

***Channa argus*** 正體中文

**System:** Freshwater

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Actinopterygii	Perciformes	Channidae

**Common name** northern snakehead (English), Amur-Schlängenkopf (German, Germany), zmeegolov (Russian), her-yu (Chinese, China), amur snakehead (English), cabeza de serpiente (Spanish, Spain), ga mul chi (Korean), kamuruchi (Japanese), raigyo (Japanese), kinesisk slangehovedfisk (Danish, Denmark), eastern snakehead (English), ocellated snakehead (English), amurinkäärmeeinpää (Finnish, Finland), idänkäärmeeinpää (Finnish, Finland), poisson tête de serpent (French, France)

**Synonym** *Ophicephalus nigricans*  
*Ophicephalus pekinensis*, (Basilewsky, 1855)  
*Ophicephalus argus warpachowskii*, (Berg, 1909)  
*Ophicephalus argus kimurai*, (Shih, 1936)  
*Channa argus argus*, (Cantor, 1842)  
*Ophicephalus argus*, (Cantor, 1842)

**Similar species** *Amia calva*, *Lota lota*, *Channa maculata*

**Summary** The cold temperate northern snakehead (*Channa argus*) is found in areas in Russia, China and Korea. It is known for its voracious predation of other fish species, ability to withstand freezing and ability to tolerate lack of water for up to four days. Used as luxury food item and as food in poor socio-economic areas, including India, the fish is farmed and transferred around the world. Recent occurrence of this \"frankenfish\" in Maryland (USA) has been the focal point of media attention.



[view this species on IUCN Red List](#)

## Species Description

The body of snakeheads is torpedo-shaped, which tapers towards the tail. They have a single, long dorsal fin, a long anal fin, and a small head with a large mouth (Cudmore & Mandrak 2006). Northern snakeheads are cylindrical fish that can grow up to 85 centimeters in length (Okada 1960, in Courtenay and Williams, 2004) however, in Russia there have been reports of captured specimens reaching 1.5 meters total length (Courtenay and Williams 2004). As the name implies, the scaled head of the fish looks like a snake; they have a large mouth with sharp teeth, a truncated, not rounded tail and are easily identified by dark irregular blotches along their sides (Sea Grant Pennsylvania 2007) on a background of golden tan to pale brown. This fish is capable of darkening its background colors to the point of almost obscuring the blotches. There is a dark stripe from just behind the eye to the upper edge of the operculum with another dark stripe below from behind the orbit extending to the lower quadrant of the operculum. Coloration of juveniles is virtually the same as in adults, a characteristic atypical for many snakehead species.

Gular part of head without patch of scales; head somewhat depressed anteriorly; interorbital area flat; eye above middle of upper jaw; mouth large, reaching far beyond eye; villiform teeth present in bands with some large canine-like teeth on lower jaw and palatines; lateral line scales 60 to 67; eight scale rows above lateral line to dorsal fin origin; 12 to 13 scale rows below lateral line to anal fin origin; dorsal fin elongated, with 49 to 50 rays; anal fin with 31 to 32 rays; origin of pelvic fin beneath fourth dorsal fin ray; pectorals extending beyond base of pelvic fins (Courtenay & Williams 2004).

It is reported that actively feeding adults make grunting noises "like pigs" (Nina Bogutskaya Pers. Comm. 2002, in Courtenay & Williams 2004). Soin (1960, in Courtenay & Williams 2004) noted clicking sounds produced by the northern snakehead in ponds in northeastern China as the fish rose to the surface to breathe air. The northern snakehead, because of its torpedo-shaped body, has limited ability to move onto land except as young, and only during flood conditions (Courtenay and Williams 2004).

