

Michelle Christy

**PESTS**SMART

# Indicative 10 Project Extension Material

## Striped Snakehead (*Channa striata*)

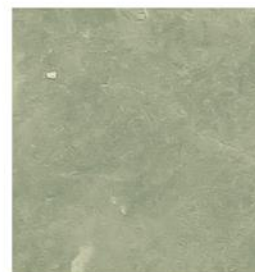
Michelle T. Christy and Win Kirkpatrick  
2017

Department of Primary Industries and Regional Development  
3 Baron-Hay Court,  
South Perth, WA 6151

*An Invasive Animals CRC Project*





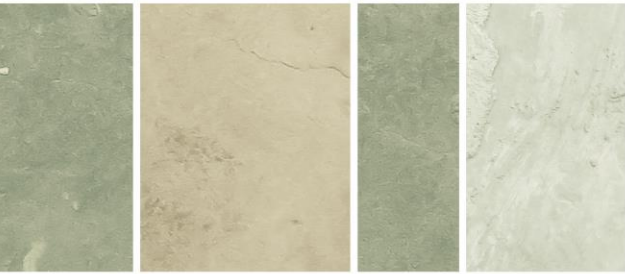


## Contents

Figures .....	1
Summary .....	2
Key Messages .....	2
Classification .....	2
Common Names .....	2
Biology and Ecology.....	3
Identification .....	3
Behaviours and Traits.....	4
Food and Foraging.....	4
Reproduction and Lifecycle .....	5
Habitat .....	5
Global Range .....	5
Potential for Introduction .....	6
Potential for Eradication .....	7
Impacts.....	7
Economic .....	7
Environmental .....	7
Social .....	7
Legislation .....	8
Image Library .....	9
Copyright Licence Restrictions of Use.....	9
Image Library - Striped snakehead ( <i>Channa striata</i> ) .....	16
References .....	19

## Figures

Figure 1. <i>Channa striata</i> Photo: Wibowo Djatmiko .....	2
Figure 2 <i>Channa striata</i> . Photo Shijan Kaakkara .....	3
Figure 3. <i>Channa striata</i> . Photo: Bedo.....	4
Figure 4. Map showing the native and introduced range of <i>Channa striata</i> .....	6



## Summary

Species on VPC List 2007?	No
Species on the live import list (EPBC Act 1999)?	No
Risk of establishment:	Extreme (Bomford 2008)
Pathways:	Intentional

## Key Messages

**Introduction pathway** - accidental (discarded bycatch) or intentional (illegal trade as food)

**Impact to economy** - Predation and competition with aquaculture species, negative impact to recreational and sport fisheries

**Impact to environment** - Outcompetes and predated native species

### General biology

- Currently considered a species complex with no known threats
- Has the potential to establish in most of Australia where rivers, streams and ponds are present.
- Considered very predatory and could alter conditions in aquatic ecosystems
- Air breathers capable of overland migration during some part of their life history
- Both parents protect and guard their young vigorously which increases the chance of survival. They are aggressive in their efforts to protect their young
- The species is a common food-fish in South East Asia

## Classification

*Channa striata* (Bloch, 1793)

Class:	Actinopterygii
Order:	Perciformes
Family:	Channidae
Genus:	<i>Channa</i>
Species:	<i>striata</i>

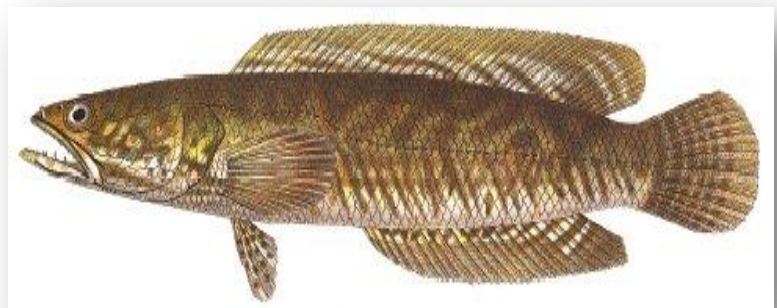


Figure 1. *Channa striata* Photo: Wibowo Djatmiko

## Common Names

Striped snakehead, common snakehead, chevron snakehead, snakehead murrel, mudfish



## Biology and Ecology

Striped snakehead is currently considered a species complex as it requires some taxonomic revision (USGS 2012).

### Identification

Striped snakehead (*Channa striata*) has a distinctive cylindrical, elongated body, with a flattened head. It derives its name from the snake-like large mouth with many well developed teeth (Courtenay et al. 1974). The fish has a rounded tail fin, and a single long top and bottom fin, both of which are more than half of the length of the fish. Colouration is usually brown to black with mottling and faint dark banding which can also extend to the fins (Froese and Pauly 2017). The ventral surface is usually white.

Fry develop a deep orange colour (Kilambi 1986). This pattern persists until the young reach a length of 15 mm when only an orange lateral stripe remains (Li et al. 2016). At 40 mm in length, all orange colour is lost (Kilambi 1986).

In captivity, the species grows up to 1 m in length and 3 kg in weight, although this size is rarely achieved in the wild (Li et al. 2016). Non-captive females mature about 300 mm in length at about 2 years of age (Ali 1999; Talwar and Jhingran 1992).



