Australian Government

Department of Agriculture, Water and the Environment

Risk Analysis

Review of listing conditions for the Golden Hamster (*Mesocricetus auratus*) on the List of Specimens taken to be Suitable for Live Import under the *Environment Protection and Biodiversity Conservation Act 1999*

August 2021

Introduction

Purpose of the review of the listing conditions

The purpose of this review is to assess the consequences of changing the listing conditions for the golden hamster to allow the importation of non-sterilised male and females golden hamsters (*Mesocricetus auratus*) for research.

Under s303EC of the *Environment Protection and Biodiversity Conservation Act* 1999 (the EPBC Act), the Minister may amend the List of Specimens taken to be Suitable for Live Import' (Live Import List) by including a specimen in the list. There are two parts to the list – Part 1 comprises specimens that can be imported without a permit under the Act and Part 2 comprises specimens, including species listed under the *The Convention on International Trade in Endangered Species of Wild Fauna and Flora species* (CITES), that require a permit under the Act to be imported. Import restrictions may be applied to the species listed on Part 2, such as 'for non-commercial purposes' or 'high security facilities only'. Additional conditions may also be applied when an import permit is issued.

Before amending the Live Import List, the Minister must consult with appropriate state and territory agencies, and consider a report assessing the potential environmental impacts of the proposed amendment. The Department will also consider all comments and information received through the consultation process for this document.

Background

The golden or Syrian hamster (golden hamster) is listed on Part 2 of the Live Import List of the EPBC Act with the conditions '*Eligible non-commercial purpose only, excluding household pets*. *Castrated males only'.*

Golden hamsters were included on the first version of Live Import List (13/12/2004) but were not listed on the *Wildlife Protection (Regulation of Exports and Imports) Act 1984*, which regulated animal imports before the EPBC Act was enacted in 2001. The first Live Import List contained species approved for import under the Wildlife Protection Act, the reason why the golden hamsters were not on the Wildlife Protection Act but appeared on the Live Import List is unknown. No other species of hamsters are listed.

The CSIRO Australian Centre for Disease Preparation (ACDP) formerly the Australian Animal Health Laboratory have requested that the listing for the golden hamster be modified to allow intact member of both sexes into their high security facility to assist in their research on the COVID-19 Virus and possible vaccinations or treatments.

The ACDP is undertaking research using castrated male golden hamster but require both sexes and preferably fertile animals to ensure that any results obtained are valid and not influenced by using only castrated males. By allowing both sexes into their

research facility it would also enable CSIRO to breed golden hamsters in house rather than needing to regularly import animals from overseas.

Conservation status

The golden hamster is listed as vulnerable on *The International Union for Conservation of Nature's Red List of Threatened Species* (IUCN Red List) due to their small population size, limited range and expanding human settlements and agricultural impacts including habitat loss, degradation and direct poisoning of the species (Yigit, & Kryštufek, 2008). They are not listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Biology and ecology of the golden hamster

The golden hamster or Syrian hamster is a common species internationally in the pet trade and is the fifth most commonly used laboratory research animal after mice, rats, rabbits, and guinea pigs (Chanut and Williams, 2016) They are a common experimental model for oncology, immunology, physiology, and reproductive biology research (Hirose & Ogura, 2018).

Despite being a very common species in laboratories and as pets, the wild population is limited to a small region of only 10 000 -15 000 km^2 ranging north and south-west of the city of Aleppo in Northern Syria (Gatterman, 2001). The entire domestic golden hamster stock originated from four siblings (three males and one female) caught in 1930 (Gattermann, 2000).

Despite a wealth of biological data about domestic golden hamsters, the species in the wild is poorly understood. Knowledge of its field ecology stem from anecdotal descriptions and short-time observations (Gatterman, 2001).

In the wild the species is a solitary animal that is very territorial with no evidence that they share burrows or share any social interactions. Cohabitating golden hamsters in captivity will result in aggressive behaviour including death (Spruce pets). Field studies found that burrows were only occupied by a single animal and occupied burrows were at least 118 m apart from each other (Gattermann, 2001).

The historical habitat of golden hamsters is described as rocky steppe or brushy slopes, but the species are now strongly linked to agricultural lands with a preference for specific crops. Golden hamsters are prolific hoarders of grains, which has resulted in government coordinated poisoning programs in cropping areas at the end of winter (Gattermann, 2001).

Ironically this strong link to cropping areas has led to decreases in the wild golden hamster population through poisoning and human encroachment to the point where the species is now defined as endangered under the IUCN. The wild range of the species is shrinking and there are no firm estimates of the wild population. The species is not

migratory, nor has it been recorded as establishing wild populations in any other country despite being widely distributed around the world as part of both the pet industry and as a research animal.