## Notes

Snakeheads (family Channidae) are airbreathing freshwater fish containing two genera, *Channa* with 26 species native to Asia, Malaysia, and Indonesia; and *Parachanna* with three species native to tropical Africa (Courtenay & Williams 2004) Some snakeheads are small, reaching about 17 centimeters, but most are much larger, the largest reported to be 1.8 meters in length (Courtenay & Williams 2004). \n

Subspecies *Channa argus kimurai* (Shih 1936): Described from two specimens of length 185 mm and 250 mm; it can be distinguished by its variation in body proportions. In particular, the lower dorsal profile and differences in the arrangement of teeth. The body colour is all white, a complete contrast to *C. argus*. Above the lateral line, some of the scales have a grey centre. Vertical fins are tipped grey (Galveston Bay Invasive Species Risk Assessment Invasive Species Summary).\n

Subspecies *Channa argus warpachowskii* (Berg 1949): A larger variant which can attain a size of 800 mm and a weight of 7 kg. Characteristics of *C. argus warpachowskii* include higher average ray counts than *C. argus* (50 to 53 in the dorsal fins and 33 to 38 in the anal fins) and smaller scales. The irregular blotches on the side of the body are dark brown, edged with black and the lower part of the head is covered with small, dark brown speckles (Galveston Bay Invasive Species Risk Assessment Invasive Species Summary).

Subspecies *Channa argus argus* is common in China and Korea whereas *C. argus warpachowskii* is found in the Amur River of Russia and China.

## Lifecycle Stages

Northern snakehead larvae are about 4.5 millimeters long. Within two weeks they have reached about 11 millimeters in length. They have absorbed their yolk sacs, their fin rays are visible and their coloration is black. Within four weeks they have reached a length of about two centimeters. Their pelvic fins are developed, their epibranchial breathing cavities are functional and their coloration becomes brown. Larvae then lose their aggregate behavior and move to deeper waters. Scales develop at a length of about four centimeters. Adults care for their young which feed on plankton until they are about four weeks old. Sexual maturity is reached at the age of two to three years and a length of about 30 centimeters. They are long lived, with one specimen recorded at eight years old and 760 mm long (Courtenay & Williams 2004; FishBase 2009; Galveston Bay Undated).

## Uses

Snakeheads have long been favored food fishes in India and many parts of Asia, particularly southeastern Asia (Lee and Ng 1991, in Courtenay & Williams 2004). Some are utilised as luxury specialty foods, available alive in aquaria for customer selection at upscale restaurants in larger cities such as Calcutta, Bangkok, Singapore, Hong Kong and other major locales. They also provide easily caught food for poorer people (Wee 1982, in Courtenay & Williams 2004). *C. argus* is the most cultured snakehead in China and the most available snakehead in North American live-food markets. *C. argus* has a modest importance in aquarium fish trade in Japan, Europe and to a lesser extent, the USA (Courtenay & Williams 2004).

## Habitat Description

The northern snakehead has a broad range of environmental tolerances and is extremely hardy (Cudmore & Mandrak 2006); it inhabits freshwater within a temperature range of 0 to 30°C (Okada 1960, in Courtenay & Williams 2004). Northern snakeheads prefer stagnant shallow ponds or swamps with mud substrate and vegetation; they can also be found in slow muddy streams (Okada, 1960, in Courtenay and Williams, 2004) and in canals, reservoirs, lakes, and rivers (Dukravets and Machulin 1978, Dukravets 1992, in Courtenay and Williams 2004). An obligate airbreather it can survive out of water for up to four days by breathing oxygen; cold temperatures reduce metabolism rates and oxygen demand, allowing them to survive under ice (Courtenay & Williams 2004).

## Reproduction

Northern snakeheads reach sexual maturity at two to three years of age and approximately 30 to 35 cm in length. Females produce eggs one to five times per year and release 22 000 to 51 000 eggs per spawn (Frank 1970, Nikol'skiy 1956, in Courtenay and Williams 2004). Females can lay as many as 100 000 eggs annually. Sexual fertilisation is external and occurring in early morning in shallow waters. The eggs are pelagic, spherical, non-adhesive, yellow and about two millimeters in diameter. Their eggs float and take approximately 28 hours to hatch at 31°C and 45 hours at 25°C; at lower temperatures the eggs take much longer to hatch (Courtenay and Williams 2004). Parents guard the young in a nest until yolk absorption is complete at approximately eight millimeters in length (Courtenay & Williams 2004). Minimum population doubling time is less than 15 months (Courtenay & Williams 2004; FishBase 2009).

