Pest animal risk assessment

Asian house gecko

Hemidactylus frenatus

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Front cover: Asian house gecko (W.A. Djatmiko, image from Wikimedia Commons under a GNU Free Documentation Licence).

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Summary

The Asian house gecko (*Hemidactylus frenatus*) is native to a large area of Asia, extending from southern India to Indonesia. It is an opportunistic hunter of a wide range of insects and spiders and can thrive in urban areas, where it hunts each night on hard surfaces such as walls. International movement of ships and cargo has assisted its spread across the world and naturalised populations now exist in numerous islands and countries. The first record of Asian house geckos in Brisbane was in 1983 near shipping wharves. It has since become abundant across much of Brisbane. There is some evidence that Asian house geckos can compete and perhaps replace locally native gecko species, especially in urban areas. However, the extent and significance of such competition in non-urban habitats requires further study. Risk assessment suggests that Asian house geckos will continue to spread in Queensland, mainly in urban areas, including towns. They appear well suited to tropical and sub-tropical climates.

Introduction

Taxonomy

Species: *Hemidactylus frenatus*

Common names: Asian house gecko, Pacific house gecko, house lizard, spiny-tailed house gecko, Chichak/Cheechak (Indonesian), bridled house gecko

Family: Gekkonidae

Related species: There are approximately 80 species of *Hemidactylus*.

No comprehensive information on phylogeny is available (Jesus et al. 2001).

Description

Hemidactylus frenatus is 7.5–15 cm long. Males are generally longer and heavier than females and have a wider jaw. Scalation is uniform, with distinctive, slightly enlarged spines scattered over the back and arranged in bands around the tail. Colour varies from matt grey or light brown through beige, to a greenish iridescence. The underside is whitish.

Biology

Life history

Incubation period: 45–70 days

Number of eggs: 2 eggs per clutch

Oviposition frequency: 21–28 days

Sexual maturity: 1 year

Sexual activity: Unknown

Life span: Approximately 5 years.

(Animal Life Resources, 2008; Krysko et al. 2003; Wikipedia, 2008b)

Mating involves a short courtship, during which the male repeatedly touches the female with his snout. He may also bite-hold her neck. Three to four weeks after mating, two hard-shelled eggs are laid, partially fixed to a solid surface. Successful incubation requires a temperature of at least 28 ˚C. Breeding occurs throughout the year in tropical areas, but is seasonal in cooler climates (breeding occurs in summer in Brisbane) (Belize Biodiversity Information System, 2001; Henkel, 1995; Krysko et al. 2003; Wilson, 2006). Females can store sperm for up to a year, a feature that probably assists the species' invasion success (Yamamoto and Ota, 2006).

Social organisation

H. frenatus is territorial with a social hierarchy (Frenkel, 2006). During the day, the animal hides in some form of shelter (e.g. inside a letterbox or a crack in a wall) and emerges at dusk to forage all night. Perhaps its most distinctive feature is its call—best described as '*chuck*, *chuck*, *chuck*'. Vocalisation is louder and more frequent than Australian native geckos (Wilson, 2006) and can be heard day and night. Males call in a variety of situations: after emerging from their daytime shelter and before moving to feeding areas; after feeding; after a male has won a fight with another male; when a male approaches a female in courtship; and after mating (Greer, 2006). It is thought that calls are used to establish and maintain territories (Marcellini, 1977).

When in contact with other gecko species, *H. frenatus* is usually the most aggressive. One study comparing *H. frenatus* with two other gecko species, *H. garnotii* and *Lepidodactylus lugubris*, showed that *H. frenatus* is more likely to approach, displace, and bite the other two species (Bolger and Case, 1992). Aggressive encounters often result in tail loss and scars (Frenkel, 2006).

Diet and feeding behaviour

H. frenatus is a generalist predator and will eat virtually any insect or spider it can capture and swallow (Wilson, 2006). A study of stomach contents from a population of *H. frenatus* in Brisbane identified prey items from seven orders of insects (Blattodea, Hymenoptera,

Homoptera, Lepidoptera, Diptera, Coleoptera, and Araneae) (Newbery and Jones, 2007). A similar study in Burma found stomach contents from insects in seven orders (Hymenoptera, Coleoptera, Lepidoptera, Orthoptera, Diptera, Hemiptera and Zygoptera) as well as spiders (Arachnida) (Tyler, 1960). *H. frenatus* consumes mosquitos (Canyon and Hii, 1997) and the adults and larvae of paper wasps (Wilson, 2006). Male and female *H. frenatus* are known to eat juveniles of other gecko species as well as their own progeny (Bolger and Case, 1992).