Figure 2 *Channa striata*. Photo Shijan Kaakkara

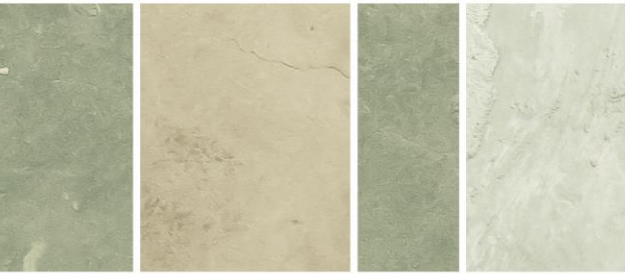


Figure 3. *Channa striata*. Photo: Bedo

## Behaviours and Traits

The striped snakehead is a very hardy, highly invasive species. It is able to breathe air and survive long periods out of water through specially adapted respiratory structure above the gills (Parameswaran and Murugesan 1976; Singh et al. 1990). The fish can move across land to escape extreme conditions or burrow in mud during dry periods (Courtenay and Williams 2004). In fact, as an adult the species is an obligate air-breather (Vivekanandan 1977) and will suffocate if it is unable to breathe air.

## Food and Foraging

The striped snakehead is a particularly aggressive, territorial, carnivorous ambush predator (Welcomme 2008) that feeds on fish, frogs, snakes, insects, worms, crustacean (including prawns), and even small birds and mammals (Conlu 1986; Courtenay and Williams 2004; Lee and Ng 1994; Li et al. 2016). Young fry feed on algae, protozoans, insects, water fleas, and other fish fry while juveniles feed on small crustaceans, fly larvae, zooplankton, and fish fry (Conlu 1986; Ng and Lim 1990).



## Reproduction and Lifecycle

The snakehead is solitary except during spawning season (Lee and Ng 1994). When conditions are favourable, pairs breed during most months (sometimes twice annually), laying between a few hundred to over 1,000 eggs per spawning (Ali 1999; Kilambi 1986; Parameswaran and Murugesan 1976; Talwar and Jhingran 1992). Peak spawning usually coincides with peak rainfall (Courtenay and Williams 2004; Kilambi 1986; Parameswaran and Murugesan 1976).

Adults sometimes prepare an area for spawning by creating a shallow depression in aquatic vegetation (Ling 1977) or lay directly in the water (Alikunhi 1953). Eggs float to the surface after fertilization (Lee and Ng 1994; Marimuthu and Haniffa 2007) and parents typically, but not always, guard them (Courtenay and Williams 2004; Ng and Lim 1990).

Eggs hatch in about one to three days from spawning (Kilambi 1986; Lee and Ng 1994; Li et al. 2016; Marimuthu and Haniffa 2007).

## Habitat

Striped snakeheads generally inhabit freshwater ponds and streams that are shallow (1 m or less), stagnant and muddy (Courtenay and Williams 2004; Kottelat 2001; Talwar and Jhingran 1992). However, it has also been found in water reservoirs, rivers, lakes, swamps, rice paddies, mining pools, and roadside ditches (Conlu 1986; Courtenay and Williams 2004; Fernando and Indrasena 1969; Lee and Ng 1994; Ng and Lim 1990).

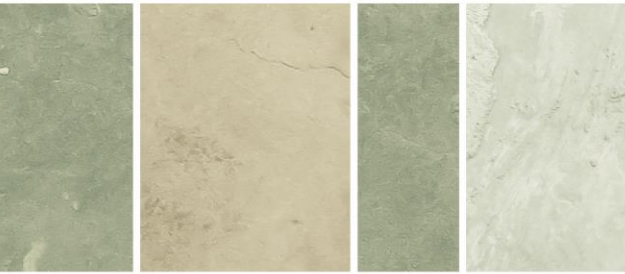
Although the species is commonly found in open waters (Ng and Lim 1990), they have also been found amongst thick vegetation and dense mats of aquatic plants (Kumar and Mittal, 1993). Lee and Ng (1994) noted that this species is the most adaptable snakehead, tolerating “foul” water (Qin et al. 1997). Varma (1979) reported the snakehead can survive in pH from 4.25 to 9.40, and Amornsakun et al. (2017) reported survival of fingerlings up to 15 ppt salinity.

## Global Range

The striped snakehead is native to the south and south-eastern regions of Asia where its distribution is extraordinarily widespread (USGS 2012). It is found throughout Indian sub-continent, southern Nepal, Bhutan and Pakistan (Courtenay and Williams 2004; Fernando and Indrasena 1969; Pethiyagoda 1991) through Bangladesh, Myanmar, Thailand, Cambodia, southern China, and Malay Archipelago (Pethiyagoda 1991; Tan et al. 2015) to western Java, Vietnam, and Laos (Kottelat 2001; Morioka et al. 2016; Tan et al. 2015).

Of all the snakehead species, striped snakeheads are considered the most widely introduced (USGS 2012). The snakehead has established in Hawaii, Philippines, Vogelkop Peninsula, Papua, Indonesia, Sundaland, Sulawesi, Lesser Sundas, Moluccas, Mauritius, and China (Conlu 1986; Courtenay and Williams 2004; Lever 1996; Roberts 1989). It was also introduced to Fiji and New Caledonia, however establishment is questionable (Eldredge 2000; Maciolek 1984). The Guam introduction was unsuccessful (Eldredge 2000; Maciolek 1984).