## Nutrition

Young northern snakeheads eat zooplankton (Courtenay and Williams). At a length of about 18 millimeters the young shift their diet and begin feeding on small crustaceans, aquatic insects and fish larvae (Courtenay and Williams, 2004; Cudmore & Mandrak 2006; Fuller 2009). All snakehead species are carnivorous thrust predators as adults, mainly piscivorous in nature (Cudmore & Mandrak 2006); at a length of four millimeters they begin to feed on fish and then at 13 to 15 centimeters, fishes comprise 64 to 70% of the diet (*National Control and Management Plan for the Northern Snakehead* Undated). They also prey on frogs and tadpoles, crustaceans, aquatic insects (including worms), reptiles (including snakes), small birds and mammals (Fuller 2009; Galveston Bay Invasive Species Risk Assessment Invasive Species Summary). They do not feed during winter but hibernate by burrowing into mud/substrate. Juvenile northern snakeheads feed in schools, with most of the activity during early evening and again in early morning, usually in vegetation close to shore (Courtenay and Williams 2004).

## General Impacts

The introduction of non-native northern snakeheads into waterways has received a great deal of media, public and political attention in the USA (US Fish and Wildlife Service & Arkansas Game and Fish Commission. 2008). The high fertility of and tolerance to a wide range of conditions of the northern snakehead, as well as the lack of natural enemies in its introduced range, make it highly likely to be a formidable invasive if it were to become established.\n

Ecosystem change: Left uncontrolled, this predatory invasive species is likely to expand its range and could permanently alter the balance of aquatic ecosystems throughout the Mississippi River basin (US Fish and Wildlife Service & Arkansas Game and Fish Commission. 2008).\n

Predation: Okado (1960, in Courtenay and Williams 2004), reported that this species is a voracious feeder of aquatic fauna. Northern snakeheads can eat prey up to 33% of their own body length with larger prey often consisting of loach, bream, carp and perch; other food items include crayfish, dragonfly larvae, beetles and frogs (Courtenay & Williams 2004). A total of 17 food items, including 15 fish species, were identified from stomach contents of (n= 219) northern snakehead from the Potomac River (Odenkirk & Owens 2007) between 2004 and 2006. Food items observed consisted mostly of banded killifish (*Fundulus diaphanus*) with white perch (*Morone americana*), bluegill (*Lepomis macrochirus*) and pumpkinseed sunfish (*Lepomis gibbosus*) also commonly consumed (Odenkirk & Owens 2007). Goldfish (*Carassius auratus*), gizzard shad (*Dorosoma petenense*), American eel (*Anguilla rostrata*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), spottail shiner (*Notropis hudsonias*), eastern silvery minnow (*Hybognathus regius*), mummichog (*Fundulus heteroclitus*), channel catfish (*Ictalurus punctatus*), green sunfish (*Lepomis cyanellus*), tessellated darter (*Etheostoma olmstedi*), frogs and crayfish were also consumed at low levels (Odenkirk 2006, in *National Control and Management Plan for the Northern Snakehead* Undated).\n

Competition: Northern snakeheads are capable of surviving in water with very low oxygen content, giving them a competitive advantage over species such as pike and bass that require more oxygen (Sea Grant Pennsylvania 2007).\n

Economic/Livelihoods: It could have significant negative economic impacts if it were to become established throughout the the Mississippi River basin (US Fish and Wildlife Service & Arkansas Game and Fish Commission. 2008).\n

Disease Transmission: The Northern snakehead is affected by the following parasites which are also known to affect native species in various parts of the world: *Mysosoma acuta* (also affects crucian carp), *Henneguya zschokkei* ? (also affects salmonids), *Cysticercus gryporhynchus cheilancristrotus* (also affects cyprinids, perches), *Clinostomum complanatum* (also affects perches) and *Paracanthocephalus cutus* (also affects cyprinids, escocids, sleepers and bagrid catfish) (for more information on parasites carried by the northern snakehead please see Courtenay & Williams 2004).

