1881. In 1895, the merchant Lindquist founded a fishing and fish processing enterprise in the Verkhne-Tambovskoe village, primarily with the goal of catching and selling sturgeons. In 1897, this enterprise produced 12 tons of salted sturgeon (Bykov, 1898), in addition to other products. This business lasted for only a few years and then collapsed. In the beginning of 20th century, the sturgeon catch decreased greatly (Table 2).

Table 2. Catches of sturgeons in Lower Amur (Soldatov 1915)

Years	1909	1910	1911	1912	1913
Catch, tons	284	365	298	349	215

From 1891 to 1913, catches decreased to more than five times less than previous levels (Figure 38). When Soviet authority was established in the Russian Far East (on January 1st 1923), the Far Eastern revolutionary committee banned sturgeon fishing in Amur until the 1st of January 1930. Although this order was not perfectly enforced, it helped with the restoration of sturgeons. The next decrease of sturgeon abundance took place during World War II, when many young sturgeons were harvested. As a result, sturgeons in the mid-20th century were much less abundant than before the war (TRAFFIC 2002).

After 18 years of fishing, a ban on catching kaluga was instituted for the Amur estuary in 1976. Then in 1991 sturgeon fishing was allowed on the Amur. Since 1994, the Khabarovsk Division of TINRO-center conducts a test fishery. Fish monitoring and the protection of fish resources is conducted by the Amur Basin Authority for the Protection of Fish Resources and Fishing Supervision (Amurrybvod). The total catch of sturgeons in Amur basin is presented in Figure 38.

In China, the development of the fish industry was a little different from Russia. In Heilongjiang Province and especially in counties near Amur, fishing and fish farming are key industries. Also, the provinces population has grown rapidly in the second half of the 20th century and especially in the last 20 years. Fishing and habitat alteration have led to the disappearance of sturgeons, salmon, and other fish species in Songhua. In the Upper and Middle Amur, sturgeon populations have significantly decreased. In the mid-1960s, the Province adopted a strategy to develop fish farming as a substitute for fishing. In 1970, fish farming produced only about 12 % of all fish products in the province, with the remainder taken mainly from the Amur. The strategy succeeded, and in 2002 fish farming produced almost 90 % of the entire regional fish harvest (over 400 thousand tons).

Figure 37. Hooks for sturgeon fishing, used in China, banned and used illegally in Russia since 1957

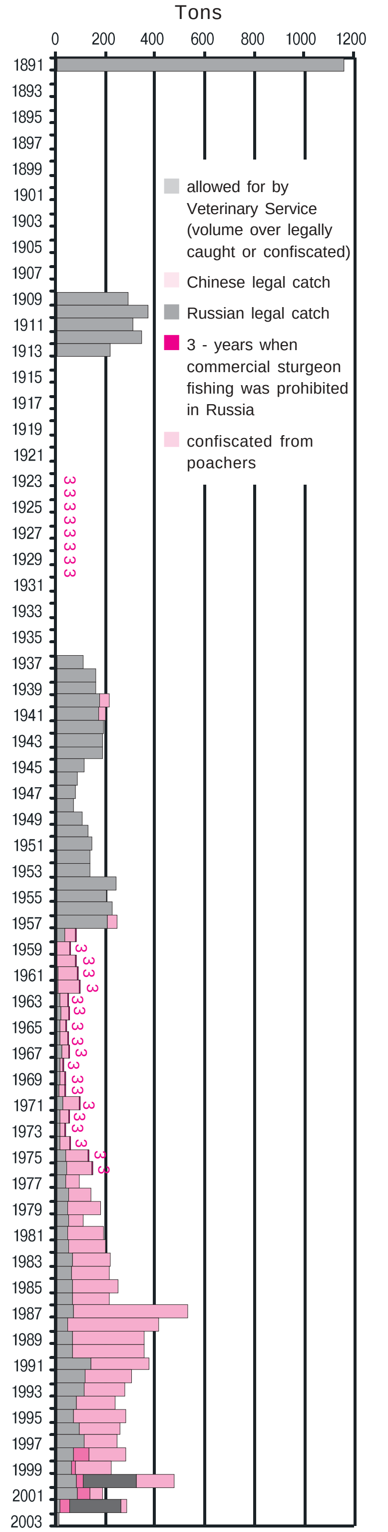


Figure 38. Catches of sturgeons in Amur (kaluga and Amur sturgeon)

Sturgeon fishing is an important part of the regional fish industry. In the early 1980s, the population in Northern China was growing very quickly, and the number of Chinese fishermen was increasing in the middle Amur (up to 5000 boats at the end of 1990s). By the late 1980s, the Chinese harvested up to 450 tons of sturgeons. Since then, catches have declined steadily, amounting to only 140 tons in 2002. Today, the low abundance of sturgeon worries Chinese authorities, and they are willing to look for ways to restore sturgeon populations. Unfortunately, thus far they are considering building more hatcheries rather than decreasing the catch, thus far.

It is necessary to denote important differences between Russian fishing and fishing in China. In China, sturgeon fishing is legal and regulated by the government. A special regulatory regime is effective on the river, with strict prosecution for violations guaranteed. Chinese fishing boats are much slower than Russia, and powerful engines are forbidden. At the same time, Chinese fish inspection authorities are equipped with fast boats. Fishermen always obey fish inspectors. For this reason, inspectors are not armed, though they are very mobile and numerous. Their boats have mobile phones, and they can always request help or check information such as license data with a call to headquarters (Pacific Star 2000).

It is necessary to mention that the Chinese sometimes harvest fish illegally in Russian waters by casting nets from one shore to another. According to the Statistics Department of the Russian Federation (2002), damages collected from Chinese fishermen by Amurrybvod and the Border Guard Service in April-August of 2002 were estimated to be 12,500,000 rubles ($430,000). The overall level of poaching in China, however, is much lower than in Russia. Many specialists estimate that Russia's illegal catch could easily be two or three times higher than the legal harvest - an unthinkable situation for China. Chinese fishermen catching sturgeons have a special mark on their boats and a special license. Today in Russia, sturgeon commercial fishing is prohibited, except for limited "test fishery" by KhoTINRO, which was 85 tons for 2000-2001 and 13 tons for 2002-2003.

Assessment of Sturgeon Poaching in the Lower Amur

On the Russian side, poaching occurs mainly in the Lower Amur downstream from Khabarovsk and from the Amur estuary. According to a TRAFFIC report (2002), primary poaching areas are towns, including the towns of Tsimmermanovka, Bilgo, Tyr, Eremei, Nizhnie Kholby, Nizhnespassk, and Lazarev. Between Khabarovsk and Nikolaevsk-on-Amur, there are 62 settlements with populations ranging from 1000 (Mago) to 8000 (Bogorodskoe), and 4 major cities - Khabarovsk, Komsomolsk-on-Amur, Amursk, and Nikolaevsk-on-Amur. The level of unemployment in every village is very high, which forces people to search for an income on the river.

According to TRAFFIC (2002), in the Amur estuary and in the Nikolaevsky District in the spring 2001, there were about 200 boats fishing sturgeon. During the 7-10 days, they each caught

300-400 kg. Therefore, for this portion of the river, which is only 150-180 km long, about 80 tons of sturgeons were taken during this time period. Compared to the 1990s, net length has increased. Usual net lengths used to be 50-60 meters, and now they are at least 100-300 meters. Each town and village sends out at least 15 boats to catch sturgeon. Bigger towns have 100-200 boats. By adding the population of cities to this number, we can estimate that over 3000 boats are catching sturgeon in Lower Amur. By fairly modest estimates, the annual volume of poaching may easily reach 750 tons.

Local fishermen say that many new poachers, who are outsiders not from the region, have recently appeared. They are equipped with good nets, mobile radios, and fast boats. Poaching tactics are simple. One boat goes downstream on the river and another goes upstream. The boat in the middle is poaching. If either of the first two boats see a suspicious boat (fish inspection, etc.), they warn the third boat and try to bribe inspectors. If these tactics are not successful, they give a warning to the poaching boat, and they hide. Often they let the net float downstream and pick it up later. Such poachers usually take only caviar and discard the fish. They usually make 90-150 thousand rubles ($3000-5000) each during the season and then go back home, usually to Khabarovsk or Komsomolsk-on-Amur. Most of this business is controlled by organized criminal structures (TRAFFIC 2002).

Fishermen and poachers have witnessed serious faults in fish inspection work (TRAFFIC 2002). People say that it is usually not a problem to set a bargain with a fish inspector, though sometimes inspectors do abuse power. Some of them passively support poaching. For instance, an inspector might wait until a poacher catches a sturgeon, arrive at this point, and take the fish without filing a protocol, while allowing poachers to continue fishing. This was observed by the author of the recent TRAFFIC report (2002) S.V. Kuznetsov within the Nanaisky District of Khabarovsky Krai. It is also known that poachers catch sturgeon not only in the summer, but also in the winter. During one raid, fish inspectors collected from so-called "nobody's" nets 53 sturgeon and kaluga specimen with a total weight about 1500 kg. Registered information about these types of incidents is absent in Amurrybvod records, which implies that the fish was taken home by raid participants. According to local fishermen, this is a typical situation. Another example occurred near the village of Reshayushy when Chinese merchants were buying caviar illegally. They bought over 200 kg of sturgeon caviar from local fishermen but did not manage to carry it away. This is because a group of people in masks and armed with automatic guns suddenly appeared. They took all the caviar and left. This incident was also never officially registered, and it is unknown who expropriated the valuable product (TRAFFIC 2002).

There are only a few hundred inspectors of Amurrybvod working on Amur. Each inspector is responsible for significant portion of the river. Their monthly salary is about $100. But the authority permitted to an individual inspector is equivalent to controlling resource valued at thousands of dollars US. It is no wonder that corruption flourishes on the river. According to TRAFFIC (2002), sturgeon fishing in the estuary costs 20-30 thousand rubles, and an inspector may not take notice of poachers that pay him off. Such facts are very difficult to prove, and this problem occurs for a number of reasons. These reasons include the facts that legislation is imperfect, law enforcement is weak, the government does not pay attention to fish inspection problems, and the fact that fish inspectors are not motivated to protect the resources and risk their lives, as well as the safety of their families in order to counter poachers. We must recognize that there are some examples of honest inspectors who suffered damages from poachers, including inspectors that have had their house set on fire, been injured, or even killed.

The Deputy Attorney of the Khabarovsk Nature Protection Attorney's Office A.V. Aleshina recently commented on the poaching situation (TRAFFIC 2002):

> "Existing measures for protecting Amur basin sturgeons do not prevent illegal catch. According to Amurrybvod in 2000, inspectors prevented 1057 violations related to sturgeon poaching from taking place, confiscated over 28.5 tons of fish and 1121 kg of caviar, and filed documents for 46 criminal cases. Unfortunately, existing legislation has many drawbacks. The Criminal Code of Russia classifies poaching as a low level crime (Article 256), with moderate punishment. Even a special case, such as when the ('violation is conducted by an organized group and abusing power') carries up to 2 years in prison as the most severe punishment. Analysis of such cases demonstrates that most of them are closed for various inexcusable reasons (amnesty, active repentance). As a result, a criminal goes free without being held responsible for the crime. One of the qualifying traits of the crime is causing 'serious damage,' but there are no mechanisms to assess the extent of damages being done to environment. Increasing liability for such crimes and specifying "species that are prohibited from being harvested" would be an efficient measure...

