This paper introduces the ecological and biological characteristics of the Inconnu (Stenodus leucichthys leucichthys). This is a Caspian Sea endemic species of the family Salmonidae, listed as Extinct in the Wild in IUCN's Red Data Book due to restricted access to spawning grounds, dam construction, illegal fishing, and environmental pollution. This valuable species has considerable ecological and economical importance for the region, but there are little data for the Caspian Sea populations. We discuss its distribution, ecological and reproductive characteristics, and the causes of its extinction in the Caspian Sea.

Zusammenfassung
In dieser Arbeit werden die ökologischen und biologischen Merkmale des Weißlachses („Inconnu“) Stenodus leucichthys leucichthys eingehend behandelt. Es handelt sich um eine endemische Art des Kaspiischen Meeres aus der Familie der Lachs fische (Salmonidae), die in der Roten Liste des IUCN als „ausgestorben“ geführt wird; als Gründe werden Einschränkung der Laichgründe, Staudamm bauten, illegale Beischling und Umweltverschmutzung genannt. Die wertvolle Art hat erhebliche ökologische und ökonomische Bedeutung für die Region, aber es gibt wenige Daten über die Populationen des Kaspi schen Meeres. Wir diskutieren die Verbreitung, die ökologischen und fort pflanzungsbiologischen Kennzeichen sowie die Gründe für die Ausrottung im Kaspi schen Meer.

Résumé
Cet article propose les caractéristiques écologiques et biologiques du Stenodus (Stenodus leucichthys leucichthys). Il s’agit d’une espèce endémique de la Caspienne, de la famille de Salmonidae, répertoriée comme éteinte dans la nature selon l’IUCN’s Red Data Book, à cause de l’accès malaisé aux frayères, à la construction d’un barrage, à la pêche illé gale et à la pollution de l’environnement. Cette espèce a une importance considérable sur le plan écologique et écono mique dans la région, mais il y a peu de données concernant les populations de la mer Caspienne. Nous traitons de sa distribution, de ses caractéristiques écologiques et reproductive et des causes de son extinction en mer Caspienne.

Sommario
Questo articolo presenta le caratteristiche ecologiche e biologiche del salmone bianco noto anche come “Inconnu” (Stenodus leucichthys leucichthys). Si tratta di una specie endemicà del Mar Caspio appartenente alla famiglia Salmonidae e elencata come “Estinta in natura” dallo IUCN Red Data Book a causa delle limitazioni degli spazi riproduttivi, della costruzione di dighe, della pesca illegale e dell’inquinamento ambientale. Questa specie ha un’importanza considerevole per la regione dal punto di vista ecologico ed economico, ma esistono pochi dati per le popolazioni del Mar Caspio. Se ne discutono la distribuzione, l’ecologia, la riproduzione e le cause dell’estinzione nel Mar Caspio.

INTRODUCTION
The Inconnu (Stenodus leucichthys leucichthys Güldenstädt) is the largest and fastest-growing member of the whitefish subfamily Coregoninae (Salmonidae). Two subspecies of Inconnu are recognized, with S. l. leucichthys isolated in the Caspian Sea drainage of western Asia, while S. l. nelma (Pallas) is found in the Arctic and sub-arctic regions of north-western North America and north ern Eurasia (Stephenson et al. 2005). It is known by a range of common names: Inconnu (English), Belorybitsa (Russian), Mahi Ziba (Persian), Stenode Blanc (French), Salmon Blanco (Spanish) Ak balyk (Kazakh) and Azatmahy (Turkmenian).

Stenodus leucichthys leucichthys is the Caspian endemic subspecies and mainly occurs along the western and eastern coasts of the middle Caspian
Sea at depths of 60-65 m (Berg 1948). Declining natural populations in the Caspian Sea due to heavy fishing pressure, increasing water pollution and habitat alteration and destruction have resulted in S. l. leucichthys being listed as “Extinct in the wild” (IUCN Red List 2010). Concerns about the decline of Stenodus l. leucichthys populations led Volga River hatcheries to carry out artificial reproduction and restocking in the Caspian Sea (Belyaeva & Milstein 1959). The Arctic subspecies, Stenodus leucichthys nelma, was introduced into the northern Volga River drainage and is now expanding, so may threaten surviving populations and cultivated stocks through hybridization (Freyhof & Kottelat 2008).

Despite the ecological and economic importance of this fish, very little is known about it in the Caspian Sea. Therefore, the aim of this study is to introduce and better understand the ecological and biological characteristics of this valuable species.

**Identification:** D II-VI (9-13), A II-IV 9-15, dorsal fin high and pointed, adipose fin present, pelvic fins with well developed axillary process, vertebrae 65-68, manubrium absent, with hook-shaped processes on the capitulum, anterior edge of hyomandibular round, only 19 to 26 gill rakers present on lower limb of first gill arch. Scales large, 99-120 in lateral line. Body fusiform and moderately slender, head relatively small, mouth large and terminal, lower jaw long, tip projecting, hind end reaching back behind eye, upper jaw reaching to level of pupil, teeth present on jaws, vomer, palatines and tongue. Pyloric caeca 191-193. Maximum length and weight 130 cm and 35 kg respectively; much larger individuals have been recorded. Sides of body silvery, belly silvery white without spots, dorsum usually green, blue or pale brown (Fig. 1). Sexual dimorphism develops during spawning period, when epithelial tubercles appear on head and side of body of males (Berg 1948; Shariaty 2001).