## Management Info

Preventative measures: The northern snakehead has a wider latitudinal range and temperature tolerance than other snakehead species, which indicates that it could become established throughout most of the contiguous United States and some waters in adjoining Canadian provinces (Courtenay and Williams, 2004). In a Canadian risk assessment prepared by Cudmore & Mandrak (2006) Part I (*Aquatic Organism Ecological and Genetic Risk Assessment Process*) revealed a "High probability of establishment estimate" (reasonably certain) and a "High consequences of establishment estimate" (reasonably certain), giving a "Final Risk Estimate" of "High" (reasonably certain). Similarly, Part II (*Pathogen, Parasite or Fellow Traveler Risk Assessment Process*) revealed a "Medium probability of establishment estimate" (reasonably certain) and a "Medium consequences of establishment estimate" was "Medium" (very uncertain), giving a "Final Risk Estimate" of "Medium" (very uncertain). \n

All snakeheads were banned from importation and interstate transport in the USA in October 2002 by the US Fish and Wildlife Service under the Lacy Act (NSWG 2006). In the USA anglers and commercial fisherman have been asked to kill and freeze all snakeheads rather than re-release them and immediately report them to the local Fish and Game Department (Sea Grant 2007). \n

Chemical: In Crofton pond, Maryland (USA) herbicides (Diquat Dibromide and Glyphosate) were used to lower oxygen levels, then a piscicide (Rotenone) was used to poison the fish (Hilton 2002). The total cost of this eradication in a 1.8 ha pond was estimated at \$110,000 (Courtenay & Williams 2004). Eradication would be much more complicated in rivers, streams, or larger lakes. \n

Physical: Electrofishing and netting may provide a low level of control to established populations but would not result in eradication due to selectivity of certain size classes (NatMangPln).\n

Decision support tools for identifying potentially invasive non-native marine and freshwater species (fish, invertebrates and amphibians) have been adapted from Pheloung Williams and Halloy (1999) Weed Risk Assessment. Please follow this link to access [the decision support tool and kit](#).

A [Risk-assessment for non-native freshwater species in the UK](#) is available for determining the level of potential invasion. The assessment can aid resource managers in decision making when it comes to management strategies.

## Pathway

The northern snakehead is a popular aquarium fish in Europe and Japan, however, because of their highly predacious nature snakeheads have not had a large following of interested hobbyists in the USA (Courtenay & Williams 2004). Some introductions are believed to be the result of intentional release of aquarium fish as they are very expensive to feed and soon outgrow their aquaria (Courtenay & Williams 2004). Many introductions of the northern snakehead are believed to be the result of intentional release of fish obtained from the live food trade (Courtenay & Williams 2004). The northern snakehead has been a market leader and is cultured in China and Korea (Courtenay & Williams 2004). This species has been exported to other nations, including Canada and the United States where it has been sold alive in certain ethnic markets and restaurants (Courtenay & Williams 2004). The northern snakehead is introduced to many locations for culture as a sport fish (Courtenay & Williams 2004). Many introductions of the northern snakehead are believed to be the result of intentional release of fish obtained from the live food trade (Courtenay & Williams 2004). The northern snakehead has been a market leader and is cultured in China and Korea (Courtenay & Williams 2004). This species has been exported to other nations, including Canada and the United States where it has been sold alive in certain ethnic markets and restaurants (Courtenay & Williams 2004).

**Principal source:** [Courtenay, W.R. Jr., & J.D. Williams. 2004. Snakeheads \(Pisces, Channidae\) - A Biological Synopsis and Risk Assessment. USGS.](#)

**Compiler:** IUCN/SSC Invasive Species Specialist Group (ISSG)

**Review:** Expert review underway: Dr. Walter R. Courtenay, Research Fishery Biologist, Center for Aquatic Resources Studies, USGS Florida Integrated Science Center USA

**Publication date:** 2009-05-21

## ALIEN RANGE

<b>[1]</b> ARAL SEA	<b>[1]</b> CAMBODIA
<b>[1]</b> CANADA	<b>[1]</b> CZECH REPUBLIC
<b>[1]</b> HONG KONG	<b>[1]</b> JAPAN
<b>[1]</b> KAZAKHSTAN	<b>[1]</b> KOREA, REPUBLIC OF
<b>[1]</b> NIGERIA	<b>[1]</b> SLOVAKIA
<b>[1]</b> THAILAND	<b>[1]</b> TURKMENISTAN
<b>[11]</b> UNITED STATES	<b>[1]</b> UZBEKISTAN
<b>[1]</b> VIET NAM	

## BIBLIOGRAPHY

38 references found for ***Channa argus***

### Management information

[Centre for Environment, Fisheries & Aquaculture Science \(CEFAS\)](#), 2008. *Decision support tools-Identifying potentially invasive non-native marine and freshwater species: fish, invertebrates, amphibians*.