We experience the most difficulties when attempting to solve issues of illegal trade of aquatic animals. According to Article 129 of the Civil Code of Russia, objects of the animal world, including sturgeons, are not limited for use or excluded from trade items. Exports of sturgeon products are regulated by the laws and international rules quite well, but in-country there are no special laws to regulate such trade. Fish products on the market are accompanied only by documents related to sanitary and quality standards and establish no requirements for proving legal origin. This is one of the gaps in the current legislation, which seriously interferes with attempts to counter the illegal trade and harvest of sturgeons, as well as for other biologic resources."

Even incomplete data for black caviar and sturgeon meat tested at the Veterinary Service of Khabarovsky Krai in 2000 and 2002 (Figure 38) shows that in recent years at least 300 tons of kaluga and Amur sturgeon have been caught. These data also indicate that the ban on sturgeon harvest does not prevent extensive overfishing. Sturgeon fishing occurs completely in the shadows and feeds corruption. For instance, illegal sturgeon products are cheaper than legal products, but the poacher must pay for "cover." This forces him to catch more. The poacher does not pay taxes, which means less money goes to the government to help protect resources and support scientific research. This does not mean that the legalization of sturgeon fishing would immediately solve the problem at hand. One of the most likely scenarios is that corruption would develop within the licensing process, and those who did not receive legal fishing permits would continue fishing illegally. In addition, legalization of sturgeon fishing would make it would be easier to sell sturgeon products, and sturgeons could be greatly overfished, which is already an issue.

Table 3. Sturgeon poaching in 2000-2002 (TRAFFIC 2002, Primorye Fisherman 2002)

Hatchery	2000	2001	2002 , 3 quart.
# of violations	1057	2554	?
confiscated nets	1195	2017	?
sturgeon meat (kg/rubles)	28658.6/429 796	26170.8/839 229	43000/1 400 000
sturgeon caviar (kg/rubles)	1121.8/95 600	691.4/190 381	500/137 678
court cases (cases/people)	46/44	56/69	?

Sturgeon Meat and Caviar Trade

According to observations by TRAFFIC Europe-Russia (2002), in 1990s and during a later period, kaluga meat was very usual in markets and stores of Nikolaevsk-on-Amur, Khabarovsk, and Komsomolsk-on-Amur. Selling sturgeon products is very profitable because all expenses are covered by the legal part of the sale, and illegal sales bring pure profit.

There are several schemes of selling poached fish (TRAFFIC 2002). Harvested fish is transported by passenger speed boats that travel between Nikolaevsk to Khabarovsk. Passengers actually witness the loading of illegal fish. Fish and caviar are also carried by cargo ships, cars, and even aircraft. The latter is an interesting case. Former and current pilots take advantage of their position in order to buy up caviar and get it on the plane without being searched. In Khabarovsk, caviar is moved within the airport to another plane and is then transported to some distant city in Russia (TRAFFIC 2002).

Caviar and sturgeon meat are everywhere in Khabarovsky Krai - in markets, restaurants, and cafes. The meat is sold quite freely in markets, and you have only to inquire for caviar. The price depends on the quality and market. It is usually 500 to 3000 rubles per kg (TRAFFIC 2002). Sturgeon meat costs up to 100 rubles per kg. In Vladivostok, sturgeon roe is sold in cans marked as "Russian Caviar" (a company from central Russia). TRAFFIC Europe-Russia experts have concluded that the labels are false. On the world market, the price for black caviar may reach $3,500 per kg.

According to TRAFFIC (2002), crews of ships that have already passed customs and remain in the vicinity of the Chastye Islands actively poach sturgeon and then transport it to Japan. These ships may export up to 4 tons of caviar annually.

The main centers for processing and trade are located in Nikolaevsk and Komsomolsk. In Ulchsky and Komsomolsky districts of Khabarovsky Krai, large volumes of sturgeons are bought up from local population. The biggest sturgeon trading and processing company is "Shantar Pacific." In 1999, this company officially processed 6075.8 kg of black caviar, in addition to 42.76 tons of harvested sturgeon meat. In 2000, this firm exported over 5 tons of caviar from Khabarovsk to Great Britain, while only 60 sturgeons had been allowed for that year's catch, which would have resulted in a maximum yield of less than 6 tons (TRAFFIC 2002).

In 1999 at a customs check point along the border of the Evreiskaya Autonomous Oblast, a man was stopped while trying to transport over 1300 kg of caviar. Overall in 1999, Far East customs confiscated 8500 kg of sturgeon products. In 2000, this number was 1358 kg. In the first half of 2001, there were 11 attempts to carry over sturgeon products with a total weight 9402 kg. From 1999 to 2001, five criminal cases were filed in accordance with Article 188 of the Criminal Code. Usually, sturgeons at customs were declared as common river species: perch, pike, etc. Most of individuals who were caught worked for Chinese or Chinese-Russian companies. Chinese citizens often try to carry small amounts of sturgeon over the border. Most of violations on the border are committed during the winter period, because sturgeon meat is transported frozen for the most part. During the winter, when Amur is covered with ice, automobile border crossing points at Blagoveshensk, Amurzet, Nizhneleninsky, Khabarovsk, and Pokrovka start working (TRAFFIC 2002).

Most of the sturgeon meat and caviar go to China. Black caviar is exported to the USA and Japan. Some informant sources claim that Chinese black caviar also goes to USA. Some amount of caviar is transported to Vladivostok and Nakhodka by train to then be shipped abroad by sea. In 2001, Blagoveshensk customs stopped two attempts to carry Chinese fertilized eggs over the border.

Population Threats and Conservation Measures

The main threats to sturgeon populations are commercial fishing in China, poaching in Russia, water pollution, hatcheries, and dams.

How serious is the threat of overfishing? It is possible to consider this question, based on the following estimates: the Chinese catch is 140 tons on average; the illegal Chinese catch does not exceed 50 tons; the poaching volume in Russia is 750 tons, and Russia's controlled catch is 33 tons. The sum of these numbers adds up to 973 tons of annual catch. According to KhoTINRO 2002 forecasts, the mature population of Amur sturgeon was 1290 tons and kaluga was 2873 tons for this year. This means that about one quarter of the mature sturgeon population is caught every year. There are also two important factors in this trend. The first is that many poachers take only females for caviar, and the second factor is that most of the mature fish are spawning for the first time. Sturgeons are long-lived fish. The Amur sturgeon matures at the age of at least 10 years, and kaluga matures at 16 years at the very least. Neither of these factors favor the reproductive capacity of sturgeons, so it will very easy to lose sturgeons to extinction in the near future.

Concerning hatcheries, fish industry leaders and even some fish biologists believe that artificial reproduction sustains population and makes up for losses from fishing. Several things are left out of the equation in this case, however. One problem is that hatcheries always need fresh spawners from wild populations, which promotes the sturgeon catch and could cover up corruption and illegal fishing. Another aspect is that the real impact of hatcheries on wild populations has not been assessed, and changes of population genotype are not monitored. It is quite possible that hatcheries in Amur bring about more damage to the population than positive results.

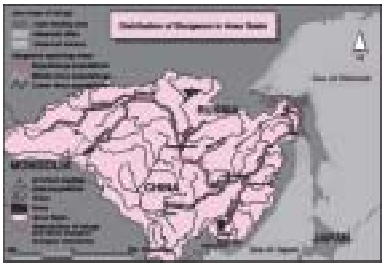


Figure 39. Map of distribution of sturgeons in Amur basin(please, see full color map in the middle)

The well known pollution of Amur waters has also not been assessed in terms of the risk to sturgeons. In the Volga, there were many incidences of catching fish with multiple eyes, or fish that are blind or otherwise crippled. It is understood that these problems result from the accumulation of mutations, which can be impacted by pollution. There is no doubt that similar processes are occurring in the Amur, but this important risk factor has not been taken into account by scientists or authorities, thus far.

Added to these negative influences are the existing dams and the threat of building new dams in the basin. The sum total results in a very sad picture. It is obvious that endemic species to the Amur require urgent measures if these globally endangered species are to be protected and restored. Such measures may include, but are not limited to:

1. Limits on Chinese fishing in the Middle Amur. There should be an effective Russian-Chinese agreement on sturgeon catches, as well as collaborative monitoring of the populations in border waters.
2. One possibility is to create transboundary refuges at key sturgeon spawning sites and to increase controls on fishing.
3. An effective federal program should be created to fight poaching. Such a program could be part of the existing goals for the program "Ecology and Natural Resources of Russia (2002-2010)" and should at least include:
   a. Improving laws to counter poaching and the trade of illegal fish products, including amendments to the Criminal Code and Civil Code, and to increase the liability level for poaching, assisting poaching, and participating in the organization of illegal trade.
   b. Blocking channels by which sturgeon meat and roe are transported and traded, and maintaining strict control over the documentation for fish products on the market.
   c. Looking for ways to improve the social-economic situation in Lower Amur villages and opportunities for decreasing unemployment.
   d. Development of sport and recreational fishing in the region as a tool for helping to solve the problem of unemployment and diminish the exclusive role of that poaching plays in the fishery.
   e. Struggle with corruption is one of the most complex, but primary actions needed to decrease poaching. It is possible to achieve desired results if state planning on quota distribution wisely considered addressing the needs of the local population (including indigenous peoples), supplying the equipment and incentives required for fish inspectors, and guaranteeing that people are held liable for violations on the river
   f. Increase effectiveness of fish protection by taking advantage of the Chinese experience and changing rules and methods of regulating fishing, such as establishing effective fish protection "sites" at the key areas for sturgeon migration and spawning.
4. A significant positive economic effect might result from Russia taking advantage of Heilongjiang Province's experience in developing captive breeding programs, including sturgeon farming. There are no visible obstacles to creating a regional program for fish farming and achieving an output level of 500 thousand tons of fish in the foreseeable future. Given long-term state planning, this would be quite feasible for Khabarovsky Krai or Primorye. It is necessary to mention that this issue is included within the long-term strategy of developing Russia's fishing industry.
5. Obviously a long-term Russian-Chinese program of sturgeon research and monitoring is needed. The program should study the genetic diversity and ecology of sturgeons, as well as the influence of pollution and hatcheries. In the long term, it may be discovered that hatcheries have a very negative impact on sturgeons.
6. Introduction of methods for researching sturgeons that allow the fish to be released, without killing it, are much needed.
7. It is necessary to assess the real necessity and impacts of hydroelectric dams of stations proposed for the Amur. In Europe and North America, dams are being decommissioned, and billions are being spent to restore nature, while in the case we may destroy a unique river without any real need for this action.
8. As an additional measures, the development of ecotourism and environmental awareness should be pursued.