Golden hamsters are hoarders, collecting food and storing it for less plentiful times or in a case of females for late pregnancy and lactation when they are less mobile. They mainly consume grains but will take insects and weeds, barley, chickpeas, lentils, and fruits and vegetables such as melon, tomato, cucumber and hibiscus (Gattermann, 2001). The species is mainly found in arable fields with annual crops such as wheat, barley, chickpeas, lentils, and vegetables (Yigit & Kryštufek, 2008).

Breeding

The golden hamster is currently listed on Part 2 of the Live Import List with the conditions, '*eligible non-commercial purposes only, excluding household pets. Castrated males only*'. The reasoning for the listing conditions is unknown. The species has a high fecundity rate and one of the shortest generation times of any mammal, this may have resulted in the listing conditions to prevent a new potentially invasive species establishing Australia.

Golden hamsters have a four-day oestrous cycle and the shortest gestation period of any placental mammal of 16 days (Hirose & Ogura 2018). Their reproductive cycle is photoperiod sensitive, with golden hamsters ceasing reproductive activities when daylength is less than 12.5 h (Darrow 1980). The female golden hamsters are reproductive maturity when the average body weight is 90–100 g (Chanut and Williams 2016) with their first litter occurring from 59 days old with an average age of first litter being about 74 days (Bond 1945). The nutritional state of the female influences the timing of puberty (Darrow 1980) and in food restricted females the gestation period may extend to 19 days (Labov 1986).

Male golden hamsters are sexually mature by six weeks of age and can successfully breed until over two years old (Bond 1945). Daylength can alter the reproductive development of males, with males born in periods of shorter day lengths maturing more slowly than animals born under longer day lengths (Darrow 1980). Female golden hamsters in close proximately have been shown to desynchronise their oestrous cycles, thus allowing breeding to occur over a wider period than in synchronised females where breeding occurs in peaks and troughs (Gattermann, 2002).

Mean litter sizes is about seven animals, ranging from two to fifteen pups (Bond 1945) with numbers increasing until the third litter and then decreasing after the fifth litter (Huck, 1988). Females can have between six and twelve litters over their lifetime, but the number of pups weaned decreases from the sixth litter with no pups being weaned from the ninth litter (Huck 1988). Females can become pregnant within 24 hours of parturition.

Golden hamsters appear to obey the Trivers–Willard hypothesis where mothers in good condition will bias investment towards sons and towards weaning more females when in poorer condition (Trivers and Willard 1973). Sex rations in early litters are equal but tend towards more females in latter litters (Labov 1986). This change is due to a combination of reabsorption of male foetuses early in pregnancy and increased maternal investment to female young. In nutritionally limited females there is also a bias towards weaning more females (Labov, 1986). This changing of the sex rations appears in response to a dominance hierarchy for breeding, with subordinate females producing smaller litters and less males than dominant females (Pratt, 1989).

Litter size is also modified due to cannibalism, with up to 75% of mothers cannibalising some of their litter. This appears to be a normal behaviour allowing the mother to adapt her litter to her specific requirements predominately occurring within a few days of giving birth (Day 1977). In captivity other adults have been recorded as killing newly born pups (Bond 1945).

The golden hamster theoretically has an enormous reproductive potential with females being able to produce a litter a month under laboratory conditions and young becoming sexually mature by two months of age. Even under perfect breeding conditions the fecundity or the number of viable pups borne per female, is probably lower than first impressions. Females do not breed past their first year and males after their second year (Bond, 1945). This may have led to the current listing condition that only castrated males may be imported and then only for non-commercial purposes.

In the wild golden hamsters are constrained by daylength and food with evidence showing impacts on both sexes from daylength (Darrow 1980) and nutritional levels (Labov, 1986). Although the literature is lacking, it is probable that wild golden hamsters only breed over late spring to summer when food is abundant and the daylength is above 12.5 hr. Laboratory studies show females fertility decreases after 5 litters which probably corresponds to the breeding season. In limited field studies pregnant females or young were only detected in February and March which corresponds to the end of the golden hamster's hibernation period between November and February (Gattermann, 2001).

The litter numbers are all based on number born not number weaned. Research shows most litters are impacted by cannibalism and as females get older their weaning rates drop (Day, 1977). This means in later litters the number of pups and the weaning rate both decrease (Huck, 1988), this means the fecundity in the wild is probably lower than the lab-based figures suggest.