Various reports indicate it was intentionally released into Hawaii before 1900 (Brock 1960; USGS 2012). Although the striped snakehead is now established on Oahu, those early



introductions were later determined to be the blotched snakehead, *Channa maculata* (USGS 2012). Like Hawaii, reports of striped snakehead establishing in Madagascar in 1978 (Reinthal and Stiansny 1991) were misidentification of blotched snakehead (USGS 2012).

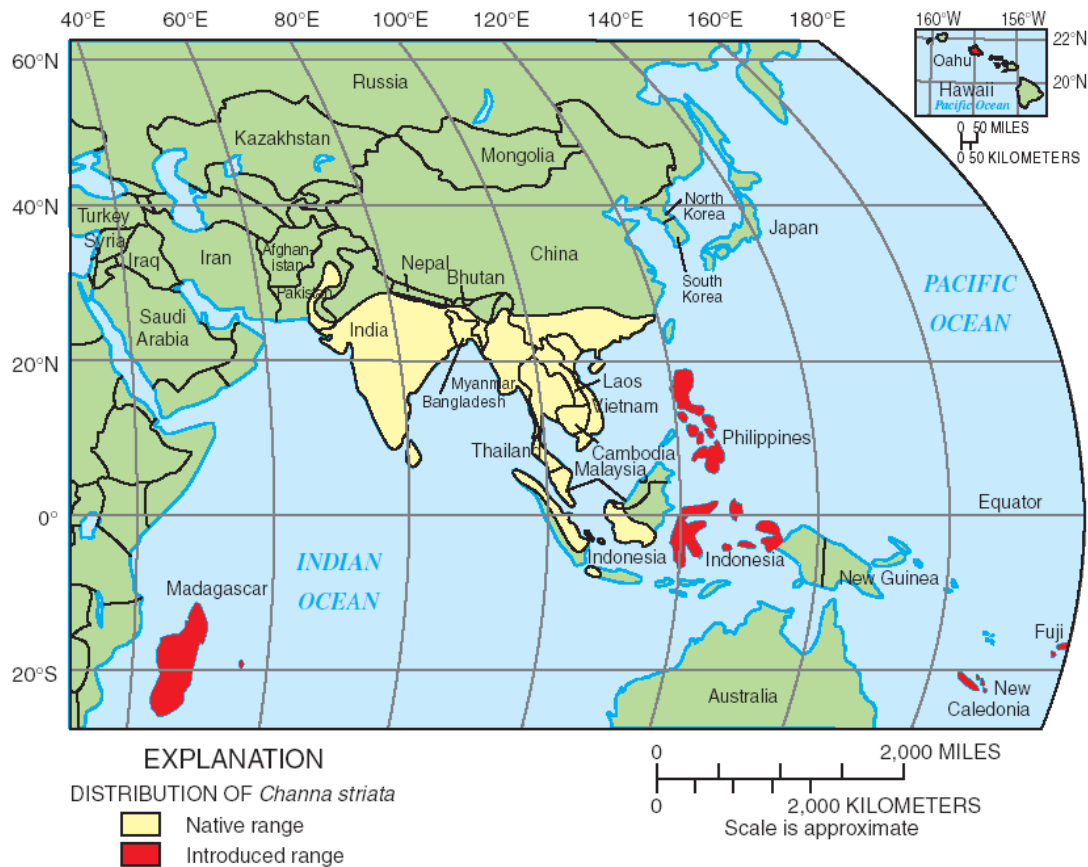


Figure 4. Map showing the native and introduced range of *Channa striata*. Image taken from (USGS 2012). August 2017.

## Potential for Introduction

The proximity of Australia to the striped snakehead's native range increases its potential for introduction. The species' adaptability, capacity to live in turbid or clear waters and their apparent ability to tolerate subtropical to warm temperate climates, suggests the probability of establishment if introduced into Australia is high. Apart from particularly arid areas of Australia, the species is likely to thrive Australia-wide, particularly in tropical regions.

It is possible that the species may be illegally brought into Australia and propagated for food. Like other snakeheads, the striped snakehead is a highly prized food fish in Asia, and is also





believed to have medicinal properties. Consequently, there is considerable economic pressure to import or rear this fish around the world (Courtenay and Williams 2004).

## Potential for Eradication

If the striped snakehead establishes in Australia, the cost and subsequent ecological impacts would prohibit successful eradication. More feasible responses include education efforts to limit the population growth of the fish (advising fishermen to kill snakeheads), as well as enforcement and education efforts to limit further spread (Courtenay and Williams 2004).

## Impacts

García-Díaz (2014) determined the potential impact of the species is high.

### Economic

If the striped snakehead were to establish in Australia control and eradication costs would likely be significant. Based on its behaviors and traits, the snakehead would be difficult to eradicate (Courtenay and Williams 2004). For example, ponds would need to be drained and dried out and fencing erected to prevent the species from migrating.

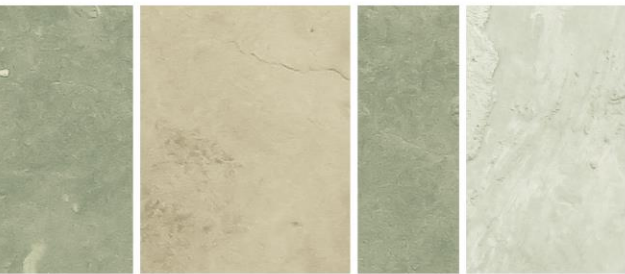
The striped snakehead may also impact aquaculture, recreational, and sport fisheries by excessive predation on smaller fishes including juvenile barramundi (e.g., Conlu 1986; Love and Newhard 2012). The species may also outcompete fish, particularly bass, trout and salmon (Conlu 1986).