Salmonids

Amur is a real kingdom of anadromous fish. Here one may meet two races of chum, pink, chinook, coho, masu salmon, Dolly Varden char and white spotted char. Some of these species migrate up to Bering Sea and back! Masu salmon overwinters close – by Japan and Kuril Islands, but this journey is over thousand kilometers! Chars are also anadromous fish. Dolly Varden char go from Amur to the Sea of Okhotsk and Pacific ocean, probably not further than Kurils. White-spotted char go to the semi-saline Amur Bay. Lenoks and taimen are typical freshwater fish that stay in the basin, but they make long migrations (300-500 km) in the summer. Only Brachymistax lenok stay at home and do not go anywhere far. Resident Amur salmonids migrate for winter from Amur tributaries to the main river and go back in the spring when ice melts.

Salmonids are very unequally distributed in the Amur Basin. Lenoks and taimen are widespread from the Lower Amur to Lake Khanka and up to Mongolian rivers. Anadromous chars stay in Amur estuary and tributaries not farther than 100 km from Amur mouth. Resident Dolly Varden live in cold mountain streams as far up as Ussury River sources and do no enter the warm Amur waters. Coho is a usual species in the biggest lower tributary of the Amur – Argun River. Pink, masu, and summer chum salmons go up on Amur not higher than 500-600 km. In the 19th cåntury fall chum used to go up 3000 km, but today this journey is limited to humble 1000 km.

All salmonids are lithophilic species, meaning they spawn on pebble bottom. The female prepares a sort of a nest called *redd* and spawns. The male fertilizes the eggs and then the female covers the eggs with more pebble so that predators cannot reach it. Lenoks and taimen spawn in the upper reaches of Amur tributaries. Masu salmon spawn from the middle parts of tributary basins to the upper reaches. Pink salmon spawn in the middle part of big tributaries like summer chum. Fall chum spawn by the sources of underground water. Ecological races of summer and fall chum are similar to chinook races of Columbia River basin.

Salmonids are predators, but most of them feed on zooplankton and insect larvae. Chum and pink often eat small fish. Masu and taimen during their first two years of life feed on aquatic insects larvae and at older age eat mostly fish. Lenoks also eat insects and sometimes fish. Chars prefer fish but eat whatever animals are abundant.

All Pacific salmon species are monocyclic, which means they die after spawning (2-6 years). All other salmonids are polycyclic – spawning several times in a lifetime. Siberian taimen live over 30 years and mature at the age of 6-7 years. *Brachymystax tumensis* live 14 years and Brachymystax lenok live 8 years. Brook Dolly Varden live up to 7 years.

Size of salmonids is the favorite subject of fishermen chat. Siberian taimen is one of the biggest salmonids of the world reaching 100 kg. All other salmonids are considerably smaller. *Brachymystax tumensis* may reach 8 kg, Brachymistax lenok is usually about 3.5 kg, fall chum males may be 14 kg, but average weight is 4 kg. Average summer chum weight is only 2.5 kg. Anadromous Dolly Varden in Amur is 1-2 kg, the brook form about 0.2 kg. White-spotted char may reach 9 kg.

Salmonid Diversity

Amur is the biggest salmon river in Asia. Its length is 4444 km. Three countries – Russia, China, and Mongolia use salmon resources of the huge basin. Anadromous salmon are very abundant in the Lower Amur – fall and summer chum (*Oncorhynchus keta*), pink (*Oncorhynchus gorbuscha*), and masu (*Oncorhynchus masu*). Coho (*Oncorhynchus kisutsch*) come to Amgun River. Anadromous chars (*Salvelinus malma and Salvelinus leucomaenis*) are abundant in rivers flowing to the Amur Bay, but in the Amur do not go higher than 100 km upstream from the mouth. Chinook (*Oncorhynchus tschawytscha* – last time caught 150 km upstream from the mouth in 2001), and steelhead (*Parasalmo mykiss*) occasionally visit Amur. Siberian taimen (*Hucho taimen*) and two species of lenoks (*Brachymystax lenok* and *Brachymystax tumensis*) are also quite abundant in the Lower Amur. Other *Salmoniformes* species in Amur include numerous graylings (3 species) and whitefish (2 species). Resident Dolly Varden char (*Salvelinus malma*) is spread in the Lower Amur basin up to the upper reaches of Ussury River tributaries. All of the above species are popular objects of commercial, amateur, sport, or subsistence fishing.

The only anadromous salmon of the Middle (from Ussury mouth to confluence of Shilka and Argun rivers) and Upper Amur (Shilka and Argun basins) is fall chum, though very scarce there these days. Siberian taimen, lenoks, graylings, and whitefish are common throughout the basin. At least in the basins of the southern Sea of Okhotsk and Sea of Japan Amur has the highest diversity of salmonids (Table 4). In the basin probably Argun River has the highest salmonids diversity.

In 20th century no species became extinct in Amur, but many populations of fall chum disappeared in the Upper and Middle Amur, and also Ussury River. Some populations of brook Dolly Varden disappeared in Ussury River basin. Many populations of Siberian taimen also disappeared. In 20th century all populations of salmonids significantly decreased in abundance, which was very likely caused by overfishing.

Population Structure

Chum is the most abundant Pacific salmon in the basin. V.Ya. Levanidov (1969) believed that Amur chum has groups of different population levels – local stocks of the 1st level (geographic areas), 2nd level (big river basins or groups of basins), and 3rd level (separate spawning channels and spawning sites). Differences in spawning, number of redds per couple, and size of redds may distinguish smaller groups, called by S.M. Konovalov (1980) “subisolates.” Levanidov defined a local stock of the 1st level as a group of similar populations in big regions. These ideas were supported by many other biologists.

There are two temporal groups (usually called races or runs) of chum in the basin – fall and summer chum. Biochemically they are similar, but spawning time is different. Summer chum come to Amur in July-August and spawn in August-September. Fall chum come in September and spawn in October. The summer chum spawn in places with slow current and fall chum spawn at the sources of underground water sources. The biggest chum populations are in the rivers Ussury, Amgun, Ul, Gur, Anyui, and Tunguska.

Pink salmon come to the Amur in June-July and spawn in August-September. The main populations are in the Amur estuary, Ul River, and Amgun River.

Brachymystax tumensis is very widespread in mountain rivers that does not migrate farther than 50-70 km. Because of that it was recommended for conservation of this species to use basin approach for 3rd and 4th level tributaries (by Horton). We believe that in Ussury basin there are 70 local populations of this species. The number of populations in the whole Amur watershed is unknown.

Brachymystax lenok population structure is closely related to its biology. This lenok is an active migrant that in the summer go to the main river and big tributaries and spend winter in special *winter pits* in big rivers. We assume that there are several populations belonging to second order tributaries, in each big tributary basin because this species migrate for 200-300 km. For instance in Ussury there may be 10 populations.

Siberian taimen migrates just as far as Brachymystax lenok and have similar population structure.

Table 4. Comparison of salmonids biodiversity (Zolotukhin, 2002)

District	Species	Number of species*
Okhotsky	*O. gorbuscha, O. keta, O. kisutch, O. tschawytscha, O. nerka, S. leucomaenis, S. malma, S. neiva.*	8
Ayano-Maisky	*O. gorbuscha, O. keta, O. kisutch, S. leucomaenis, S. malma.*	5
Tuguro-Chumikansky	*O. gorbuscha, O. keta, O. kisutch, S. leucomaenis, S. malma. P. mykiss (Shantar Islands only), B. lenok, B. tumensis, H. taimen.*	9
Sakhalin Gulf	*O. gorbuscha, O. keta, O. kisutch, S. malma, B. tumensis, S. leucomaenis.*	6
Amur River Watershed	*O. gorbuscha, summer chum (O. keta), fall chum (O. keta), O. masou, B. lenok, B. tumensis, H. taimen, S. leucomaenis, anadromous Dolly Varden char (S. malma curilus), brook Dolly Varden char (S. malma curilus).*	10
Rivers of Amur Bay	*O. gorbuscha, summer chum (O. keta), Fall chum (O. keta), O. masou, H. taimen, B. tumensis, S. leucomaenis, anadromous Dolly Varden char (S. malma curilus), brook Dolly Varden char (S. malma curilus).*	9
Tatar Strait continental coast	*O. gorbuscha, O. keta, O. kisutch, O. masou, B. tumensis, P. perryi, S. leucomaenis, anadromous Dolly Varden char (S. malma curilus), brook Dolly Varden char (S. malma curilus).*	9

* - without taking into account rarely observed or stray fish

Masu salmon population structure was studied by many researchers. It is usually perceived as big territorial groups or populations of big spawning rivers. M.L. Krykhtin (1962) believed in separate populations of geographic regions like Amur. V.N. Ivankov and A.Yu. Semenchenko believe that this species in its whole range has only two groups. One is “Southern Primorye” that inhabits Sea of Japan and could be called fall temporal race. The second group is the summer race that inhabits Northern Primorye, Sakhalin, Western Kamchatka, and the Amur. It is believed that Amur masu spend winter near Kunashir and Iturup Kuril Islands, also Hokkaido and the south of the Sea of Japan (A.Yu. Semenchenko1989, V.N. Ivankov 1991).

Southern Dolly Varden includes anadromous and resident forms that do not differ from each other genetically or morphologically. Only anadromous fish are bigger in size. The cariotype of southern Dolly Varden char indicates that this should be a separate species.

White-spotted char migrations were studied in the north-west of the Russian Far East and specialists concluded that this char does not migrate far. We also believe that these fish do not go far from the river mouth and do not leave Amur Bay.

Coho are regularly caught during chum commercial fishing in Amur Bay and Amgun, where it might spawn.