Figure 1. *Hemidactylus frenatus* eating a spider.
(Photo: Ehollins. Image from Wikimedia Commons under a Public Domain Licence)

Preferred habitat

H. frenatus is a tropical and subtropical species and is uncommon or absent in cool areas.

H. frenatus is most abundant in urban environments, often seen on the walls of houses, on windows at night and in gardens: hence the common name 'house gecko'. However, it can survive away from buildings, albeit in generally lower numbers, in woodlands, patches of forest, on trees in open fields, rocky and forested areas, coconut palm trunks, under rotting logs, and among dense, low ground-cover such as *Ipomea* and *Canavalia* (Dutton, 1980; Greer, 2006). A study in New Caledonia found *H. frenatus* in seemingly pristine forests (Watkins-Colwell, undated).

H. frenatus prefers habitats that have structurally simple hunting spaces, such as walls and vertical rock walls, combined with locally concentrated populations of insects (e.g. around lights). Such conditions are common in urban areas. The species is less abundant in forested habitats that have complex topographic structures and more evenly dispersed insect populations. In forests with unusually high insect numbers, *H. frenatus* can be found but seems to coexist with native gecko species (Petren and Case, 1998).

Predators and diseases

Predators include cats, snakes, rats, dogs, large spiders, birds, preying mantids and larger lizards (Barquero and Hilje, 2005; Case et al. 1994; Dutton, 1980; Greer, 2006; Lever, 2003).

Parasites include apicomplexans (protozoans), cestodes (tapeworms), nematodes (round worms), pentastomes (tongue worms), and trematodes (flukes) (Greer, 2006). Pentastomid parasites have been discovered on *H. frenatus* in Australia. Pentastomes feed on the blood of their host and can affect the host's ability to reproduce and compete (Barton, 2007).

Two species of red gecko mite (*Geckobia bataviensis* and *G. keegani*) live on the toes of *H. frenatus* (Wilson, 2006). The red gecko mite (*Geckobia bataviensis*) has been found on *H. frenatus* in the Northern Territory (Arnhem Land), and also on *H. frenatus* at Wynnum, south-east Queensland (Domrow, 1991, 1992). Some species of mites carry protozoans that cause serious diseases in lizards overseas (Wilson, 2006).

Conservation status

H. frenatus is widespread and abundant. It is not listed on the IUCN Red List and is not listed by CITES.

Threat to human safety

H. frenatus does not present a threat to human safety.

Distribution and abundance

Australia

H. frenatus was first recorded in Australia in 1845 at Port Essington, on the Coburg Peninsula, Northern Territory. However, it was not recorded again until the 1960s when a population was found in suburban Darwin. In Brisbane, the species was first recorded in 1983 around wharves, presumably arriving on ships from Asia or the Pacific. Today, the species is the most abundant house-dwelling gecko in Brisbane. Other incursions probably occurred simultaneously elsewhere, since the species currently exists in all states and territories (Figure 2).

A population has also established on the main island of Norfolk Island (Cogger et al. 2005).