### Environmental

As a voracious predator and competitor of native fish species, the striped snakehead is implicated in the decline of rare and threatened fish in its introduced range (e.g., Froese and Pauly 2017). It is also known to have wider, unpredictable effects on the estuarine ecosystems, through alteration of food webs (Courtenay and Williams 2004).

### Social

As discussed above, predation and competition with recreational and sport fishing species is likely. Since the species stirs up the muddy bottom of ponds and other waterbodies, their presence could increase turbidity and odor of ponds in parklands and other public areas that could have a negative impact on the community's enjoyment. Public safety is also an issue as the snakehead is known to cause serious bite injuries to humans (USGS 2012).



## Legislation

The high risk and potential pest status of the striped snakehead is recognised throughout Australia, as indicated in Table 1.

Table 1: Current status of the striped snakehead under jurisdictional legislation

Jurisdiction	Legislation	Status
Australia	Biosecurity Act 2015	Noxious under Schedule 1
Australia	Environment Protection and Biodiversity Conservation Act 1999	not suitable for import
Australia	List of specimens taken to be suitable for live import	not listed
Western Australia	Fish Resources Management Regulations 1995	Noxious under Schedule 5
South Australia	Fisheries Management Act 2007	Noxious
New South Wales	Fisheries Management Act 1994	Class 1 Noxious under Schedule 6c
Queensland	Fisheries Act 1994	Noxious under Schedule 6
Victoria	Fisheries Act 1995	Noxious



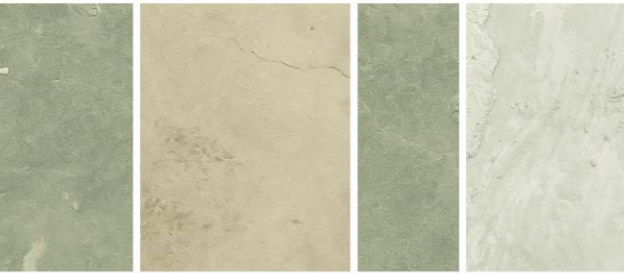
# Image Library

This section contains a library of images and copyright licences that can be used in a range of related printed and electronic extension materials.

## Copyright Licence Restrictions of Use

Table 2 is a list of copyright codes and their terms of use that relate to the images in the catalogue. The terms list what you can do and how you can use each image.

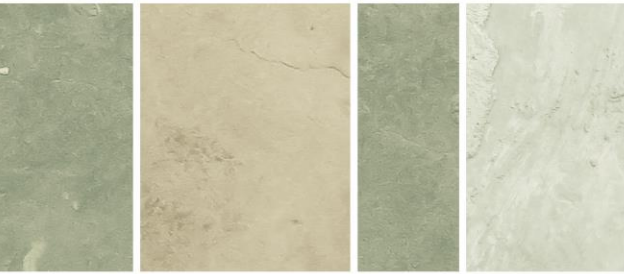
Type	Terms of Use
No copyright	No copyright restrictions known and no permissions required
Attribution - 2.0 Generic (CC BY 2.0) <a href="https://creativecommons.org/licenses/by/2.0/legalcode">https://creativecommons.org/licenses/by/2.0/legalcode</a>	<p><b>You are free to:</b></p> <ul style="list-style-type: none"><li>• Share – copy and redistribute the material in any medium or format for any purpose, even commercially.</li><li>• Adapt – remix, transform, and build upon the material for any purpose, even commercially.</li><li>• The licensor cannot revoke these freedoms as long as you follow the license terms.</li></ul> <p><b>Under the following terms:</b></p> <ul style="list-style-type: none"><li>• Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.</li><li>• No additional restrictions – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.</li></ul>
Attribution - No Derivs 2.0	<p><b>You are free to:</b></p> <ul style="list-style-type: none"><li>• Share – copy and redistribute the material in any medium or format for any purpose, even</li></ul>



Type	Terms of Use
Generic (CC BY-ND 2.0) <a href="https://creativecommons.org/licenses/by-nd/2.0/legalcode">https://creativecommons.org/licenses/by-nd/2.0/legalcode</a>	commercially. <ul style="list-style-type: none"> <li>The licensor cannot revoke these freedoms as long as you follow the license terms.</li> </ul> <b>Under the following terms:</b> <ul style="list-style-type: none"> <li>Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.</li> <li>No Derivatives – If you remix, transform, or build upon the material, you may not distribute the modified material.</li> <li>No additional restrictions – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.</li> </ul>
Attribution - Non Commercial 2.0 Generic (CC BY-NC 2.0) <a href="https://creativecommons.org/licenses/by-nc/2.0/legalcode">https://creativecommons.org/licenses/by-nc/2.0/legalcode</a>	<b>You are free to:</b> <ul style="list-style-type: none"> <li>Share – copy and redistribute the material in any medium or format</li> <li>Adapt – remix, transform, and build upon the material</li> <li>The licensor cannot revoke these freedoms as long as you follow the license terms.</li> </ul> <b>Under the following terms:</b> <ul style="list-style-type: none"> <li>Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.</li> <li>Non Commercial – You may not use the material for commercial purposes.</li> <li>No additional restrictions – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.</li> </ul>
Attribution - Non Commercial - No Derivs 2.0 Generic (CC BY-NC-ND 2.0)	<b>You are free to:</b> <ul style="list-style-type: none"> <li>Share – copy and redistribute the material in any medium or format</li> <li>The licensor cannot revoke these freedoms as long as you follow the license terms.</li> </ul>