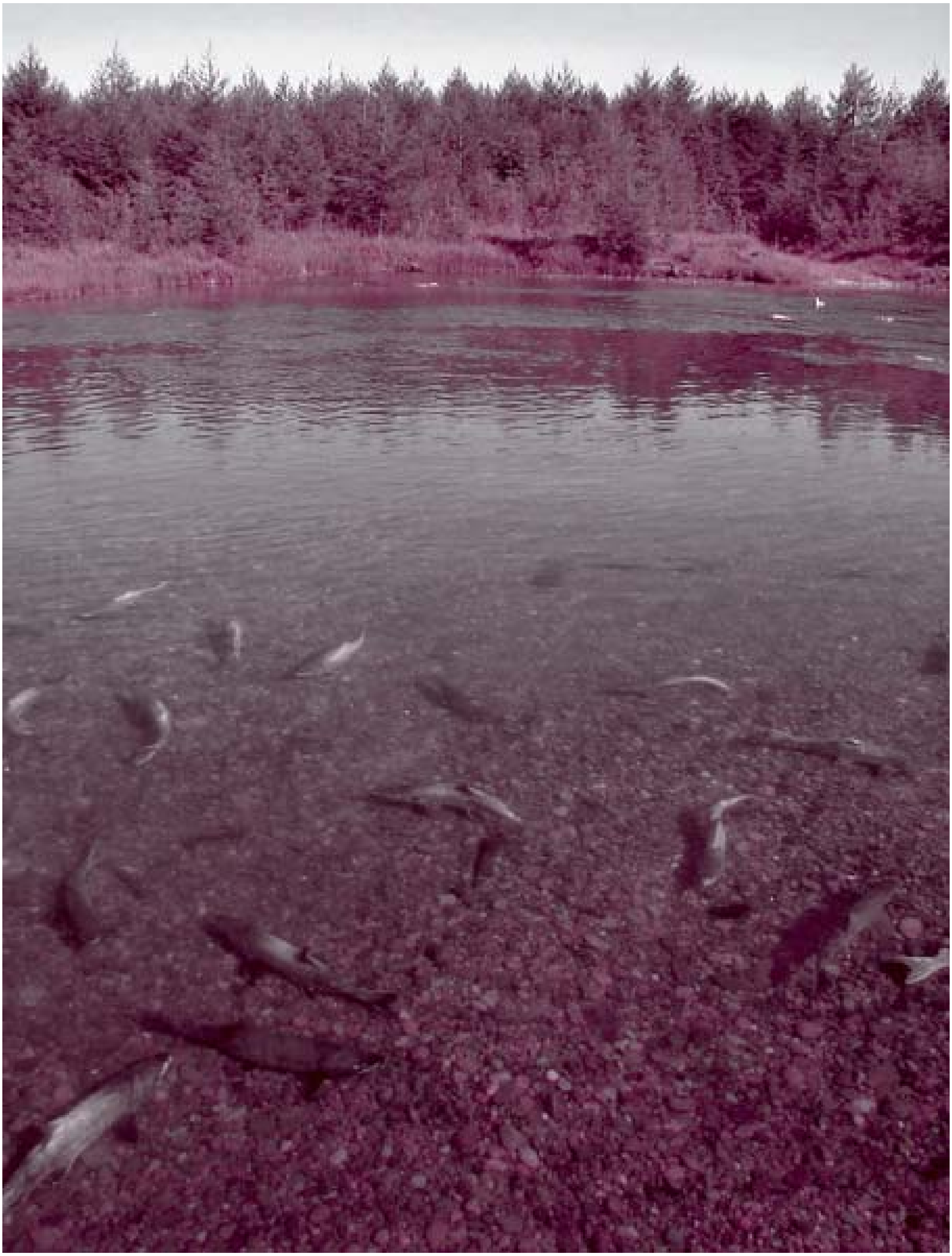


Figure 40. Spawning grounds filled with chum that managed to escape from predators, drift nets and hooks

Chinook and **steelhead** in Amur basin are strayed fish that are caught once every several years.

The population structure of Amur salmonids is still not sufficiently researched. Even today there is no list or mapped distribution of salmonids populations and subpopulations in Amur watershed, which make it more difficult to manage and protect this valuable resource.

Historical and Present Distribution of Salmonids in Amur Watershed

Fall chum is one of the most valuable resources of Amur. Chum range used to be huge – fish came up to Argun and few reached even Onon River (over 3000 km from Amur mouth). In Ussury chum went almost to the river sources. In the past century sustainable commercial fishing of chum existed up to Albazino Village 2200 km upstream from the Amur mouth. Since 1960s only very few chum come for spawning to rivers of the Middle Amur. Poorly regulated commercial fishing and poaching on spawning grounds are considered the main reasons of population decrease.

Levanidov was the only researcher who estimated historical chum spawning range. In late 1950s in relation to plans of building dams on Amur he was asked to assess possible damage to salmon. He showed that any dam would cut off the bigger portion of spawning range the lower on Amur it is situated. The lowest projected dam was estimated to cut off 80% of chum spawning population. Those dams were not built, but today those plans are talked about more and more by authorities.

In China Songhua River about 50% of its tributaries were historically suitable for chum spawning, but today the river valley is used for agriculture and many forests were logged. The water carries a lot of suspended particles, and chum do not enter Songhua River. Ussury River has a lot of tributaries in China, but unlike tributaries on the Russian territory there soils are clay and sand, which is not suitable for chum. There are some good spawning habitats for chum in China in Amur tributaries just upstream from the Songhua river mouth but the recent research of Chinese biologists in 2000 did not reveal actual spawning. The capacity is estimated at least one million chum.

Putting together Russian and Chinese estimates we obtained a historical and present share of chum spawning are in the whole Amur basin (Table 5). It is also shown on a map (Figure 42). In areas 6-10 fall chum is either extinct or close to it. In 4-5 fall chum enter rivers in numbers from a few hundred to several thousand, and only in 1-3 thousands and hundred thousand spawners come. 1-3 are also areas where summer chum, pink, and masu spawn.

Commercial fishing is allowed only in the estuary and the lower 100 km of the Amur. The local population is allowed to catch some fish but it is usually not sufficient and people catch much more. A big problem is caviar poaching. Poachers catch salmon on the river and even at the spawning grounds to harvest caviar.

In China fishermen use special boats 7-10 meters long and nets 200-300 meters. Usually 2-3 people work in each boat. We could estimate fishing effort of Chinese fishermen on Ussury by data from Federal Border Guard Service for 1996-2000. There were 230 fishermen on 92 boats. In August before

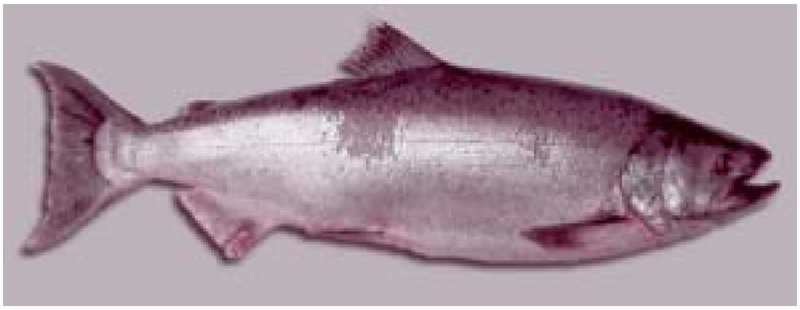


Figure 41. Chinook caught in Amur by Tahta village in 2001 year, length - 56 ñì

Table 5. Estimates of historic and present chum spawning areas in Amur watershed (Levanidov 1958, Zolotukhin 2002)

Name of the area and number	Historic spawning area, million sq. m	Historic share of spawning area, %	Present share of spawning area, %
1. Amur Bay and tributaries before Amgun	0.4525	3.95	5.0
2. Between Amgun and Ussury	2.715	23.71	40.0
3. Amgun	1.81	15.8	50.0
4. From Ussury to Zeya (Russia)	0.362	3.16	0.54
5. Right tributaries of Ussury (Russia)	3.62	31.61	4.5
6. Left tributaries of Ussury (China)	0.18	1.57	0.0
7. From Zeya to Argun&Shilka (Russia)	0.09	0.78	0.0
8. From Ussury to Argun&Shilka (China)	0.02	0.17	0.0
9. Songhua basin (China)	2.2	19.21	0.0
10. Argun&Shilka basins	0.005	0.04	0.0
Amur River Watershed	**11.4545**	**100**	**100**
Lower Amur (up to Ussury)	8.7775	76.6	954.0
Middle Amur (from Ussury to Zeya)	2.562	22.4	5.0
Upper Amur (from Zeya to Argun&Shilka)	0.115	1.0	0.0

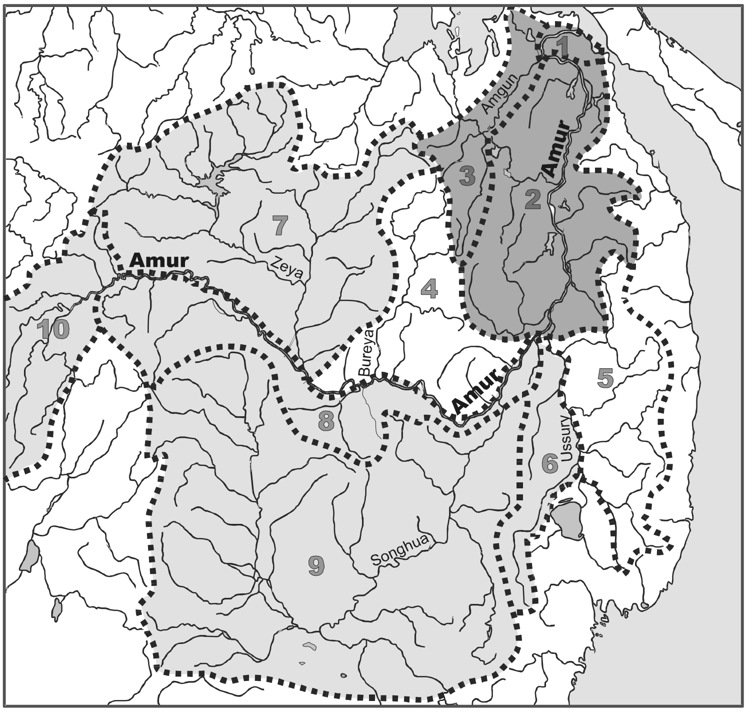


Figure 42. Distribution of Pacific Salmon in Amur Watershed

Figure 43. Typical Chinese boat

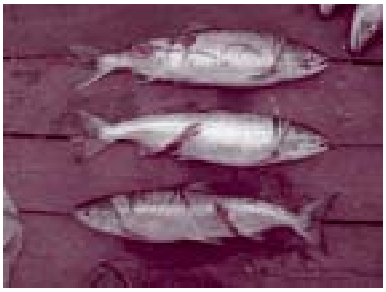


Figure 44. Amur summer chum with seal wounds near Tyr town

chum came they conducted about 8280 control castings of 200-300 meter nets. In September when chum came they conducted about 22000 castings. In October that number reached 25-30 thousand. This is much-much higher than in the Lower Amur.

We can say that the total range of chum decreased by the size of Ussury, Songhua, Middle and Upper Amur basins. About 4-6 million chum are not reaching their former spawning grounds in Russia.

Summer chum in Amur usually do not go farther than 500 km from the mouth. Most of its spawning grounds are located in the Amgun tributaries. Sometimes though, summer chum abundance goes up and spawning range temporarily expands. There are data about spawning migration of summer chum in Ussury in 1890s, 1951, and later years. Catches of Amur summer chum in the beginning of ÕÕ century reached 53.4 thousand tons (1910) and then rapidly decreased. In 1930s catches were about 15000 tons and later did not exceed 3000 tons. Some specialists refer that to some long term cycles and special climate conditions. The historical range of summer chum did not change. Summer chum is caught in the Amur, near Kuril Islands, and in Japanese waters (where it is called *tokisirazu*).

Pink salmon spawning range coincides with summer chum. Its main spawning sites are located in Amgun River tributaries and historical spawning range did not change.