Stress and antisocial behaviour

The golden hamster is one of the most solitary animals in the wild, with wild animals living independently and both sexes aggressively defending their territory against to other golden hamsters, including mature conspecifics (Fritzche, 2006). In captivity, they

must be house separately to avoid fighting which can lead to injuries and death (Spruce Pets). Single sex animals can be housed together once dominance positions are established via fighting (Fritzche, 2000). Females are more aggressive than males with the female's aggression increasing during pregnancy (Pratt, 1989).

This aggressive behaviour can manifest as dominant and submissive animals within the population, dominant animals tend to be the larger animals and once a male is dominated it remains so even when exposed to a smaller golden hamster (Morrison, 2014) and may last for several months (Paul, 2007). A dominated female will show only a short-term response and returns to defending its territory within 4 days (Huhman, 2003). In captivity dominance can vary in a group of females and is linked to each animal's oestrous cycle meaning female golden hamsters social hierarchies alter with resulting changes in stress hormones in the group (Fritzsche, 2000).

This dominance behaviour influences the litter size and sex ratios of pups born and weaned (Pratt 1989). Dominant females produce larger litters, larger pups and more males than subordinate females (Labov, 1986, Pratt, 1989) and this impact can be induced by short term exposure to a dominant female during pregnancy (Pratt, 1989). Although the impacts of stress on fecundity rates in the wild is unknown it is plausible that there may be some feedback loop between an increasing population of golden hamsters driving down fertility rates due to the stress of more frequent interactions (Pratt, 1989).

Genetic bottle neck

The world population domestic golden hamsters consisting of several million individuals originated from four siblings (three males and one female) caught in 1930 and having lost around 70% of their genetic diversity (Gattermann, 2000). Despite this extreme level of inbreeding the domestic population remains healthy and is only slightly less fertile than wild golden hamsters (Fritzsche, 2006).

This suggests that theoretically golden hamster populations could establish from a very small founding population. However, this has not been demonstrated in the wild. The wild population is estimated at about 30 000 individuals (Neumann, 2007) with numbers greatly fluctuating due to seasonal conditions and may reach 200 000 before crashing again (Gattermann 2000).

The biology and ecology of the golden hamster is complex with most literature based on captive or domesticated populations. It is likely that if golden hamsters were imported for pets or under a Part 1 listing that they have the potential to establish and could cause environmental damage. For this reason, any importation should be limited for specific purposes and under controlled conditions such as can be applied under a Part 2 listing to prevent the species from establishing.

Modifying listing conditions to allow fertile golden hamsters into Australia.
The current Part 2 listing conditions limit importation to castrated males only for non-commercial purposes excluding household pets. The reasons for these conditions being applied are unknown but may be based on concerns about the golden hamster's high reproductive ability.

Golden hamsters are classic r-strategists which can rapidly increase in numbers under favourable environmental conditions (Neumann, 2007). Despite this there is no evidence that the species is abundant in the wild, expanding its native range or has established a feral population. This may be due to the species being highly antisocial with limited dispersal occurring. A rapid increase in the population is likely to result in reduced breeding/pup survival and therefore sustained population increases are not likely. The distribution of the golden hamster has remained stable in the wild and has shrunk in recent times due to anthropogenic factors. Fossil records show the species range to be similar that of the mid to late Pleistocene period (770, 000 to 12,000 years ago) (Neumann, 2007).

If the request to vary the listing conditions are approved this will result in female golden hamsters being allowed to be imported for research purposes only. Establishing a breeding population of golden hamsters in a research facility should not alter the risk rating of the species to the point where the species poses a threat to the Australian environment. All breeding would occur under controlled conditions and the likelihood of animals escaping is very low.

Predation

Evidence suggests that predators strongly influence the feeding and above ground behaviours. It is known that in their native environment golden hamsters are preyed on by a range of species resulting in antipredator strategies being applied by golden hamsters.

In their native range the timing of golden hamsters' activity periods is predominantly during daylight hours which varies dramatically to the nocturnal activity cycles observed in the laboratory and in outdoor enclosures (Gattermann, 2008), possibly indicating high pressure from predators at night

Wild female golden hamsters make up to 10 foraging trips per day. The average length of each trip was 5 min 34 s with 14% of this time (43 s) spent in pre-foraging vigilance behaviour. Vigilance is defined as the animal either having only their head above ground or sitting motionless within half a meter of the burrow, not actively gathering food (Larimer 2001). Peak foraging behaviour is between 0600–0800 and 1600–1930 suggesting an adaption to high predator nocturnal pressure (Larimer, 2001) with individual animals showing a preference for morning or afternoon foraging (Gattermann,

2008). Above ground activity ceased in the middle of the day (10.00–16.00) or after 20.00 hours (Gattermann, 2008).