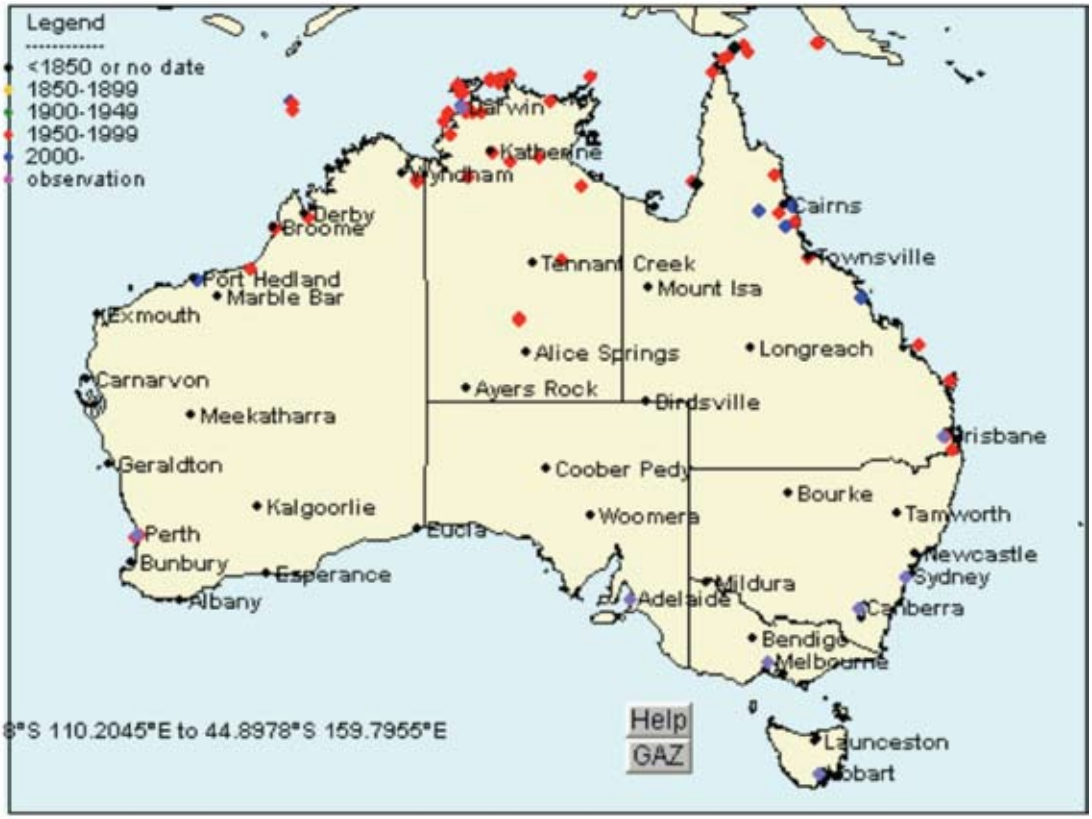

Figure 2. Distribution of *Hemidactylus frenatus* as represented by 213 specimen records in museum collections.
(Source: www.museum.wa.gov.au/faunabase/_asp_bin/MapITcx.asp?d=Reptiles&t=Hemidactylus+frenatus&r=&g=OZ1.gif&pn=true&ss=6&si=true)

Overseas

H. frenatus is native to southern India, Bangladesh, Indo-China, Thailand, western Malaysia, and much of Indonesia.

As well as in Australia, naturalised populations exist in:

- Asia: Philippines, Japan (Ryukyu Islands), Vietnam
- Africa: Kenya, Madagascar
- North America: Mexico, Florida
- Oceania: Atlantic Ocean (St Helena, Ascension Island), Indian Ocean (Andaman and Nicobar Islands, Mascarene Islands, Seychelles, Comores Islands, Christmas Island, Cocos (Keeling) Islands), Pacific Ocean (Hawaiian Islands, Federated States of Micronesia, New Caledonia, American Samoa, Western Samoa, Fiji Islands, Mariana Islands, Vanuatu, Society Islands, Marquesas Islands) (Lever, 2003).

Figure 3. Worldwide distribution of *Hemidactylus frenatus*.
(Source: http://us.mirror.gbif.org/species/13500022/)

History as a pest overseas

H. frenatus has invaded island habitats throughout the Pacific and the Americas over the past 60 years, facilitated by increased international shipping and cargo movement (Newbery and Jones, 2007). It is often first detected in port areas after 'hitching a ride' in shipping containers and cargo (Lever, 2003). The species has adhesive, water-resistant eggs, a feature that facilitates dispersal on a wide range of shipped items (Case et al. 1994).