Masu nowhere else in its range go up inland as high as in Amur. The farthest spawning sites are 600 km upstream from the mouth of the Amur (Gur River), though most masu spawn in the same rivers as pink and summer chum. The historical range has not changed over time.

Siberian taimen and lenoks are spread throughout the basin in streams that do not get warm in the summer. In Songhua basin taimen has disappeared. Probably there are very few of these fish in China and they live in Amur tributaries above Songhua. In Russia taimen retained its historical range.

Coho, chinook, sockeye, steelhead are rare guests in the Amur. Possibly, only coho may spawn in Amgun River, but it was never proven. In 1928-1931 Kamchatka sockeye was attempted to acclimatize in Amur, but the attempt failed.

Anadromous chars usually stay near estuary and their historical range has not changed.

Hatcheries and Ecosystems of Amur Salmon Rivers

The first salmon hatcheries for production of fall chum smolts were built in 1928 (Teplovsky) and 1934 (Bidzhansky) 1200 km and 1500 km upstream from the Amur mouth. In 1963 Udinsky hatchery was built on Amgun River and in 1968 another hatchery was built on Gur River (Figure 45). Later it turned out that chum was losing its range and no longer reached some of the upper hatcheries during the spawning run.

Figure 45. Location of chum hatcheries in Amur basin

The work of hatcheries is very poorly assessed. Usually all fish downstream from the hatchery is considered “from the hatchery” or at least a mix of wild and artificially grown fish. Relationships of wild and hatchery fish were little studied and the efficiency of natural reproduction was not accounted for when assessing hatchery’s actual output.

The number of released smolts is considered the main indicator of hatcheries work. Today in Amur basin there are 5 hatcheries with total projected output is 49.5 million smolts per year. The actual releases went down in recent years to 6 million smolts per year, which is very little compared with the natural rates of reproduction (Figure 46, 47). The last hatchery was built in the fall 1999 on Anyui with projected output of 20 million smolts. In 2000 it released first 350 thousand smolts.

In 1995 there was a plan of building in Khabarovsky krai 53 hatcheries to produce chum (559 mln), pink (220 mln), masu (9-15 mln), and coho (5-6 mln) smolts. Alaskan technology of cultivation of salmon in marine environment was also proposed. Today this plan is practically obsolete.

The first problem is absence of spawners. Because of constant lack of spawners (fish had to go as far as 1,200 kilometers) hatchery managers installed special electric blockers to prevent chum from

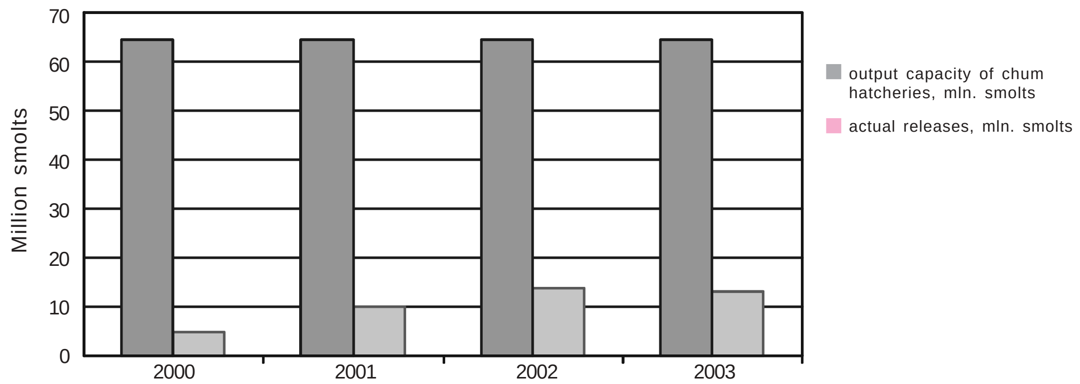


Figure 46. Projected output of hatcheries and actual releases in 2000-2003

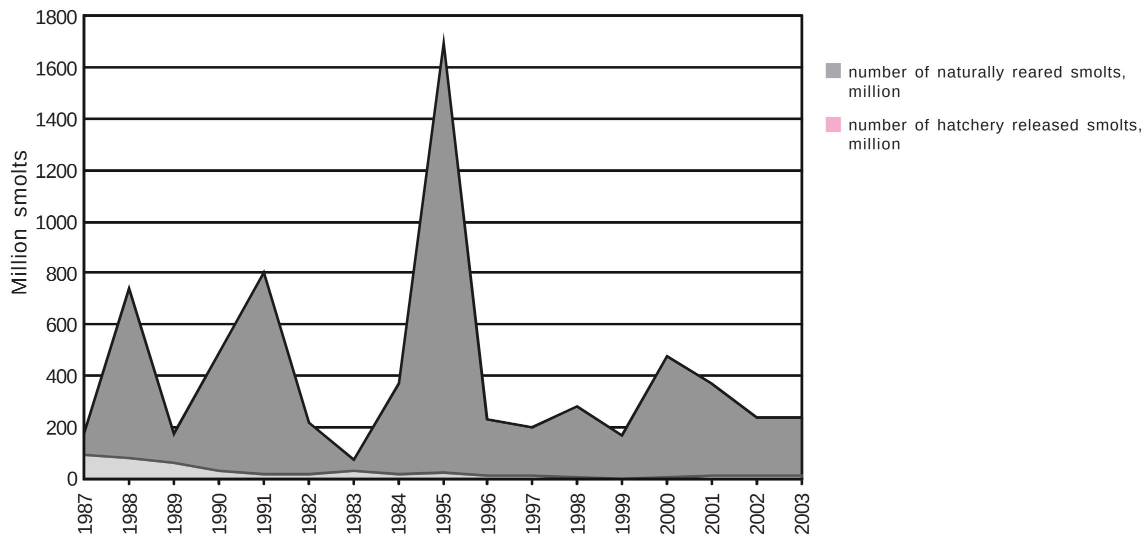


Figure 47. Dynamics of natural production of smolts and total from hatcheries in the recent years in Amur basin (million)

passing by the stream where hatchery is operating. These devices were set up in 1980-1990s and succeeded in killing a lot of taimen. Also hatcheries decreased the share of males by the "upper" hatcheries and simplified size-weight and age structure of artificial salmon.

The rate of return is known as the main estimate of hatchery efficiency. According to KhoTINRO scientist Yu.S. Roslyi (1980, 1987), the long-term rate from 1933 to 1965 for Teplovsky hatchery was 0.11%, for Bidzhansky 0.06 %. Research of the 1990s showed that these rates became ten or more times lower in recent years.

The comparison of artificial and natural reproduction in 1987-1999 shows that while there were 4570 million wild smolts, hatcheries released about 411 million smolts (Figure 47). This proves that input of hatcheries in reproduction of chum in the basin is insignificant. The system of "upper" hatcheries failed to serve as reproduction centers for chum in the Middle Amur. The present work of hatcheries leads to nowhere and many specialists understood that.

This existing practice of putting electrical devices on rivers leads to extermination of wild fish, especially taimen. Plans for production of millions of smolts that require use of many wild spawners could really hurt populations in unproductive years. Special attention should be paid to existing abuse of the need to get eggs for hatcheries. A lot of eggs are just poached on best spawning sites during that process.

Hatcheries could be centers of reproduction for rivers where they are located and conduct monitoring of populations to determine real input of hatcheries and status of populations. It is necessary to monitor thoroughly both artificial and natural reproduction. A hatchery in some ecosystems could become something filling in natural processes and should not be some alien power to modify river solely for the purposes of fishing industry. Wise planning of salmon resources is worth attracting highly qualified specialists with proper compensation.

Fishing of Amur Salmonids

Commercial Fishing

From the ancient times fishing and hunting fed people on Amur. French missioner la Bruniere who visited rivers Amur, Songhua, and Ussury in XVIII century described local population as depending on chum. He wrote that the country suffered great hunger in unproductive years of this fish. Russians catch chum in Amur waters for over two centuries. It is for sure that Amur commercial fishing of salmon is much bigger than in other rivers of the Russian Far East.

Nikolaevsky fishing district (Amur River, Amur Bay, and North-east Sakhalin) in the beginning of the 20th century was the main salmon catching area in Russia. The railroad built in 1899 was used to transport caught salmon to central Russia. Most of fish was bought up from the local population by merchants. The fish was excellent quality – "silver ", as it still had long way before spawning.

Figure 48. "Amur fishing plant" catching summer chum and pink salmon: several barges with refrigerators, kitchen, processing area, living decks and fishing boats

Figure 49. For this Japanese boat it takes one hour to cast a 30 km net

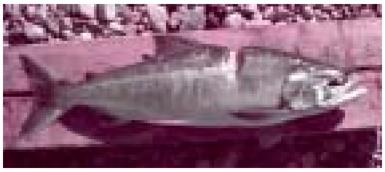


Figure 50. Muscles on the back of this chum were cut by ocean drift net, but the fish returned

The impressive resources of Amur salmon were very noticeable even in the sea. Most of fish caught by Japanese fishermen was produced by Amur and this population started decreasing. In the second half of the 20th century sea fishing was controlled according to international agreements. In 1980s all countries protected their fish resources by 200 mile economic zones. Commercial fishing statistics became more transparent. Japan decreased drifter net fishing in the sea but salmon did not get more abundant!

After catching 93,500 tons in early 1900s, 3,000 tons of chum by the end of 1990s look like a collapse of populations (Figure 51). Where is all that wealth? The first footprint is found in commercial fishing statistics. The actual catches in Amur are different from the official data. Many people that lost jobs after perestroika started earning their income illegally on the river. Subsistence fishing supports most of unemployed local residents in the Lower Amur. KhoTINRO scientist G.V. Novomodny assessed the volume of fall chum subsistence fishing of local population in 1990s as almost 9000 tons (Figure 52).