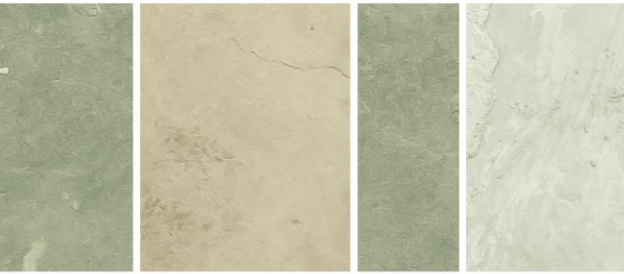
Type	Terms of Use
<a href="https://creativecommons.org/licenses/by-nc-nd/2.0/legalcode">https://creativecommons.org/licenses/by-nc-nd/2.0/legalcode</a>	<p><b>Under the following terms:</b></p> <ul style="list-style-type: none"> <li>• Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.</li> <li>• Non Commercial – You may not use the material for commercial purposes.</li> <li>• No Derivatives – If you remix, transform, or build upon the material, you may not distribute the modified material.</li> <li>• No additional restrictions – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.</li> </ul>
<p>Attribution - Share Alike 1.0 (CC BY-SA 1.0)</p> <a href="https://creativecommons.org/licenses/by-sa/1.0/legalcode">https://creativecommons.org/licenses/by-sa/1.0/legalcode</a>	<p><b>You are free to:</b></p> <ul style="list-style-type: none"> <li>• Share – copy and redistribute the material in any medium or format for any purpose, even commercially.</li> <li>• Adapt – remix, transform, and build upon the material for any purpose, even commercially.</li> <li>• The licensor cannot revoke these freedoms as long as you follow the license terms.</li> </ul> <p><b>Under the following terms:</b></p> <ul style="list-style-type: none"> <li>• Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.</li> <li>• ShareAlike – If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.</li> <li>• No additional restrictions – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.</li> </ul>
<p>Attribution - Share Alike 2.0 Generic (CC BY-SA 2.0)</p>	<p><b>You are free to:</b></p> <ul style="list-style-type: none"> <li>• Share – copy and redistribute the material in any medium or format for any purpose, even commercially.</li> </ul>



Type	Terms of Use
<a href="https://creativecommons.org/licenses/by-sa/2.0/legalcode">https://creativecommons.org/licenses/by-sa/2.0/legalcode</a>	<ul style="list-style-type: none"> <li>• Adapt – remix, transform, and build upon the material for any purpose, even commercially.</li> <li>• The licensor cannot revoke these freedoms as long as you follow the license terms.</li> </ul> <p><b>Under the following terms:</b></p> <ul style="list-style-type: none"> <li>• Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.</li> <li>• Share Alike – If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.</li> <li>• No additional restrictions – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.</li> </ul>
Attribution - Share Alike 2.5 Generic (CC BY-SA 2.5)  <a href="https://creativecommons.org/licenses/by-sa/2.5/legalcode">https://creativecommons.org/licenses/by-sa/2.5/legalcode</a>	<p><b>You are free to:</b></p> <ul style="list-style-type: none"> <li>• Share – copy and redistribute the material in any medium or format for any purpose, even commercially.</li> <li>• Adapt – remix, transform, and build upon the material for any purpose, even commercially.</li> <li>• The licensor cannot revoke these freedoms as long as you follow the license terms.</li> </ul> <p><b>Under the following terms:</b></p> <ul style="list-style-type: none"> <li>• Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.</li> <li>• Share Alike – If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.</li> <li>• No additional restrictions – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.</li> </ul>
Attribution - Share Alike	<p><b>You are free to:</b></p> <ul style="list-style-type: none"> <li>• Share – copy and redistribute the material in any medium or format for any purpose, even</li> </ul>



Type	Terms of Use
<p>3.0 Unported (CC BY-SA 3.0)</p> <p><a href="https://creativecommons.org/licenses/by-sa/3.0/legalcode">https://creativecommons.org/licenses/by-sa/3.0/legalcode</a></p>	<p>commercially.</p> <ul style="list-style-type: none"><li>• Adapt – remix, transform, and build upon the material for any purpose, even commercially.</li><li>• The licensor cannot revoke these freedoms as long as you follow the license terms.</li></ul> <p><b>Under the following terms:</b></p> <ul style="list-style-type: none"><li>• Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.</li><li>• Share Alike – If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.</li><li>• No additional restrictions – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.</li></ul>
<p>Attribution - Share Alike 4.0 International (CC BY-SA 4.0)</p> <p><a href="https://creativecommons.org/licenses/by-sa/4.0/legalcode">https://creativecommons.org/licenses/by-sa/4.0/legalcode</a></p>	<p><b>You are free to:</b></p> <ul style="list-style-type: none"><li>• Share – copy and redistribute the material in any medium or format for any purpose, even commercially.</li><li>• Adapt – remix, transform, and build upon the material for any purpose, even commercially.</li><li>• The licensor cannot revoke these freedoms as long as you follow the license terms.</li></ul> <p><b>Under the following terms:</b></p> <ul style="list-style-type: none"><li>• Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.</li><li>• Share Alike – If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.</li><li>• No additional restrictions – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.</li></ul>