**Distribution:** Stenodus l. leucichthys is found only in rivers draining to the Caspian Sea, from which it mainly ascends the Volga, while very few fish ascend the Ural, and it is rarely found in the Terek. It is widely found along the western coast north of Makhach-kala and along the eastern coast (Mangyshlak). Its closest relative, Stenodus leucichthys nelma, penetrates into the Caspian Sea from the Arctic Ocean basin through the Post-Glacial ponded lakes which are situated between the basins of the Volga and the Kama, on the one hand, and of the Baltic Sea and the Arctic Ocean, on the other (Berg 1948). Stenodus l. leucichthys spends the warm season in the central and southern regions of the Caspian Sea (Kottelat & Freyhof 2007) mainly in Guilan and no record of this species has been reported from the Mazandaran and Golestan coasts (FAO 1991). Figure 2 shows the distribution of S. l. leucichthys in the Caspian Sea basin.

**Habitat and ecology:** Stenodus l. leucichthys is a pelagic species which inhabits open waters to the depth 65 m, and has not been found below 65 m (its optimum depths are 25-45 m). This fish is an oxyphilic species and prefers waters with temperature below 20°C. It is heterotrophic and an active

![Fig. 1. Stenodus leucichthys leucichthys from the southern part of the Caspian Sea; weight 4300 g; total length 75 cm. Photo by S. Pourseid.](image)
At 30 days after hatching, fingerlings begin to feed on invertebrates and larvae and small juveniles of other fishes. In the sea, adult *S. l. leucichthys* feeds mainly on small fish (clupeids, engraulids, juvenile cyprinids, atherinids, gobids etc) (Podlesny 1947; Svetovidov 1984; Shariaty 2001). *Stenodus l. leucichthys* is amphidromous. However, amphidromy is not obligatory and non-amphidromous populations have been described in some locations (Petrova 1976). Mature adults migrate from sea to the delta of the Volga in the fall, winter and the early spring. Therefore, the species has two seasonal forms, spring and autumn, which are differentiated in time of entry to the Volga for spawning (Berg 1948). Adults migrate downward to the sea after spawning, but many of them die (Freyhof & Kottelat 2008). The alevins immediately descend to the sea after hatching.

**Reproduction:** The main spawning sites of *S. l. leucichthys* are located in the basin of the Kama, in the Ufa River, 3000 km upstream from the mouth of the Volga (Shariaty 2001). The secondary spawning grounds are situated in the Belaya between Ufa and Sterlitamak. The spawning season in the Ufa begins from the middle of October to the beginning of November. Males mature at +5 to +6 years while females reach maturity at the age of +6 to +7 years (Freyhof & Kottelat 2008). *Stenodus l. leucichthys* spawns twice during its life cycle with an interval of two years (Berg 1948). Its optimum temperature for reproduction is 0.1 to 6°C. Semi-adhesive eggs are deposited on the gravel and rock substrate (Kottelat & Freyhof 2007). The sex ratio of brooders in the natural spawning grounds is almost 1:1 as for the subspecies *Stenodus leucichthys nelma* (Brown 2000). The average fecundity is 250×10^3 eggs per individual (104.5-400×10^3). On average, about 26% of the total weight of each fish is egg weight (Berg 1948). Embryonic development takes about 180-200 days. Fry hatch from March up to the early May (mostly the second half of April). From the seventh day onward, fry begin to feed on plankton. The fry stage lasts around two months and then they develop into fingerlings (Berg 1948).

**Threats:** The sharp decline in their abundance due to the construction of dams, insufficient spawning areas, increasing illegal fishing, unstable hydrological conditions, river contamination and damage caused by other fish (especially kilka) and crustaceans has resulted in this species being listed as extinct in the wild (Letichevski 1983; IUCN 2010).
governments should be made in understanding the biology, ecology and behaviour for managing this valuable species. One key objective in working with endangered species is to increase the number of individuals of the species concerned by artificially/controlled reproduction in captivity. Unfortunately, there is no policy for preserving this species in the Caspian Sea from illegal fishermen by countries bordering the Sea and this should be done according to fishing methods, size of net mesh and time/place prohibition. Previously, the Russian federation enhanced the spawning areas in the lower parts of the Volgograd hydroelectric power station for increased efficiency of natural reproduction.

In connection with the present study, the negative influences of the modern environment needs to be studied (i.e. all possible causes of stress, environmental changes, destruction of spawning grounds) in order to better organize protection of this species and thus develop the necessary strategies for action.

Findings from this preliminary data suggest that further research is needed for the future, including population genetics, artificial spawning, domestication for future aquaculture activities, natural behaviour during migration and spawning, as well as ionic balance and osmoregulation. The collective goal of this research should enhance the effectiveness of breeding programs, increase populations of remaining wild stock, and to improve our understanding of the biological knowledge of this species. Since stocks have declined, much effort is needed to rehabilitate the wild populations by all countries around the Caspian Sea.

REFERENCES