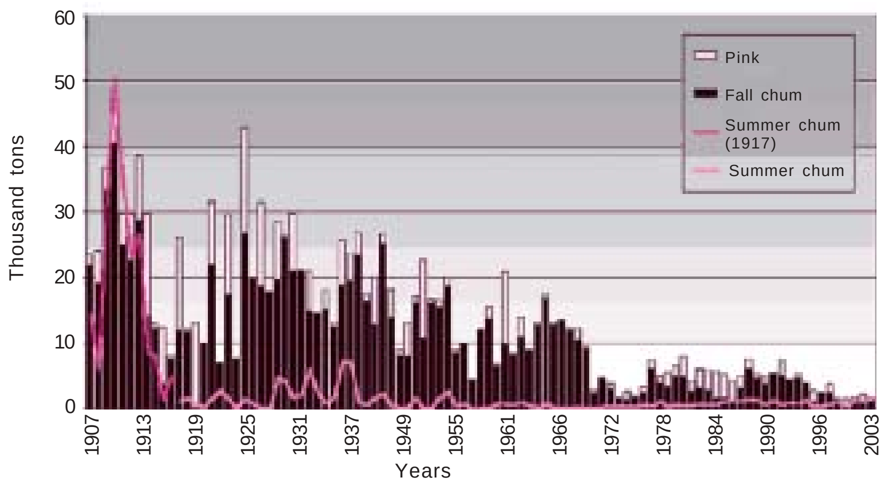


Figure 51. Dynamics of Pacific salmon catch in Amur (1907-2003)

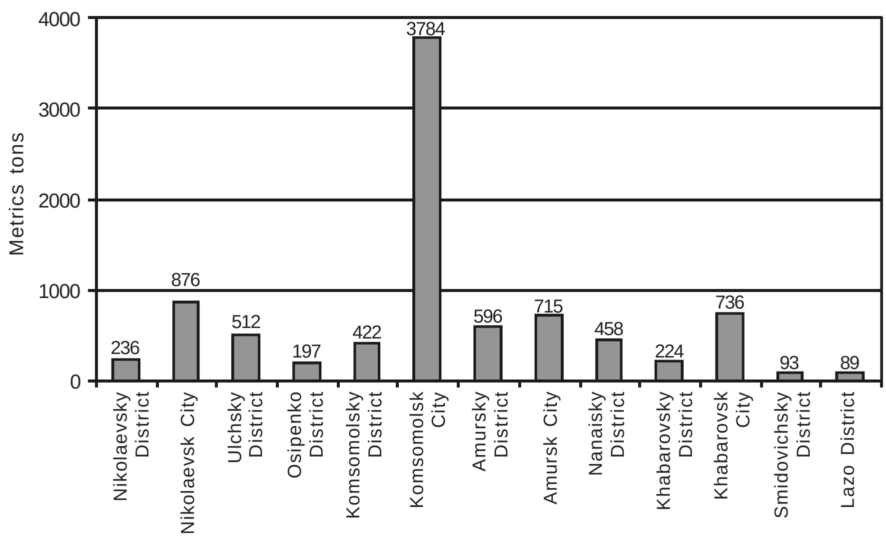


Figure 52. Assessment of subsistence catch of fall chum in Amur Basin by district in 1990s

Selling illegally caught salmon allows buying new nets, boat engines, and gas. Subsistence fishing actually goes together with small scale commercial fishing. There is a whole black market on the river that provides living for local residents, merchants, and even some fish inspectors.

Another footprint of Amur chum is found just up front of the Amur River mouth – North-western coast of Sakhalin Island! The migration route of Amur salmons lie very close to towns Rybnovsk and Rybnoe on Sakhalin and it is even easier to catch fish there than in Amur estuary. In the beginning of 20th century Amur chum in that area made about 10% of catch, by the end of the century the share increased up to 25%, while Amur pink makes 30-40% (Figure 53).

Since 1960s a so called total allowable catch (ODU) was introduced in order to optimize commercial fishing. This assessment never accounted for fishing in Sakhalin, because Amur is in Khabarovsk region while Rybinsk is in Sakhalin. As a result in the second half of 20th century Amur salmons were continuously overfished, but no responsible person took any action to correct the situation.

The third footprint of Amur salmon resources is found at Kuril Islands! Here between Kunashir and Iturup islands salmon from the Pacific Ocean enter the Sea of Okhotsk. Fishermen know migration routes pretty well so coastal waters of the islands are filled with nets. What is the share of Amur salmon? Probably the most reliable data today was obtained during Russian-Japanese chum research in 1999-2001. Samples of scale, muscle tissues, heart, and liver were analyzed and fish of different stocks from Japan, Sakhalin, Amur, and Kamchatka were determined. According to that research the share of Amur fall chum in Japanese waters was 30 to 62 %, three year average – 50%. Share of Amur summer chum varied from 13 to 49 %, average – 29%. So the total share of both races of Amur chum in Japanese waters was on the average 52 %.

Pink salmon is not so much valued as chum. Pink come in the hottest season – July, when the water is 24-28°C. Only in Amur Bay, the coldest area in the basin it is possible to deliver fish home without losing meat quality. For these reasons resources of pink salmon in Amur basin could be actually underused today. In the Lower Amur people take pink only for eating right away or preparing caviar. Almost all nets have bigger mesh for catching chum. The biggest threat for chum is poaching at the spawning grounds where poachers cut fish for eggs and prepare many tons of caviar every year.

Amateur salmon fishing in Amur is catching fish by fishing licenses. After ban on free salmon fishing in 1957 it is the only way for local population to fish legally. Licenses are often bought up by professional fishermen so licensed fishing is as a matter of fact a usual subsistence or small scale commercial fishing that has nothing in common with recreation or sport.

Sport (trophy) fishing is not developed in the basin. Separate fish tours are mostly for foreigners and are too expensive for Russians. "Catch and release" fishing is really difficult to comprehend for Russian and indigenous people who see the purpose of fishing to get food.

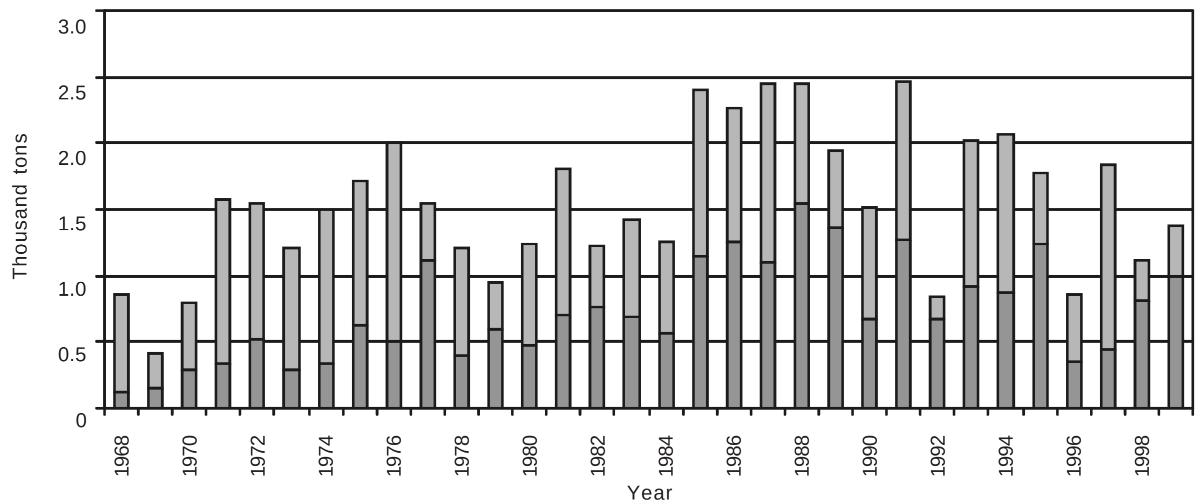


Figure 53. Catches of Amur summer chum in Amur and North-western Sakhalin in 1968-1999 (thousand tons). Amur share – blue color, Sakhalin – orange

Indigenous nations – Nivkhi, Nanai, Ulchi, and other are old salmon fishing cultures. Many of their fairy tales and legends are about fish. Fishing is their lifestyle, main food, and spiritual source. Traditional fishing equipment of Amur indigenous people is often seen in many world ethnographic museums. Some indigenous people are united in brigades (associations), some obtain individual licenses. Very often they sell their licenses.

Unlike indigenous people Russians see fish only as a trade and food item. It is never a cultural and esthetics item. Amur tiger and Himalayan bear are the symbols of Primorye and Khabarovsk, but neither chum as a basis of the region's fish industry nor Siberian taimen as the world biggest salmonid are chosen as symbols of the region. Maybe people would think about this species more when they disappear?

Threats to Populations and Conservation Measures

Up until the end of 19th century Amur was not connected by trade routes with Europe. At the end of 19th century a railroad was built. At the same time Japanese started buying salmon from the local population and fish trading merchants. Sturgeon, salmon, and caviar were exported to Europe. Trade greatly stimulated fishing on Amur. Russian and Chinese caught fish and greatly altered the river valley.

In 20th century fall chum practically disappeared in China. In Songhua River habitats were lost. In places where spawning grounds are still in good shape chum do not spawn because those populations were exterminated by overfishing and poaching. A group of poachers usually harvests up to 0.5-1.5 tons of red caviar and have a “cover” of criminal structures or authorities. The main threats for fall chum is loss of habitat and overfishing in China, poaching on spawning grounds, and fishing in the sea. Chum is valued much more than pink salmon, so many fishing brigades buy permits for catching pink but catch summer chum instead. So summer chum is regularly overfished.

Masu salmon (the southern analog of coho) is priced very highly in Russian and Japanese markets. Since 1957 this species is forbidden for commercial fishing and only few hundred licenses are sold for amateur fishing. This led to cease on monitoring of this species making masu the least studied salmon. The total catch of masu in Russia is about 10 tons. The main reason for collapse of the population specialists believe to be the unfavorable climate period that affects abundance of this species forage.

Masu spawning and feeding sites are generally in good condition, but the main threat is that in the southern part of its range there are many roads with lots of people and poachers. People also catch a lot of smolts to eat or feed cats considering it a kind of trout. It is known that sometimes people even catch it to feed pigs.

Siberian taimen used to be widespread throughout the Amur basin, but then it disappeared in China and decreased in abundance in Russia. In the beginning of 20th century settlers caught tons of taimen. In the second half of 20th century it was a very big luck to catch 10 taimen at a time. Today this fish

Figure 54. Salmon fishing using stationary nets is the most popular method in the Far East

Figure 55. Tons of cut chum – result of poachers work – usual picture on Amur

does not form groups at all. Sport fishing and catch and release are still not developed. The main threat is absence of river protection and poaching.

Lenoks are the most abundant salmonids of Amur basin. In Russia they are still in decent condition. In China these species live wherever forests are left. The threats are pretty general – forest fires, logging, changes of stream morphology.

Brook Dolly Varden could die if the water temperature is higher than 10°C. It is possible that many populations are lost because of logging or forest fires. Forest fires are dangerous for all salmonids. The ash causes change of pH. Soil gets eroded. Redds get covered with sediments. Fish and eggs die. Restoration of forest is followed by recovering of the salmonids river.

A natural negatively influencing factor is decreasing of water level. This leads to death of smolts in small streams because of drying up and increase of water temperature. This situation could be worsened by big dams of hydro power stations on Amur tributaries. Change of climate may also influence this process.

In general the main threats for salmons are: poaching for meat and caviar, loss of habitat, logging, pollution, dams, and forest fires. The main conservation measure is to organize effective protection of fish during migration and spawning grounds. Organization of salmon refuges at the key spawning areas, development of fish tourism, environmental awareness, decrease of logging in salmon river basins, and introduction of best practices and salmon friendly forest management are possible roads to save the incredibly diverse and unique salmon river Amur.

Specific measures may include, but are not limited to:

1. Increase capacity of existing protected areas that cover salmon rivers. Amend federal and regional laws to specifically recognize salmon protected areas, and create new and increase wherever appropriate status of existing salmon protected areas.