Across its naturalised range, *H. frenatus* appears to be causing significant declines in the abundance of native gecko species. In Hawaii, *H. frenatus* first appeared after World War II. The population increased across urban and suburban habitats, while native gecko species became scarce. It is now the most abundant gecko species, found not only in urban habitats, but also in rural and secondary forest areas. In Vanuatu, *H. frenatus* is the dominant urban gecko species in the city of Port Vila on Efate (though it is restricted to this area) and in the town of Santo on Espiritu Santo (Fiedler and Kareiva, 1998; Lever, 2003). In Mauritius, *H. frenatus* is thought to be displacing the endemic ornate day gecko (*Phelsuma ornate*) from native ebony forest (Lever, 2003). Across Réunion, Rodrigues, and mainland Mauritius, geckos from the genus *Nactus* have undergone a catastrophic reduction in range, including local extinctions, coinciding with the introduction of *H. frenatus* (Cole et al. 2005). On the Revillagigedo Archipelago of Mexico, an area of national and global ecological importance, there is concern that the survival of the only other reptile species (*Urosaurus auriculatus*) may be at risk due to invasion by *H. frenatus*. On Christmas Island, *H. frenatus* has the potential to adversely affect the endemic Christmas Island gecko (*Lepidodactylus listeri*) (Lever, 2003). It is also thought to be a threat to the survival of Norfolk Island's native gecko (*Christinus guentheri*) (Cogger et al. 2005).

The ability of *H. frenatus* to replace locally native gecko species seems most pronounced in urban areas. Artificial lighting on buildings attracts large numbers of insects and *H. frenatus* is well adapted to utilise this food resource, perhaps more so than native gecko species, which may be better adapted to hunting more dispersed insect populations. In addition, *H. frenatus* is an aggressive and territorial species, features that allow it to successfully compete with native species. A study of *H. frenatus* and native *Nactus* spp. on the Mascarene Islands found that interactions were often aggressive, with *H. frenatus* frequently observed stalking, lunging towards and biting *Nactus* spp.—for example, two individual *N. coindemirensis* lost toes, a further two individuals lost their tails and one male was eaten. *H. frenatus* was also found to aggressively exclude *Nactus* spp. from daytime refugia, making these native species more vulnerable to predation and adverse climatic conditions (Cole et al. 2005).

H. frenatus can consume juveniles of other gecko species (Case et al. 1994; Dame and Petren, 2006).

Potential distribution and impact in Queensland

H. frenatus is already widespread and abundant in Brisbane and in towns along coastal Queensland, from the Torres Strait south to the New South Wales border.

Climate is a primary factor that determines a species' distribution. Climate-modelling software (CLIMATE version 1) was used to predict the area of Australia where climate is considered suitable for *H. frenatus* (Figure 4).

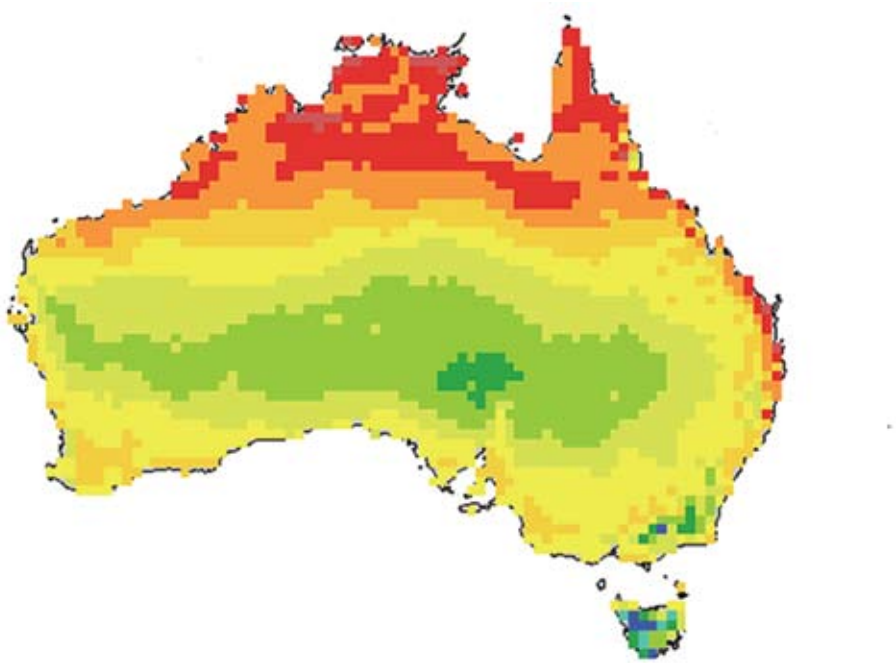

Figure 4. Potential distribution of *Hemidactylus frenatus* in Australia.