**Summary:** The electronic tool kits made available on the Cefas page for free download are Crown Copyright (2007-2008). As such, these are freeware and may be freely distributed provided this notice is retained. No warranty, expressed or implied, is made and users should satisfy themselves as to the applicability of the results in any given circumstance. Toolkits available include 1) FISK- Freshwater Fish Invasiveness Scoring Kit (English and Spanish language version); 2) MFISK- Marine Fish Invasiveness Scoring Kit; 3) MI-ISK- Marine invertebrate Invasiveness Scoring Kit; 4) FI-ISK- Freshwater Invertebrate Invasiveness Scoring Kit and AmphISK- Amphibian Invasiveness Scoring Kit. These tool kits were developed by Cefas, with new VisualBasic and computational programming by Lorenzo Vilizzi, David Cooper, Andy South and Gordon H. Copp, based on VisualBasic code in the original Weed Risk Assessment (WRA) tool kit of P.C. Pheloung, P.A. Williams & S.R. Halloy (1999).

The decision support tools are available from:

<http://cefas.defra.gov.uk/our-science/ecosystems-and-biodiversity/non-native-species/decision-support-tools.aspx> [Accessed 13 October 2011]

The guidance document is available from [http://www.cefas.co.uk/media/118009/fisk\\_guide\\_v2.pdf](http://www.cefas.co.uk/media/118009/fisk_guide_v2.pdf) [Accessed 13 January 2009].

[Clearwater, Susan J.; Chris W. Hickey and Michael L. Martin, 2008. Overview of potential piscicides and molluscicides for controlling aquatic pest species in New Zealand. Science for conservation 283, March 2008, New Zealand Department of Conservation](#)

**Summary:** Available from: <http://www.doc.govt.nz/upload/documents/science-and-technical/sfc283entire.pdf> [Accessed 20 March 2008]  
[Copp, G.H., Garthwaite, R. and Gozlan, R.E., 2005. Risk identification and assessment of non-native freshwater fishes: concepts and perspectives on protocols for the UK. Sci. Ser. Tech Rep., Cefas Lowestoft, 129: 32pp.](#)

**Summary:** The discussion paper presents a conceptual risk assessment approach for freshwater fish species that addresses the first two elements (hazard identification, hazard assessment) of the UK environmental risk strategy. The paper presents a few worked examples of assessments on species to facilitate discussion.

Available from: <http://www.cefas.co.uk/publications/techrep/tech129.pdf> [Accessed 1 September 2005]

[Courtenay, Walter R. Jr., & James D. Williams., 2004. Snakeheads \(Pisces, Channidae\)- A Biological Synopsis and Risk Assessment. U.S. Geological Survey Circular 1251.](#)

**Summary:** Available from: [http://fisc.er.usgs.gov/Snakehead\\_circ\\_1251/circ\\_1251\\_courtenay.pdf](http://fisc.er.usgs.gov/Snakehead_circ_1251/circ_1251_courtenay.pdf) [Accessed 23 April 2009]  
Courtenay, W., pers. comm. May 2003.

**Summary:** Additional information provided via email correspondence during review of species profile.

[Galveston Bay Invasive Species Risk Assessment, undated. Northern snakehead, \*Channa argus\*](#)

**Summary:** Available from: [http://prtl.uhcl.edu/portal/page/portal/EIH/Research/invasive/Appendix\\_E/Channa\\_argus-northern\\_snakehead.pdf](http://prtl.uhcl.edu/portal/page/portal/EIH/Research/invasive/Appendix_E/Channa_argus-northern_snakehead.pdf) [Accessed 23 April 2009]

[Hilton, R., 2002. The Northern Snakehead: An Invasive Fish Species. Cambridge Scientific Abstracts.](#)

**Summary:** Report on description, distribution, biology, affects, benefits, and look-alike species.

Lazur, A., Early, S. & Jacobs, J.M. 2006. Acute toxicity of 5% rotenone to northern snakeheads. North American Journal of Fisheries Management. 26(3). 628-630.