In the wild golden hamsters are predated on by raptors, storks, owls, foxes, snakes, cats, and dogs (Larimer, 2001). Owls appear to the main nocturnal predator and dogs the main daytime predator. Given the presence of these types of predators in Australia, it is likely that any golden hamsters that did escape would be subject to a range of predators, which may limit their ability to establish.

Environmental and agricultural Impacts

There is no evidence that golden hamsters are an environmental problem in their native range and have not established populations elsewhere. They are listed as a serious pest in Syria in leguminous crops and are heavily targeted by farmers in late winter (Gattermann 2001). Although the baiting campaigns are government sponsored the area impacted only covers about 8 percent of Syria (Gattermann, 2001).

The reported agricultural impacts may also be an artifact of the golden hamster's natural range being heavily urbanised with typical refuge areas like barren ground, hedges or bushes disappearing (Neumann, 2007). The species close association with crops—while related to an abundance of food—provides cover and denning requirements and therefore may overstate the impacts or perceived numbers of golden hamsters in crops. They are locally abundant near some crops but at low density on a landscape scale.

Reason for changing listing conditions

As golden hamsters display clinical signs and can transmit the Severe Acute Respiratory Coronavirus 2 (SARS CoV2), virus like humans, they are a crucial component to SARS-CoV-2 research (Chan, 2020) and for modelling immune responses to the virus (Rogers 2020). The CSIRO Australian Centre for Disease Preparedness (ACDP) would like to import intact male and female golden hamsters to avoid any gender biases associated with the sole use of male or castrated golden hamsters in disease research.

There are gender differences to COVID infection and pathogenicity reported in both humans (Moradi, 2020) and in golden hamsters (Yuan, 2021, Dhakal et al (2021). An animal model displaying these differences in morbidity and mortality between males and females would allow researchers to better understand differences in the mechanisms of COVID-19 infections and the immune response and clearance of the virus.

At the moment, only castrated male golden hamsters can be imported; the CSIRO would like this condition amended to allow females to be imported as well. It is known that castration leads to changes in estrogen levels in males (Hume, 2005) and that estrogen has a role in immune responses to infections (Oertelt-Prigione, 2012). It has been reported that estrogen may play a role in protecting women from COVID and that

the increase in COVID pathogenicity observed in menopausal women may be due to a drop in estrogen levels (Pirhadi, 2021).

It is therefore plausible that using castrated male golden hamsters as a model may not truly reflect the disease resulting in a different aetiology to that seen in intact golden hamsters of either sex.

CSIRO has proposed as a concession to listing both sexes to tighten the current listing condition from *Eligible non- commercial purpose only, excluding household pets* to *Research purposes only. Secure facilities.*

This would limit where the golden hamsters could be imported to and for what purposes they can be possessed in Australia. The Department considers that the research and secure facilities amendment would offset any potential risk by allowing intact golden hamsters to be imported.

Listing as research purposes only would also allow CSIRO to establish a breeding colony to supply animals for their research. This would fall under the normal research or Approved Arrangement requirements and would minimise the number of animals being imported for experiments. The department does not consider that allowing controlled breeding for research purposes would increase the risk of the golden hamsters establishing or having any environmental impacts.

Although the species is illegal to import and therefore possess, there are limited numbers of golden hamsters in the Australian pet community. There is no evidence of these animals escaping or establishing in Australia.

Bomford Risk Assessment Model

The department used the Australian Bird and Mammal Risk Assessment Model developed by Mary Bomford (2008) to assess the risks posed by the importation of the golden hamster (**Appendix A**). The results indicate that the species has:

- a low risk of establishing a wild population in the Australian environment if released.
- a moderate risk of becoming a pest if it were to establish.
- poses no danger to the public from either captive or released individuals.
- a theoretical Environment and Invasive Committee (formerly Vertebrate Pest Committee) threat category of **moderate** (using Australian Bird and Mammal Risk Assessment Model and Table 2.3 in Bomford, 2008).

The climate match, comparing the native range of the species to Australian climates using Climatch software, indicates that the golden hamster has a very low climate match to Australia **(Appendix B**). This species has a highest Climatch class of ‘6’ (out of 10) and no matches in the highest 4 classes, indicating that most of Australia is

climatically dissimilar to their natural habitat. As there are no weather stations in the species native range a larger range was selected to give some rigour to the predicted range. Therefore, the selected range was increased to include the 12 stations surrounding the native range of the golden hamster. This increased the golden hamsters known native range of between 10 000 to 15 000 km^2 to almost 238 000 km^2.