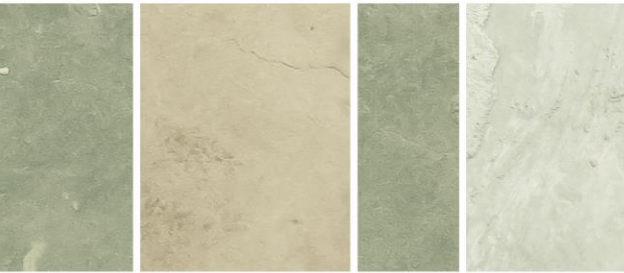


Type	Terms of Use
No Copyright - CC0 1.0 Universal (CC0 1.0) - Public Domain Dedication  <a href="https://creativecommons.org/publicdomain/zero/1.0/legalcode">https://creativecommons.org/publicdomain/zero/1.0/legalcode</a>	<p><b>No Copyright</b></p> <ul style="list-style-type: none"> <li>• This license is acceptable for Free Cultural Works.</li> <li>• The person who associated a work with this deed has dedicated the work to the public domain by waiving all of his or her rights to the work worldwide under copyright law, including all related and neighbouring rights, to the extent allowed by law.</li> <li>• You can copy, modify, distribute and perform the work, even for commercial purposes, all without asking permission.</li> </ul> <p><b>Other Information</b></p> <ul style="list-style-type: none"> <li>• In no way are the patent or trademark rights of any person affected by CC0, nor are the rights that other persons may have in the work or in how the work is used, such as publicity or privacy rights.</li> <li>• Unless expressly stated otherwise, the person who associated a work with this deed makes no warranties about the work, and disclaims liability for all uses of the work, to the fullest extent permitted by applicable law.</li> <li>• When using or citing the work, you should not imply endorsement by the author or the affirmer.</li> </ul>
Public Domain - US: Public Domain - Out of copyright worldwide	<ul style="list-style-type: none"> <li>• This media file is in the public domain in the United States. This applies to U.S. works where the copyright has expired, often because its first publication occurred prior to January 1, 1923.</li> <li>• This image might not be in the public domain outside of the United States; this especially applies in the countries and areas that do not apply the rule of the shorter term for US works, such as Canada, Mainland China (not Hong Kong or Macao), Germany, Mexico, and Switzerland. The creator and year of publication are essential information and must be provided. See Wikipedia: Public domain and Wikipedia: Copyrights for more details.</li> </ul>
Public Domain - work prepared by an officer or employee of the US Government - USGS	<p><b>Acknowledging or Crediting USGS as Information Source</b></p> <ul style="list-style-type: none"> <li>• Most U.S. Geological Survey (USGS) information resides in the public domain and may be used without restriction. When using information proper credit is given. Note that some non USGS photographs, images or graphics require permission from the copyright holder under the copyright law.</li> </ul>








Type	Terms of Use
<a href="https://www2.usgs.gov/visual/credit_usgs.html#copyright">https://www2.usgs.gov/visual/credit_usgs.html#copyright</a>	
<p>Public Domain - work prepared by an officer or employee of the US Government</p> <p><a href="https://en.wikipedia.org/wiki/Copyright_status_of_work_by_the_U.S._government">https://en.wikipedia.org/wiki/Copyright_status_of_work_by_the_U.S._government</a></p>	<ul style="list-style-type: none"><li>• A work of the US government is "a work prepared by an officer or employee" of the federal government "as part of that person's official duties."</li><li>• In general, under section 105 of the Copyright Act, such works are not entitled to domestic copyright protection under U.S. law and are therefore in the public domain.</li><li>• This act only applies to U.S. domestic copyright as that is the extent of U.S. federal law. The U.S. government asserts that it can still hold the copyright to those works in other countries.</li></ul>
<p>GNU General Public License, Version 2</p> <p><a href="https://www.gnu.org/licenses/old-licenses/gpl-2.0.html">https://www.gnu.org/licenses/old-licenses/gpl-2.0.html</a></p>	<p>This work is free software</p> <ul style="list-style-type: none"><li>• You can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation.</li><li>• This work is distributed in the hope that it will be useful, but without any warranty; without even the implied warranty of merchantability or fitness for a particular purpose.</li></ul>







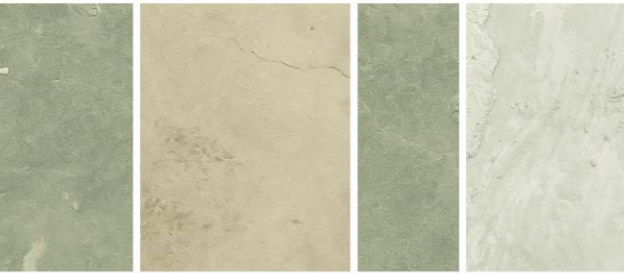
## Image Library - Striped snakehead (*Channa striata*)



Note: Until available online, high resolution images can be requested via [michelle.christy@dpird.wa.gov.au](mailto:michelle.christy@dpird.wa.gov.au)