**Summary:** Abstract: The confirmation of northern snakeheads *Channa argus* caught by an angler in a private pond in Maryland resulted in significant media attention and generated numerous resources for risk identification and the development of action plans to prevent the introduction of this normative species into state waters. Rotenone was selected as an eradication option, and a bioassay was conducted with captured northern snakehead juveniles to determine toxicity and application dose. The lowest rotenone concentration evaluated, 0.075 mg of active ingredient per liter of water, resulted in 100% mortality within 1 h. Pond treatment was highly successful; 8 adult and 834 juvenile snakeheads were recovered. Study results show that northern snakeheads are susceptible to normal doses of rotenone and that standard pond treatment techniques are effective in eradicating this invasive species./p>

[Maryland Department of Natural Resources \(MDNR\). 2002. Snakehead Scientific Advisory Panel First Report To The Maryland Secretary Of Natural Resources \(July 26, 2002\)](#)

**Summary:** Detailed description of history and management plan.

Mendoza, R.E.; Cudmore, B.; Orr, R.; Balderas, S.C.; Courtenay, W.R.; Osorio, P.K.; Mandrak, N.; Torres, P.A.; Damian, M.A.; Gallardo, C.E.; Sanguines, A.G.; Greene, G.; Lee, D.; Orbe-Mendoza, A.; Martinez, C.R.; and Arana, O.S. 2009. *Trinational Risk Assessment Guidelines for Aquatic Alien Invasive Species*. Commission for Environmental Cooperation. 393, rue St-Jacques Ouest, Bureau 200, Montréal (Québec), Canada. ISBN 978-2-923358-48-1.

**Summary:** In 1993, Canada, Mexico and the United States signed the North American Agreement on Environmental Cooperation (NAAEC) as a side agreement to the North American Free Trade Agreement (NAFTA). The NAAEC established the Commission for Environmental Cooperation (CEC) to help the Parties ensure that improved economic efficiency occurred simultaneously with trinational environmental cooperation. The NAAEC highlighted biodiversity as a key area for trinational cooperation. In 2001, the CEC adopted a resolution (Council Resolution 01-03), which created the Biodiversity Conservation Working Group (BCWG), a working group of high-level policy makers from Canada, Mexico and the United States. In 2003, the BCWG produced the  Strategic Plan for North American Cooperation in the Conservation of Biodiversity.  This strategy identified responding to threats, such as invasive species, as a priority action area. In 2004, the BCWG, recognizing the importance of prevention in addressing invasive species, agreed to work together to develop the draft CEC Risk Assessment Guidelines for Aquatic Alien Invasive Species (hereafter referred to as the Guidelines). These Guidelines will serve as a tool to North American resource managers who are evaluating whether or not to introduce a non-native species into a new ecosystem. Through this collaborative process, the BCWG has begun to implement its strategy as well as address an important trade and environment issue. With increased trade comes an increase in the potential for economic growth as well as biological invasion, by working to minimize the potential adverse impacts from trade, the CEC Parties are working to maximize the gains from trade while minimizing the environmental costs.

Available from: English version: [http://www.cec.org/Storage/62/5516\\_07-64-CEC%20invasives%20risk%20guidelines-full-report\\_en.pdf](http://www.cec.org/Storage/62/5516_07-64-CEC%20invasives%20risk%20guidelines-full-report_en.pdf) [Accessed 15 June 2010]

French version: [http://www.cec.org/Storage/62/5517\\_07-64-CEC%20invasives%20risk%20guidelines-full-report\\_fr.pdf](http://www.cec.org/Storage/62/5517_07-64-CEC%20invasives%20risk%20guidelines-full-report_fr.pdf) [Accessed 15 June 2010]

Spanish version: [http://www.cec.org/Storage/62/5518\\_07-64-CEC%20invasives%20risk%20guidelines-full-report\\_es.pdf](http://www.cec.org/Storage/62/5518_07-64-CEC%20invasives%20risk%20guidelines-full-report_es.pdf) [Accessed 15 June 2010].