(red indicates areas where climate is most suitable for the species; orange and yellow indicate areas where climate is marginally suitable; and light green, dark green, light blue and dark blue indicate areas where climate is generally unsuitable). (Map produced by Martin Hannan-Jones)

Based purely on an assessment of climatic suitability, *H. frenatus* is likely to survive over large areas of Queensland, with coastal and northern areas being most suitable. It is important to note, however, that other habitat attributes, such as the availability of food and predator abundance, will influence range and abundance.

The species is occasionally detected in more temperate localities such as Albury in New South Wales, but these areas are probably too cold in winter for a population to persist (Greer, 2006).

Of concern is the potential for *H. frenatus* to displace native gecko species as it has done overseas. In coastal south-east Queensland, *H. frenatus* is most likely to compete with native gecko species that currently occupy urban areas, namely the Dtella (*Gehyra dubia*) and the Robust Velvet Gecko (*Oedura robusta*).

H. frenatus co-exists with another species of velvet gecko (*Oedura jacovae* sp. nov.) in houses adjoining the Mt Coot-tha bushland reserve (Brisbane), but has not expanded beyond the urban environment (Couper et al. 2007).

In Darwin, where *H. frenatus* has been present for at least 20 years longer than in south-east Queensland, its population has expanded beyond urban habitats into nearby native bushland (Couper et al. 2007). The native species, *Oedura rhombifer*, was once reported to be abundant on houses in Darwin. However, a survey in 2002 found no specimens. Anecdotal evidence suggests that *H. frenatus* is outcompeting and displacing *O. rhombifer*, as well as *G. dubia*, in urban habitats of Darwin (Keim, 2002).

Legislative restrictions

In New South Wales, *H. frenatus* is listed as a Category 2 Non-Indigenous Animal under the Non-Indigenous Animals Regulation 1997. A Category 2 animal is a 'species of high pest potential or of significant conservation value' (New South Wales State Government, 2006).

In Victoria, *H. frenatus* is listed as a Category 3a species of Regulated Pest Animals under the *Catchment and Land Protection Act 1994*. *H. frenatus* can be kept for certain reasons with a permit (State of Victoria Department of Primary Industries, 2007).

H. frenatus is a Class 2 declared pest in South Australia under the *Natural Resources Management Act 2004* (South Australian Government Gazette, 2005).

In Western Australia, *H. frenatus* is a Declared Animal under the *Agriculture and Related Resources Protection Act 1976* (Department of Agriculture and Food WA, 2008).

In the Northern Territory, *H. frenatus* is not listed as a declared feral species under the *Territory Parks and Conservation Act 2001*, nor is it considered a pest (Northern Territory Government, 2007).

In the ACT, *H. frenatus* is a protected species under the *Nature Conservation Act 1980*, as it is not listed as an exempt animal nor is it listed as a Pest Animal under the *Pest Plants and Animals Act 2005* (Department of Territory and Municipal Services, 2006).

In Tasmania, *H. frenatus* cannot be imported as there is no authority for it under the *Animal Health Act 1995* (Department of Primary Industries and Water, 2008).

In Queensland, *H. frenatus* is not a declared pest under the *Land Protection (Pest and Stock Route Management) Act* 2002.

Numerical risk assessment using the 'Bomford assessment'

A numerical risk assessment system developed by Bomford (2008) is widely applied in Australia to assess the level of risk posed by vertebrates. This approach enables numerical ranking and prioritisation of large numbers of species. First, a species' potential distribution is predicted using climate-modelling computer programs. The remaining steps involve allocation of scores for a number of attributes relevant to a species' pest status, including biology, costs to the economy, the environment and society, and management efficacy.

Using the Bomford system, *H. frenatus* was assessed as a 'serious' threat species (refer to attachment).

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Attachment

Using the Bomford (2008) system, *H. frenatus* was ranked as a 'serious' threat species in Queensland.