No	Photograph	Photo Credit	Image Size (Pixels)	Copyright Licence	Licence Link	File Name
1		Bernard Dupont	4000 x 2382	Attribution-Share Alike 2.0 Generic (CC BY-SA 2.0)	<a href="https://creativecommons.org/licenses/by-sa/2.0/legalcode">https://creativecommons.org/licenses/by-sa/2.0/legalcode</a>	1 Striped Snakehead Bernard Dupont.jpg
2		Wibowo Djatmiko	1107 x 705	Attribution-Share Alike 3.0 Unported (CC BY-SA 3.0)	<a href="https://creativecommons.org/licenses/by-sa/3.0/legalcode">https://creativecommons.org/licenses/by-sa/3.0/legalcode</a>	2 Striped Snakehead Wibowo Djatmiko.jpg
3		Wibowo Djatmiko	1106 x 549	Attribution-Share Alike 3.0 Unported (CC BY-SA 3.0)	<a href="https://creativecommons.org/licenses/by-sa/3.0/legalcode">https://creativecommons.org/licenses/by-sa/3.0/legalcode</a>	3 Striped Snakehead Wibowo Djatmiko.jpg



No	Photograph	Photo Credit	Image Size (Pixels)	Copyright Licence	Licence Link	File Name
4		BEDO	640 x 426	Attribution-Share Alike 4.0 International (CC BY-SA 4.0)	<a href="https://creativecommons.org/licenses/by-sa/4.0/legalcode">https://creativecommons.org/licenses/by-sa/4.0/legalcode</a>	4 Striped Snakehead Bedo.jpg
5		Shijan Kaakkara	3648 x 2736	Attribution - Share Alike 3.0 Unported (CC BY-SA 3.0)	<a href="https://creativecommons.org/licenses/by-sa/3.0/legalcode">https://creativecommons.org/licenses/by-sa/3.0/legalcode</a>	5 Striped Snakehead Shijan Kaakkara.jpg
6		U. S. Geological Survey	489 x 142	Public Domain - work prepared by an officer or employee of the US Government	<a href="https://www2.usgs.gov/visual-id/credit_usgs.html#copyright">https://www2.usgs.gov/visual-id/credit_usgs.html#copyright</a>	6 Striped Snakehead USGS.jpg
7		Florentino Floro	4608 x 3456	Attribution-Share Alike 4.0 International (CC BY-SA 4.0)	<a href="https://creativecommons.org/licenses/by-sa/4.0/legalcode">https://creativecommons.org/licenses/by-sa/4.0/legalcode</a>	7 Striped Snakehead Florentino Floro.jpg

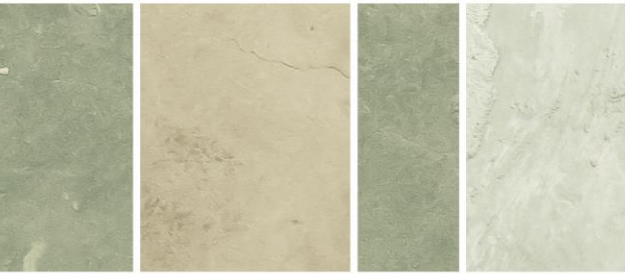


No	Photograph	Photo Credit	Image Size (Pixels)	Copyright Licence	Licence Link	File Name
8		Juan Wei	1024 x 629	Attribution-NonCommercial-NoDerivs 2.0 Generic (CC BY-NC-ND 2.0)	<a href="https://creativecommons.org/licenses/by-nc-nd/2.0/legalcode">https://creativecommons.org/licenses/by-nc-nd/2.0/legalcode</a>	8 Striped Snakehead Juan Wei.jpg
9		Juan Wei	1024 x 629	Attribution-NonCommercial-NoDerivs 2.0 Generic (CC BY-NC-ND 2.0)	<a href="https://creativecommons.org/licenses/by-nc-nd/2.0/legalcode">https://creativecommons.org/licenses/by-nc-nd/2.0/legalcode</a>	9 Striped Snakehead Juan Wei.jpg



## References

- Ali AB. 1999. Aspects of the reproductive biology of female snakehead (*channa striata* bloch) obtained from irrigated rice agroecosystem, malaysia. *Hydrobiologia* 411:71-77.
- Alikunhi K. 1953. Notes on the bionomics, breeding and growth of the murrel, *ophicephalus striatus* bloch. *Proceedings: Plant Sciences* 38:10-20.
- Amornsakun T, Vo VH, Petchsupa N, Pau TM, bin Hassan A. 2017. Effects of water salinity on hatching of egg, growth and survival of larvae and fingerlings of snake head fish, *channa striatus*. *Songklanakarin Journal of Science and Technology* 39:137-142.
- Bomford M. 2008. Risk assessment models for establishment of exotic vertebrates in australia and new zealand: Invasive Animals Cooperative Research Centre Canberra, ACT.
- Brock VE. 1960. The introduction of aquatic animals into hawaiian waters. *International Revue Gesamte Hydrobiologie* 45:463-480.
- Conlu P. 1986. Guide to philippine flora and fauna: Natural Resources Management Center, University of the Philippines Quezon City, Philippines.
- Courtenay WR, Sahlman HF, Miley WW, Herrema DJ. 1974. Exotic fishes in fresh and brackish waters of florida. *Biological Conservation* 6:292-302.
- Courtenay WR, Williams JD. 2004. Snakeheads (pisces, channidae): A biological synopsis and risk assessment: United States Geological Survey. San Fransisco, CA.
- Eldredge LG. 2000. Non-indigenous freshwater fishes, amphibians, and crustaceans of the pacific and hawaiian islands. In: Sherley S, editor. *Invasive species in the pacific: A technical review and draft regional strategy*. South Pacific Regional Environment Programme and AusAid. Apia, Samoa. pp 173-190.
- Fernando C, Indrasena H. 1969. The freshwater fisheries of ceylon. *Bulletin of the Fisheries Research Station, Ceylon* 20:101-134.
- Froese R, Pauly D. 2017. Fishbase. [Fishbase.org](http://www.fishbase.org). World Wide Web Electronic Publication. <http://www.fishbase.org>.
- García-Díaz P. 2014. Evaluation of potential impacts of species proposed for category 1 list. Invasive Animals and Plants Committee Adelaide, SA. 32 pp.
- Kilambi R. 1986. Age, growth and reproductive strategy of the snakehead, *ophicephalus striatus* bloch, from sri lanka. *Journal of fish biology* 29:13-22.
- Kottelat M. 2001. *Fishes of laos*: Wildlife Heritage Trust Publications. Colombo, Sri Lanka.
- Lee P, Ng PK. 1994. The systematics and ecology of snakeheads (pisces: Channidae) in peninsular malaysia and singapore. *Hydrobiologia* 285:59-74.
- Lever C. 1996. *Naturalized fishes of the world*: Academic Press. San Diego, CA. 408 pp.
- Li K-c, Shieh B-s, Chiu Y-w, Huang D-j, Liang S-h. 2016. Growth, diet composition and reproductive biology of the invasive freshwater fish chevron