Figure 56. Methods and results of poaching: river-crossing nets and tons of rotting pink

Figure 57. Forest fire in Amur Basin

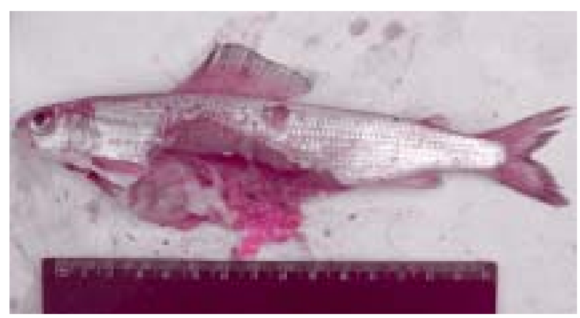


Figure 58. Salmon eggs in grayling belly. Predators often eat eggs that got flushed away from the redd

Figure 59. One of Amur channels 100 km downstream from Khabarovsk, June 2003

2. Enable a special program of protection of spawning grounds that is scientifically based and takes into account ethnic, economic, and social situation in administrative districts. There must be sufficient federal and regional financing and participation of local residents for such program to be.
3. Develop a special program on use of hatcheries in Amur River Basin
    a. Cease existing hatcheries practice of putting electrical devices on rivers
    b. Reconsider role of hatcheries in Amur ecosystem and limit their use to restoring populations in the Middle Amur.
    c. Conduct proper monitoring of impacts of hatcheries on wild salmon.
    d. Impose strict control on collecting eggs for hatcheries.
    e. Achieve coordination of hatcheries production and monitoring between Russia and China
4. Create an effective federal program to fight poaching. Such a program could be part of the existing program "Ecology and Natural Resources of Russia (2002-2010)" and should at least include:
    a. Improving laws to counter poaching and the trade of illegal fish products, including amendments to the Criminal Code and Civil Code, and to increase the liability level for poaching, assisting poaching, and participating in the organization of illegal trade.
    b. Blocking channels by which salmon caviar is transported and traded, and maintaining strict control over the documentation for fish products on the market.
    c. Looking for ways to improve the social-economic situation in Lower Amur villages and opportunities for decreasing unemployment.
        i. Development of sport and recreational fishing in the region as a tool for helping to solve the problem of unemployment and diminish the exclusive role of that poaching plays in the fishery.
        ii. Development of sustainable, community-based commercial fishing as a way to create jobs and keep benefits in the community.
    d. Struggle with corruption is one of the most complex, but primary actions needed to decrease poaching. It is possible to achieve desired results if state planning on quota distribution wisely considered addressing the needs of the local population (including indigenous peoples), supplying the equipment and incentives required for fish inspectors, and guaranteeing that people are held liable for violations on the river
    e. Increase effectiveness of fish protection by taking advantage of the Chinese experience and changing rules and methods of regulating fishing.
5. Assess the real necessity and impacts of hydroelectric dams of stations proposed for the Amur. In Europe and North America, dams are being decommissioned, and billions are being spent to restore nature, while in the Amur case we may destroy a unique river without any real need. The World Commission on Dam's final report also questioned the role and effectiveness of large dams in economic development.
6. Achieve proper consideration of impacts of planned timber harvest on salmon and impose strict control on road building and respecting water protective (riparian reserve) zones by logging companies.
7. Develop fish tourism and promote environmental awareness among fishermen and local population.
8. Developing a common biodiversity conservation strategy for salmonids throughout the Russian Far East. Such a regional strategy will help eliminate jurisdictional differences in management and research.

10. Complete and adopt federal law on fisheries.
11. Increase public involvement in salmon conservation.

Amur Problems

Although the Amur watershed has been inhabited for thousands of years, it took a little over 20 years (since 1980) for Amur to become one of the most densely populated coldwater river watersheds of the world. This northern river is not capable of absorbing the growing load of industrial, agricultural, and sewage pollution. The river water, used by population for drinking, is turbid because of suspended particles, has distinctive smell (especially noticeable in the winter time), and is filled with pathogenic bacteria, heavy metals, and pesticide residues. The most critical situation is in the Lower Amur because Songhua River adds its pollution to wastes brought from the Upper and Middle parts of Amur. Pollution of the Khabarovsky krai also further deteriorates water quality.

Flooding is another issue that besides being a natural disturbance factor grew into a huge problem for both people and nature. Logging forests, converting wetlands into agricultural lands, construction of various dykes, particularly in Songhua River Basin and Middle Amur, resulted in significant changes to the hydrologic regime and appearance of catastrophic floods that carry more pollution into Amur, destroy settlements, and even kill people.

Development of the Amur basin and urbanization bring more and more problems. Most of people that live in the basin on either side of the border have very low level of environmental education. The communist ideology claimed nature a subject to conquer, use, and control. Because of that today we see people that easily load landscapes with trash, kill animals without any second thoughts, collect eggs of rare birds, and over-harvest fish. The problem of minds of both ordinary citizens and government officials of any rank is a serious problem for the basin, and it is obviously impossible to improve the environmental situation in the basin without addressing these issues.

Studying the fish of the Amur has always been major challenge. The size of the watershed means significant resources are required for thorough studies. There are very few management agreements and research protocols among Russia, China and Mongolia. There have been few (if any) joint research projects, and it has been hard or impossible to gain access to research done in other countries.

The fish community of the great Far Eastern river has also significantly changed over time. Many stocks of valuable salmon and sturgeon species became extinct in some parts of the basin. Several species actually disappeared. At the same time out of almost 140 species that can be found in the Amur, at least 20 were introduced by people. Some of those species proved really invasive and formed high concentrations in some parts of the basin. Proper monitoring of invasive species and their impacts on native species was never funded in Russia or China. On the contrary, both countries strived hard to “improve” fish communities by introducing new species in the river and taking Amur species to distant basins. It is astonishing that today the species at the highest risk of extinction is Amur subspecies of common carp (*Cyprinus carpio*)! This fish is simply dissolving through assimilation with introduced Japanese, Chinese, and even German carps. Its close relative Amur subspecies of gold fish (*Carassius auratus gibelio*) is also getting mixed with southern Chinese subspecies (*Carassius auratus auratus*) and other relative species.

The problems of invasive species, pollution, massive logging, changing landscapes, loss of wetlands, poorly controlled fishing, loss of habitats, and shrinking of many species' ranges make a far incomplete list of issues that have impacts on fish and are the main causes of decrease in fish resources of the basin. As a matter of fact, solving problems of Amur fish means solving problems common for the whole basin, which demands taking into account all aspects of the socio-economic development and use of natural resources of the southern Russian Far East, northern China, and eastern Mongolia. Fish are often only an important indicator of the situation in one or another region that allows judging about environmental problems and use of natural resources. It is obvious that health of the fish community of Amur and its tributaries is the best indicator of health of the very river and only saving this resource we can talk about conservation of unique nature of the Amur River Basin.

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Appendix

LIST of 139 species of fish living (or likely living) in Amur River Basin today (including introduced, semi-saline, marine, and occasional species)

Marks:

+ – not listed in the "Annotated Check-List of Cyclostomata and Fishes of the continental Waters of Russia" (1998);

* – *Misgurnus mohoity* and *M. nikolskyi* were not considered separate species, so «+» is only against abundant native for Amur *M.mohoity*;

I(+) – introduced accidentally or on purpose (**s**), abundant and spawning (**i** – possibly only in the water bodies where it was introduced);

I(-) – introduced, but existence today under question;

?I – probably introduced;

À(-) – occasional anadromous fish or even having small populations;

K, C, KC – abundant only in Lake Khanka, China, or in lake Khanka and;

R – found in Russia;

Sea, Evr – marine of semi-saline waters fish;

? (before species name) – existence of species in the basin is quesionable;

?= (before species name) – name is questionable;

Latin names are cited by: "Annotated Check-List …" 1998 **(1)**; Chu Xinluo, Zheng Baoshan, Dai Dingyuan et al. 1999 **(2)**; Richter 1983 **(3)**; Vasilieva 2001 **(4)**; Choi, K.C., S.R. Jeon, I.S. Kirn & Y.M. Son 1990 **(5)**; Chen Yiyu et al. 1998 **(6)**, Fish Description… 1995 **(7)**, Beneresku and Nalbant 1968 **(8)**, Shedko 2001 **(9),** *http://kffish.chonbuk.ac.kr/fish_eng/default.htm* **(10),** Vasilieva and Makeeva 2003 **(11),** Dong Ch., Li H., Mu Zh. & Zhan P., 2001 **(12)**. Genus names follow "Annotated Check-List …" 1998. The list is organized by families, subfamilies, genus, and species. The number after family name is the number of species in the family.

Acipenseridae – 5	
Acipenser baerii (Brandt, 1869) – Siberian sturgeon	+Ii(-)(1)
Acipenser medirostris (Ayres, 1854) – Sakhalin sturgeon	A(-)(1)
Acipenser ruthenus (Linnaeus, 1758) – sterlet	+I(-)(1)
Acipenser schrenckii (Brandt, 1869) – Amur sturgeon	(1)
Huso dauricus (Georgi, 1775) – kaluga	(1)
Bagridae – 5	
?=Leiocassis argentivittatus (Regan, 1905)	?I (2)
Pelteobagrus fulvidraco (Richardson, 1846) - banded catfish	(1)
?=Pelteobagrus nitidus (Sauvage et Dabry, 1874)	(2)
?Pseudobagrus herzensteini (Berg, 1907)	(1)
Pseudobagrus ussuriensis (Dybowski, 1872)	(2)
Balitoridae – 3	
?=Barbatula nudus (Bleeker, 1865) – stone loach	+(10)
Barbatula toni (Dybowski, 1869) – Siberian stone loach	(1)
Lefua costata (Kessler, 1876) – rice loach	(1)
Belontiidae – 1	
Macropodus chinensis (Bloch, 1790)	+I(+)CR(3)
Channidae – 1	
Channa argus (Cantor, 1842) – snakehead	(1)