Mito, T. & T. Uesugi 2004. *Invasive Alien Species in Japan: The Status Quo and the New Regulation for Prevention of their Adverse Effects*. *Global Environmental Research* 8(2): 171-191

**Summary:** Available from: <http://www.aries.or.jp/publication/ger/pdf/08-02-08.pdf> [Accessed 23 April 2009]

*National Control and Management Plan for the Northern Snakehead (Channa argus)*. Undated. Submitted to the Department of Interior Prepared by the Northern Snakehead Working Group

**Summary:** Available from:

<http://www.fws.gov/northeast/marylandfisheries/reports/National%20Management%20Plan%20for%20the%20Northern%20Snakehead.pdf> [Accessed 20 December 2009]

*New York State Department of Environmental Conservation (NYDEC), 2008. DEC's Plan to Eradicate Northern Snakehead Fish*. <http://www.dec.ny.gov/animals/45488.html>

**Summary:** Available from: <http://www.dec.ny.gov/animals/45488.html> [Accessed 23 April 2009]

Rixon C.A.M., I.C. Duggan, N.M.N. Bergeron, A. Ricciardi & H.J. Macisaac. 2005. Invasion risks posed by the aquarium trade and live fish markets on the Laurentian Great Lakes. *Biodiversity and Conservation* Volume 14, Number 6

*South Carolina Department of Natural Resources. 2007. South Carolina Aquatic Invasive Species Management Plan. Prepared in coordination with the South Carolina Aquatic Invasive Species Task Force by the South Carolina Department of Natural Resources*

**Summary:** Available from: <http://www.dnr.sc.gov/water/envaff/aquatic/aisfiles/draftscmgtplan8092007.pdf> [Accessed 23 April 2009]

*US Fish and Wildlife Service & Arkansas Game and Fish Commission. 2008. Environmental Assessment for Northern Snakehead Eradication and Restoration of Native Fishery to the Piney Creek Drainage, Lee County and Monroe County, Arkansas*.

**Summary:** Available from: [http://www.fws.gov/arkansas-es/docs/20080822\\_EA\\_Snakeheads%20in%20BigPineyCreek.pdf](http://www.fws.gov/arkansas-es/docs/20080822_EA_Snakeheads%20in%20BigPineyCreek.pdf) [Accessed 20 December 2009]

## General information

Courtenay, Walter R. Jr. 2007. Introduced species: What species do you have and how do you know? *Transactions of the American Fisheries Society*. 136(4). JUL 2007. 1160-1164.

**Summary:** Abstract: The introduction of fishes, whether of foreign origin or from one part of North America to another, has been part of fisheries management for much of the past century, some introductions dating well back into the nineteenth century. Federal, state, and provincial agencies, along with aquaculture facilities and private aquarists, have all played important roles in this history. In recent decades there have been many unauthorized introductions via a rapidly increasing number of pathways, some of which are difficult to control. One very large problem in dealing with introduced fish is the inability of many fishery biologists and managers to identify native fishes in their jurisdictions, recognize introduced species, and appreciate the management problems that might result. Proper management cannot be done by those who have little knowledge of systematic ichthyology and who are thus unable to identify the fishes they are dealing with, be they native or introduced. I suggest a solution to some of these problems and recommend a curriculum change to better train future fishery biologists and managers.

*Courtenay, W.R., Jr., J.D. Williams., R. Britz, M.N. Yamamoto., P.V. Loiselle. 2004. Identity of Introduced Snakeheads (Pisces Channidae) in Hawaii and Madagascar, with comments on Ecological concern. Bishop Museum Occasional Papers. Number77. 13 Pages*

**Summary:** Available from: <http://hbs.bishopmuseum.org/pdf/op77.pdf> [Accessed 23 April 2009]

*Do You Know The Difference. Virginia Department Of Game And Inland Fisheries (2002)*

**Summary:** Short report on identification and risks. Includes detailed pictures useful for correct identification.

[Fishbase, 2003. Species profile \*Channa argus argus\* Snakehead](#)

**Summary:** FishBase is a global information system with all you ever wanted to know about fishes . FishBase on the web contains practically all fish species known to science. FishBase was developed at the WorldFish Center in collaboration with the Food and Agriculture Organization of the United Nations (FAO) and many other partners, and with support from the European Commission (EC). Since 2001 FishBase is supported by a consortium of seven research institutions. You can search on [Search FishBase](#)

This species profile is available from:

<http://www.fishbase.org/Summary/SpeciesSummary.cfm?ID=4799&genusname=Channa&speciesname=argus%20argus>

[FishBase, 2008. \*Channa argus argus\* Snakehead Common names](#)

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<http://www.fishbase.org/comnames/CommonNamesList.php?ID=4799&GenusName=Channa&SpeciesName=argus+argus&StockCode=5028> [Accessed 23 April 2009]