- snakehead *channa striata* on a subtropical island. *Zoological Studies* 55:1-11.
- Ling S-W. 1977. Aquaculture in southeast asia. A historical overview. A Washington Sea Grant Publication. Washington University Press. Seattle, WA. pp 108.
- Love JW, Newhard JJ. 2012. Will the expansion of northern snakehead negatively affect the fishery for largemouth bass in the potomac river (chesapeake bay)? *North American Journal of Fisheries Management* 32:859-868.
- Maciolek J. 1984. Exotic fishes in hawaii and other islands of oceania. In: Courtenay W, Stauffer JJ, editors. Distribution, biology, and management of exotic fishes. Western Fisheries Research Center. Baltimore, MD. pp 131-136.
- Marimuthu K, Haniffa M. 2007. Embryonic and larval development of the striped snakehead *channa striatus*. *Taiwania* 52:84-92.
- Morioka S, Vongvichith B, Chanthasone P, Phommachane P, Suzuki N. 2016. Reproductive season, age estimation and growth in a striped snakehead *channa striata* population in nasaythong district, vientiane province, central laos. *Aquaculture Science* 64:183-191.
- Ng P, Lim K. 1990. Snakeheads (pisces: Channidae): Natural history, biology and economic importance. In: Chou L, Ng P, editors. Essays in zoology papers commemorating the 40th anniversary of the department of zoology National University of Singapore Singapore. pp 127-152.
- Parameshwaran S, Murugesan V. 1976. Breeding season and seed resources of murrels in swamps of karnataka state. *Journal of the Inland Fisheries Society of India* 8:60-67.
- Parameswaran S, Murugesan V. 1976. Observations on the hypophysation of murrels (ophicephalidae). *Hydrobiologia* 50:81-87.
- Pethiyagoda R. 1991. Freshwater fishes of sri lanka: Wildlife Heritage Trust Publications. Colombo, Sri Lanka.
- Qin J, Fast AW, Kai AT. 1997. Tolerance of snakehead *channa striatus* to ammonia at different ph. *Journal of the World Aquaculture Society* 28:87-90.
- Reinthal P, Stiassny M. 1991. The freshwater fishes of madagascar: A study of an endangered fauna with recommendations for a conservation strategy. *Conservation Biology* 5:231-243.
- Roberts TR. 1989. The freshwater fishes of western borneo (kalimantan barat, indonesia). California Academy of Sciences. San Francisco, CA. 210 pp.
- Singh B, Yadav A, Prasad M, Mishra A, Singh I. 1990. Neo-morphic organ for co2 elimination in air breathing teleosts. *European archives of biology* 101:257-267.
- Talwar P, Jhingran A. 1992. Inland fishes of india and adjacent countries: Springer International Publishing. Rotterdam, Netherlands. 1158 pp.
- Tan M, Jamsari A, Muchlisin Z, Azizah MS. 2015. Mitochondrial genetic variation and population structure of the striped snakehead, *channa striata* in malaysia and sumatra, indonesia. *Biochemical Systematics and Ecology* 60:99-105.
- USGS, (United States Geological Survey). 2012. *Channa striata* (bloch, 1793) chevron snakehead. United States Geological Survey, Southeast Ecological Science Center. Gainesville, FL.  
[http://fl.biology.usgs.gov/Snakehead\\_circ\\_1251/html/channa\\_striata.html](http://fl.biology.usgs.gov/Snakehead_circ_1251/html/channa_striata.html).



- Varma B. 1979. Studies on the ph tolerance of certain freshwater teleosts.  
COMPARATIVE PHYSIOLOGY AND ECOLOGY 4:116-117.
- Vivekanandan E. 1977. Surfacing activity and food utilisation in the obligatory  
air-breathing fish ophiocephalus striatus as a function of body weight.  
Hydrobiologia 55:99-112.
- Welcomme RL. 2008. Inland fisheries: Ecology and management. Nations  
FaAOotU, editor: Blackwell Science. London, UK. 380 pp.