Species		***Hemidactylus frenatus* (Asian house gecko)**
Date of assessment		18.12.2008
Literature search type and date		See references
Factor	**Score**	
A1. Risk to people from individual escapees (0–2)	0	Nil risk
A2. Risk to public safety from individual captive animals (0–2)	0	Nil risk
Stage A. Public Safety Risk Rank = Sum of A 1 to 2. (0–4)	**0**	**Not dangerous**
B1. Climate match (1–6)	4	High climate match in Australia. CMS = 969.
B2. Exotic population established overseas (0–4)	4	Asian house geckos have established in Australia and across Asia and the Pacific.
B3. Overseas range size (0–2)	1	Overseas range size of 5.1 million square kilometres (Bomford et al. 2005).
B4. Taxonomic class (0–1)	1	Reptile.
B5. Diet (0–1)	1	Generalist diet of various insects.
B6. Habitat (0–1)	1	Asian house geckos are best adapted to urban environments.
B7. Migratory (0–1)	1	Non-migratory.
B. Probability escaped or released individuals will establish a free-living population = Sum of B 1 to 7. (1–16)	**13**	**Serious establishment risk**
C1. Taxonomic group (0–4)	0	Other group.
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2)	0	Approximately 5.1 million square kilometres (Bomford et al. 2005).
C3. Diet and feeding (0–3)	0	Not a mammal.
C4. Competition with native fauna for tree hollows (0–2)	0	Does not use tree hollows.
C5. Overseas environmental pest status (0–3)	2	Moderate environmental pest across the Pacific.
C6. Climate match to areas with susceptible native species or communities (0–5)	5	The species has more than 20 grid squares within the highest two climate match classes, and has more than 100 grid squares within the four highest climate match classes that overlap the distribution of any susceptible native species or communities.
C7. Overseas primary production pest status (0–3)	0	No report of damage to crops or other primary production in any country or region.

Species		*Hemidactylus frenatus* (Asian house gecko)
C8. Climate match to susceptible primary production (0–5)	0	Nil (Table 1).
C9. Spread disease (1–2)	1	Reptile.
C10. Harm to property (0–3)	0	$0
C11. Harm to people (0–5)	1	Very low risk as a social nuisance in buildings.
C. Probability an exotic species would become a pest (for birds, mammals, reptiles and amphibians) = Sum of C 1 to 11. (1–37)	**9**	**Moderate pest risk**
A. Risk to public safety posed by captive or released individuals		
A = 0 = not dangerous A = 1 = moderately dangerous A ≥ 2 = highly dangerous	**0**	**Not dangerous**
B. Risk of establishing a wild population		
For birds and mammals: B ‹ 6 = low establishment risk B = 7–11 = moderate establishment risk B = 12–13 = serious establishment risk B › 14 = extreme establishment risk	**13**	**Serious establishment risk**
For reptiles and amphibians: B ‹ 3 = low establishment risk B = 3–4 = moderate establishment risk B = 5–6 = high establishment risk B › 6 = extreme establishment risk		
C. Risk of becoming a pest following establishment		
C ‹ 9 = low pest risk C = 9–14 = moderate pest risk C = 15–19 = serious pest risk C › 19 = extreme pest risk	**9**	**Moderate pest risk**
VPC threat category		**Serious**

Table 1. Calculating Total Commodity Damage Score

Industry	Commodity Value Index[1] (CVI)	Potential Commodity Impact Score (PCIS, 0–3)	Climate Match to Commodity Score (CMCS, 0–5)	Commodity Damage Score (CDS, columns 2 × 3 × 4)
Cattle (includes dairy and beef)	11	0	Not estimated	0
Timber (includes native and plantation forests)	10	0	Not estimated	0
Cereal grain (includes wheat, barley sorghum etc)	8	0	Not estimated	0
Sheep (includes wool and sheep meat)	5	0	Not estimated	0
Fruit (includes wine grapes)	4	0	Not estimated	0
Vegetables	3	0	Not estimated	0
Poultry and eggs	2	0	Not estimated	0
Aquaculture (includes coastal mariculture)	2	0	Not estimated	0
Oilseeds (includes canola, sunflower etc)	1	0	Not estimated	0
Grain legumes (includes soybeans)	1	0	Not estimated	0
Sugarcane	1	0	Not estimated	0
Cotton	1	0	Not estimated	0
Other crops and horticulture (includes nuts, tobacco and flowers)	1	0	Not estimated	0
Pigs	1	0	Not estimated	0
Other livestock (includes goats, deer, camels, rabbits)	0.5	0	Not estimated	0
Bees (includes honey, beeswax and pollination)	0.5	0	Not estimated	0
Total Commodity Damage Score (TCDS)	—	—	—	**0**

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