Cobitidae – 9	
Cobitis choii (Kim et Son, 1984) – Chii spiny loach	(1)
Cobitis lutheri (Rendahl, 1935) – Luther spiny loach	(1)
?=Cobitis melanoleuca (Nichols, 1925) – Siberian spiny loach	(1)
?=Cobitis sinensis (Sauvage & Dabry de Thiersant, 1874) – Chinese spiny loach	+?I (10)
?=Leptobotia mantschurica (Berg, 1907) – leptobotia	(1)
Misgurnus anguillicaudatus (Cantor, 1842) – East-Asian weatherfish	+Ii(+)C(4)
Misgurnus mohoity (Dybowski, 1868) – Mohoity weatherfish	(4)*
Misgurnus nikolskyi (Vasilieva, 2001) – Nikolsky weatherfish	+(4)*
Paramisgurnus dabrianus (Guichenot in Dabry de Thiersant,1872) – Darbi loach	+I(+)CR(4)
Coregonidae – 6	
Coregonus autumnalis migratorius (Georgi, 1775) – arctic cisco	+Isi(+)(1)
Coregonus chadary (Dybowski, 1869) - Chadary whitefish	(1)
Coregonus lavaretus pidschian (Gmelin, 1788) – common whitefish	+Isi(-)(1)
Coregonus peled (Gmelin, 1789) – peled	+Isi(-)(1)
Coregonus sardinella (Valenciennes, 1848) – Siberian whitefish	+Isi(-)(1)
Coregonus ussuriensis (Berg, 1906) – Amur whitefish	(1)
Cottidae – 3	
Cottus poecilopus (Heckel, 1837) – alpine bullhead	(1)
Megalocottus platycephalus (Pallas, 1814) – flathead sculpin	Sea(1)
Mesocottus haitej (Dybowski, 1869) – Amur sculpin	(1)
Cyprinidae – Acheilognathinae – 7	
Acanthorhodeus asmussii (Dybowski, 1872) – Russian bitterling	(1)
Acanthorhodeus chankaensis (Dybowski, 1872) – Khanka bitterling	(1)
?=Acanthorhodeus gracilis (Regan, 1908) – Korean spined bitterling	+?I(5)
?=Acanthorhodeus macropterus (Bleeker, 1871) – Chinese rainbow bitterling	+(6)
?=Rhodeus fangi (Miao, 1934) – Fangi bitterling	?I(+)(6)
Rhodeus ocellatus (Kner, 1867) – rosy biterling	+I(+)(6)
Rhodeus sericeus (Pallas, 1776) – European bitterling	(1)
Cyprinidae – Barbinae – 3	
Ctenopharyngodon idella (Valenciennes, 1844) – white carp	(1)
Mylopharyngodon piceus (Richardson, 1846) – black carp	?I(1)
Squaliobarbus curriculus (Richardson, 1846) – barbel chub	?ICR(1)
Cyprinidae – Cultrinae – 6	
Chanodichthys dabryi (Bleeker, 1871)	KC(1)
Chanodichthys erythropterus (Basilewsky, 1855) – skygazer	(1)
Chanodichthys mongolicus (Basilewsky, 1855)	(1)
Culter alburnus (Basilewsky, 1855) – lookup	(1)
Hemiculter leucisculus (Basilewsky, 1855) – Korean sawbelly	(1)
Hemiculter lucidus (Dybowski, 1872) – Ussurian sawbelly	(1)
Cyprinidae – Cyprininae – 2	
Carassius auratus (Linnaeus, 1758) – gold fish	(1)
Cyprinus carpio (Linnaeus, 1758) – common carp	(1)
Cyprinidae – Gobioninae – 18	
?Abbottina lalinensis (Huang et Li, 1995)	+C(7)
Abbottina rivularis (Basilewsky, 1855) – rounded gudgeon	(1)
Gnathopogon strigatus (Regan, 1908) – Manchurian lake gudgeon	(1)
Gobio cynocephalus (Dybowski, 1869) – Amur gudgeon	(1)
*Gobio Soldatovi (*Berg, 1914) – Soldatov gudgeon	(1)
Gobiobotia pappenheimi (Kreyenberg, 1911) – eight-whiskered gudgeon	(1)
?Gobiobotia sp. – (Kryzhanovsky, Smirnov, Soin 1951)	+
Hemibarbus labeo (Pallas, 1776) – Barbel steed	(1)
Hemibarbus maculatus (Bleeker, 1871) – stopped barbel	(1)
Ladislavia taczanowskii (Dybowski, 1869) – vladislavia	(1)

Pseudorasbora parva (Temminck et Schlegel, 1846) – stone moroko	(1)
Romanogobio tenuicorpus (Mori, 1934) – Amur whitefin gudgeon	(1)
Rostrogobio amurensis (Taranetz, 1937) – Amur beak gudgeon	(6)
Sarcocheilichthys nigripinnis czerskii (Berg, 1914) – oily shiner	(8)
Sarcocheilichthys sinensis (Bleeker, 1871) – scarlet carp	(1)
Saurogobio dabryi (Bleeker, 1872) – lizard gudgeon	(1)
Squalidus argentatus (Sauvage et Dabry, 1874) – silver slenderhead shiner	+(6)
Squalidus chankaensis (Dybowski, 1872) – Khanka slenderhead shiner	(1)
Cyprinidae – Leuciscinae – 16	
Aristichthys nobilis (Richardson, 1845) – bigheaded carp	Is(+)(1)
Elopichthys bambusa (Richardson, 1845) – yellowcheek	(1)
Hypophthalmichthys molitrix (Valenciennes, 1844) – white bigheaded carp	(1)
Leuciscus waleckii (Dybowski, 1869) – Amur ide	(1)
Megalobrama amblicephala (Yuh, 1955) – Chinese bream	+Isi(+)C(7)
Megalobrama mantschuricus (Basilewsky, 1855) – black Amur bream	(11)
Parabramis pekinensis (Basilewsky, 1855) – white Amur bream	(1)
Phoxinus czekanowskii (Dybowski, 1869) – Chekanowsky minnow	(1)
Phoxinus lagowskii (Dybowski, 1869) – Lagovsky minnow	(1)
Phoxinus oxycephalus (Sauvage et Dabry de Thiersant, 1874) – Chinese minnow	(9)
Phoxinus perenurus (Pallas, 1814) – Lake minnow	(1)
Phoxinus phoxinus (Linnaeus, 1758) – minnow	(1)
Phoxinus sahalinensis (Berg, 1906) – Sakhalin lake minnow	+
Pseudaspius leptocephalus (Pallas, 1776) – Amur asp	(1)
Rutilus rutilus (Linnaeus, 1758) – roach	+Isi(+)C(1)
Tribolodon hakuensis (Günther, 1880) – bigscale redfin	A(-)(1)
Cyprinidae - Rasborinae – 4	
Aphyocypris chinensis (Günther, 1868) – Chinese bleak	CR(1)
Ochetobius elongatus (Kner, 1867) – ochetobius	I(-)K(1)
Opsariichthys uncirostris (Temminck et Schlegel, 1846) – Notch chub	(1)
Zacco platypus (Temmick et Schlegel, 1846) – freshwater minnow	+Isi(+)C(6)
Cyprinidae - Xenocyprininae - 3	
Plagiognathops microlepis (Bleeker, 1871) – smallscale carp	KC(1)
Pseudobrama simioni (Bleeker, 1864)	+Isi(+)C(7)
Xenocypris argentea (Basilewsky, 1855) – blackbelly	(1)
Eleotrididae – 2	
Micropercops cinctus (Dabry, 1872) – eleotris	CR(1)
Perccottus glenii (Dybowski, 1877) – Chinese sleeper	(1)
Esocidae – 1	
Esox reichertii (Dybowski, 1869) – Amur pike	(1)
Gadidae – 1	
Eleginus gracilis (Tilesius, 1910) – Saffron cod	Sea(1)
Gasterosteidae - 5	
Gasterosteus sp. - (Shedko 2001) – three-spine stickleback	+
Pungitius bussei (Warpachowski, 1887) – Bussei stickleback	+(9)
Pungitius pungitius (Linnaeus, 1758) – nine-spine stickleback	(1)
Pungitius sinensis (Guichenot, 1869) – Chinese stickleback	(1)
Pungitius tymensis (Nykolsky, 1889) – short-spine (Sakhalin) stickleback	+(1)
Gobiidae – 4	
Gymnogobius sp. – (Novomodny, present listing)	+Ii(+)CR
Gymnogobius urotaenia (Hilgendorf, 1879) – ukigori	(9)
?=Rhinogobius cliffordpopei (Nichols, 1925) – freshwater goby (reported by S.V. Shedko)	(7)
Tridentiger bifasciatus (Steindachner, 1881) – Shimofuri goby	Evr(9)
Ictaluridae – 1	
Ictalurus punctatus (Rafinesque, 1818) – channel catfish	+Ii(-)(1)

Lotidae – 1	
Lota lota (Linnaeus, 1758) – burbot	(1)
Mugilidae – 1	
Mugil cephalus (Linnaeus, 1758) – flathead mullet	Sea(1)
Oryziatidae – 1	
Oryzias latipes (Temminck et Schlegel, 1846) – medaka	+Is(+)C(1)
Osmeridae – 3	
Hypomesus nipponensis (McAllister, 1963) – Japanese smelt	(9)
Hypomesus olidus (Pallas, 1814) – pond smelt	(9)
Osmerus mordax (Mitchill, 1814) – rainbow smelt	(1)
Percichthidae – 1	
Siniperca chuatsi (Basilewsky, 1855) – Chinese perch	(1)
Percidae – 2	
Perca fluviatilis (Linnaeus, 1758) – redfin perch	Is(+)(1)
Stizostedion lucioperca (Linnaeus, 1758) – pikeperch	Is(+)(1)
Petromyzontidae - 2	
Lethenteron camtschaticum (Tilesius, 1811) – Far Eastern lamprey	(9)
Lethenteron reissneri (Dybowski, 1869) – Far Eastern brook lamprey	(1)
Pholidae – 1	
Pholis pictus (Kner, 1868) – painted gunned	Sea(9)
Pleuronectidae - 2	
Liopsetta pinnifasciata (Kner, 1870) – barfin plaice	Sea(1)
Platichthys stellatus (Pallas, 1787) – starry flounder	Sea(1)
Salangidae – 1	
Protosalanx hyalocranius (Abbott, 1901) – clearhead icefish	+Isi(+)C(1) (12)
Salangichthys microdon (Bleeker, 1860) – microdon	Sea(1)
Salmonidae – 12	
Brachymystax lenok (Pallas, 1773)	(9)
Brachymystax tumensis (Mori, 1931)	(9)
Hucho taimen (Pallas, 1773) – Siberian taimen	(1)
Oncorhynchus gorbuscha (Walbaum, 1792) – pink (humped)	(1)
Oncorhynchus keta (Walbaum, 1792) – chum	(1)
Oncorhynchus kisutch (Walbaum, 1792) – coho	A(-)(1)
Oncorhynchus masou (Brevoort, 1856) – masu	(1)
Oncorhynchus nerka (Walbaum, 1792) – sockeye	Is(-)A(-)(1)
Oncorhynchus tschawytscha (Walbaum, 1792) – chinook	+A(-)(1)
Parasalmo mykiss (Walbaum, 1792) – steelhead	A(-)(1)
Salvelinus leucomaenis (Pallas, 1814) – white spotted char	A(-)(1)
Salvelinus malma curilus (Pallas, 1814) – Dolly Varden char	(9)
Siluridae – 2	
Silurus asotus (Linnaeus, 1758) – Amur catfish	(2)
Silurus Soldatovi (Nikolsky et Soin, 1948) – Soldatov catfish	(1)
Thymallidae – 4	
Thymallus grubii (Dybowski, 1869) – upper Amur grayling	(9)
Thymallus pallasi (Vallenciennes, 1848) – East-Siberian grayling (possible Amur subspecies)	+
Thymallus sp.1 (Shedko, 2001) – Amur grayling	+
Thymallus sp.2 (Shedko, 2001) – yellowspotted grayling	+