[FishBase, 2008. \*Channa argus argus\* Snakehead Country list](#)

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[FishBase, 2008. \*Channa argus argus\* Snakehead Introductions](#)

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[FishBase, 2008. \*Channa argus argus\* Snakehead Species summary](#)

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[FishBase, 2008. \*Channa argus argus\* Snakehead Synonyms](#)

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[Fuller, P., 2003. \*Channa argus\* Nonindigenous Aquatic Species Database, Gainesville, FL.](#)

**Summary:** Available from: <http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=2265>

Han M., Fukushima M. & Fukushima T. 2008. A spatial linkage between dams and non-native fish species in Hokkaido, Japan. *Ecology of Freshwater Fish* 17: 416-424

Herborg, L., Mandrak, N.E., Cudmore, B.C. & MacIsaac, H.J. 2007. Comparative distribution and invasion risk of snakehead (Channidae) and Asian carp (Cyprinidae) species in North America. *Canadian Journal of Fisheries and Aquatic Sciences*, Volume 64, Number 12, pp. 1723-1735(13)

**Summary:** Herborg and colleagues (2007) predict suitable environments of 14 high-profile species of nonindigenous snakehead (Channidae) and Asian carp (Cyprinidae) species in North America based upon ecological niche modelling.

[ITIS \(Integrated Taxonomic Information System\), 2004. Online Database \*Channa argus\*](#)

**Summary:** An online database that provides taxonomic information, common names, synonyms and geographical jurisdiction of a species. In addition links are provided to retrieve biological records and collection information from the Global Biodiversity Information Facility (GBIF) Data Portal and bioscience articles from BioOne journals.

Available from: [http://www.itis.gov/servlet/SingleRpt/SingleRpt?search\\_topic=TSN&search\\_value=166680](http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=166680) [Accessed December 31 2004]

Ma, X., X. Bangxi., W. Yindong. & W. Mingxue. 2003. Intentionally Introduced and Transferred Fishes in China's Inland Waters. *Asian Fisheries Science* 16: 279-290

Odenkirk, J. and S. Owens. 2006. Northern Snakeheads in the Tidal Potomac River System. *Transactions of the American Fisheries Society Article*: pp. 1605-1609 , Volume 134 Issue 6

Odenkirk, J. & Owens, S. 2007. Expansion of a northern snakehead population in the Potomac River system. *Transactions of the American Fisheries Society*. 136(6). 1633-1639.

**Summary:** A population of northern snakeheads Channa argus was documented in the Potomac River system in 2004 and the expansion of this population documented from 2004 to 2006.

[Orrell, T.M. & L. Weigt. 2005. The Northern Snakehead \*Channa argus\* \(Anabantomorpha: Channidae\), a non-indigenous fish species in the Potomac River, U.S.A. \*Proceedings of the Biological Society of Washington\* 118\(2\):407-415.](#)

**Summary:** Available from: <http://hbs.bishopmuseum.org/pdf/op77.pdf> [Accessed 23 April 2009]

[Sea Grant Pennsylvania. 2007. Northern Snakehead \*Channa argus\*](#)

**Summary:** Available from: <http://seagrant.psu.edu/publications/fs/snakehead2007.pdf> [Accessed 23 April 2009]

Shafland, L.P., K.B. Gestring & M.S. Stanford. 2007. *Florida's Exotic Freshwater Fishes - 2007*. Non-Native Fish Laboratory, Florida Fish & Wildlife Conservation Commission

[Snakeheads - The Newest Aquatic Invader. U. S. Fish and Wildlife Service, USGS.](#)

**Summary:** Fact sheet.

[U.S. Geological Survey](#)

**Summary:** Available from: [http://fisc.er.usgs.gov/Snakehead\\_circ\\_1251/index.html](http://fisc.er.usgs.gov/Snakehead_circ_1251/index.html) [Accessed 24 September 2004]

**USGS (US Geological Survey), NAS (Non-indigenous Aquatic Species). 2009. *Channa marulius* (bullseye snakehead) Fishes Exotic to United States Collection Information**

**Summary:** Available from: <http://nas3.er.usgs.gov/queries/CollectionInfo.aspx?SpeciesID=2266&State=> [Accessed 21 December 2009]