Increasing the range used in the Climatch model resulted in a Climatch total of 107/19236 which equates to a score of 1 (< 691). For the purposes of the Bomford model the Climatch score of 2 was used. This provides a worst-case scenario for the predicted range and the model due to the limited native range for the species. it is also consistent with the model rule where if insufficient weather stations are located within the native range that the Climatch score is increased by 1 to allow for any bias caused by the lack of data points.

Comments from consultation rounds

The golden hamster is listed on Part 2 of the Live Import List, CSIRO has requested that the species stays on Part 2, but the conditions are varied to allow both sexes into a high security facility for the purposes of research. As such the public consultation requirements under section 303EF of the EPBC Act do not apply as the species is not being added rather its listing conditions are amended.

The department will circulate the Departments draft report to all states and territories for comment and will consider any comments in finalising this report before providing it to the Minister for their decision to vary the listing conditions for the golden hamster.

Conclusion

In considering the request to revise the listing conditions for the golden hamster in Part 2 of the Live Import List the Department has undertaken a risk analysis based on the proposed new conditions and reviewed the available information on the species.

The biology and ecology of the golden hamster suggest that they pose a low probability of establishing a wild population if released and that conditioning fertile hamsters of both sexes to research facilities should not increase this risk.

The department recommends that the listing conditions for the Golden Hamster on Part 2 of the Live Import List be varied to: ***Research only. High security facilities only.***

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Websites:

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Attachment 1: Bomford Model

Australian Government
Department of Agriculture, Water and the Environment

Australian Bird and Mammal Risk Assessment Model

Species identification and sources	Golden Hamster
Common name	Golden Hamster
Scientific name	*Mesocricetus auratus*
Date assessed	14-Apr-21
Literature Search Type And Date:	Literature, IUCN, CITES

Risks posed by captive or released individuals	Value	Comment
A1. Risk to people from individual escapees (0–2)	0	unlikely to attack even when cornered, any injuries unlikley to require hospitalisation
A2. Risk to public safety from individual captive animals (0–2)	0	nil risk
A. Risk posed by captive or released individuals (= Sum of A 1 to 2).	**0**	**not dangerous**

Risk of establishment	Value	Comment
B1. Climate Match Score (1–6)	2	limited native range means score has been increased by 1 to compensated for limited imput range. Sum 6 score was 107.
B2. Exotic Population Established Overseas Score (0–4)	0	no exotic populations has ever been recorded
B3. Overseas Range Size Score (0–2)	0	10 000 -15 000 Km^2
B4. Taxonomic Class Score (0–1)	1	mammal
B5. Diet Score (0–1)	1	mostly grains, some fruits and vegetables
B6. Habitat Score (0–1)	1	mostly found near crops.
B7. Migratory Score (0–1)	1	non migratory
Model	2	
B. Risk of Establishment (Model 1 = Sum of B1 to B4; Model 2 = Sum of B1 to B7).	**6**	**Low**

Risk of becoming a pest	Value	Comment
C1. Taxonomic group (0–4)	2	Order Rodentia
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2)	0	less than 10 million km^2
C3. Diet and feeding (0–3)	3	mammalian herbivore
C4. Competition with native fauna for tree hollows (0–2)	0	does not use tree hollows
C5. Overseas environmental pest status (0–3)	0	never reported as an environmental pest
C6. Climate match to areas with susceptible native species or communities (0–5)	1	no grid squares in highest 4 climate match classes but some in the highest 6 classes
C7. Overseas primary production pest status (0–3)	2	Considered a significant pest in Syria. But only occupy a small area and populations are decreasing.
C8. Climate match to susceptible primary production (0–5) **Hint: Use the "commodity" sheet created when a CLIMATCH grid is opened.**	3	commodity score = 54
C9. Spread disease (1–2)	2	mammal
C10. Harm to property (0–3)	0	no damage
C11. Harm to people (0–5)	1	very low risk
C. Pest Risk Score (= Sum of C 1 to 11).	**14**	**Moderate**

Summary	Value	
A. Risk to public safety posed by captive or released individuals	**0**	**not dangerous**
B. Risk of establishing a wild population	**6**	**Low**
C. Risk of becoming a pest following establishment	**14**	**Moderate**

EIC Threat Category : **Moderate**

Disclaimer This risk assessment does not account for everything that is likely to affect to the risk of establishment. It should be interpreted in the light of any other information you may have.

Attachment B: Climatch for Golden Hamster