

Australian Capital Territory

Nature Conservation (Unnatural fragmentation of habitats) Conservation Advice 2019

Notifiable instrument NI2019–833

made under the

Nature Conservation Act 2014, s 90C (Conservation advice)

1 Name of instrument

This instrument is the *Nature Conservation (Unnatural fragmentation of habitats) Conservation Advice 2019*.

2 Commencement

This instrument commences on the day after its notification day.

3 Conservation advice for the Unnatural fragmentation of habitats

Schedule 1 sets out the conservation advice for the Unnatural fragmentation of habitats.

Arthur Georges
Chair, Scientific Committee
17 December 2019

Schedule 1

(see s 3)



ACT
Government

Environment, Planning and
Sustainable Development



CONSERVATION ADVICE

UNNATURAL FRAGMENTATION OF HABITATS

ELIGIBILITY

The Scientific Committee has determined that the threatening process *Unnatural fragmentation of habitats* is eligible to be listed on the Key Threatening Processes List as it meets the following criterion.

Criterion C The threatening process adversely affects two or more listed threatened species (other than the national category of conservation dependent species and the regional category of provisional) or two or more listed threatened ecological communities.

This criterion refers to species or ecological communities which are currently listed under the *Nature Conservation Act 2014* (NC Act). In order to be adversely affecting a species or ecological community, the threatening process must currently occur where the species or ecological community occurs, and there must be evidence of a current effect.

Adverse effects can include: mortality; injury; spread of disease; disturbance to breeding, feeding, roosting habits, movements or dispersal; habitat alteration; or habitat destruction. The extent of impact which can be considered to be an adverse effect depends on the attributes of the population, ecological characteristics and category in which the species/ecological community is listed. The impacts of the *unnatural fragmentation of habitats* on two threatened species are outlined below:

Endangered Grassland earless dragon (*Tympanocryptis lineata¹)**

The re-naming of *T. pinguicoides* to *T. lineata* has important implications here as the species formerly referred to as *T. pinguicola* is now recognised to consist of several separate species. *T. lineata* is found only in the Australian Capital Territory and adjacent New South Wales at Jerrabomberra. The restricted distribution and smaller population size may lead to

¹ This name was (re)assigned by Melville et al. (2019) and accepted by the Australian Faunal Directory in July 2019. Formerly, and in most of the references cited herein, it is referred to as *T. pinguicola*. At the time of writing, the ACT threatened species listing still refers to *T. pinguicola*.

its threatened status being increased, and the responsibility for securing the species will rest almost entirely with the ACT.

The Grassland Earless Dragon has been the subject of considerable research effort since its re-discovery in 1991 after not being recorded in the area for 30 years (Osborne et al. 1993). Surveys have been undertaken across the ACT in apparently suitable habitat across the ACT. Prior to European settlement there was probably continuous grassland across the region from Dickson to Majura and Queanbeyan to Yarralumla, dissected by the Molonglo River (Hoehn et al. 2013). Within such extensive grassland, fluctuations in population numbers caused by extreme localised events, would have been ameliorated by immigration from nearby populations (Hoehn et al. 2013).

This is no longer the case due to the extensive fragmentation of the grasslands. The Grassland Earless Dragon is now considered to be restricted to the area from Majura to Jerrabomberra. Within that small area the habitat is severely fragmented, and this is reflected in the dragon's genetics. Over relatively small distances (1-2km) there is clear population structure evident in microsatellite (Hoehn et al. 2013, Carlson et al. 2016) and genomic (SNP) DNA (Melville et al. 2019). Populations at Majura, Jerrabomberra West and a cluster of populations at Jerrabomberra East, Bonshaw and Queanbeyan Nature Reserve can be readily separated genetically (Hoehn et al. 2013). Even the eastern cluster of populations show genetic separation with the only evidence of genetic exchange being only two immigrants from Bonshaw to Jerrabomberra East (1.6km distant across agricultural land) and one from Queanbeyan to Jerrabomberra East (300m across a railway line)(Hoehn et al. 2013), indicating limited dispersal ability and a particular susceptibility to unnatural habitat fragmentation.

Fragmentation of habitat leaves separated populations smaller and more isolated, and thus more vulnerable to stochastic events and less amenable to the rescue effect of immigration. This appears to be playing out for the Grassland Earless Dragon. The largest population, at Jerrabomberra West, suffered a decline of approximately 88% between 2006 and 2007 and has not recovered, while three populations appear to have been extirpated (Dimond et al. 2012). Overall, an ongoing regional decline is expected for this species (Dimond et al. 2012). Unnatural fragmentation, from original grassland clearing and ongoing infrastructure development, is a key contributor to the lack of resilience in these small populations.

Endangered Macquarie Perch (*Macquaria australasica*)

Stream habitats are a particular case of an environment vulnerable to fragmentation because they are linear, such that a single barrier can be sufficient to fragment a population. Common unnatural barriers that may prevent movement of fish include dams, weirs and road crossings. Within the ACT Macquarie Perch has been impacted by Cotter, Bendora and Scrivener Dams, the weir at Casuarina Sands and road crossings such as Vanitys Crossing, Point Hut Crossing and Angle Crossing.

The historical distribution of Macquarie Perch included all major river systems in the south-eastern part of the Murray-Darling Basin (Lintermans 2007). The species was widespread and abundant, but is now restricted to a small subset of its former range. The population within the Murrumbidgee River in the ACT crashed in the mid-1980s (Lintermans 2002) and an isolated population upstream of Googong Dam on the Queanbeyan River appears to

have been extirpated during the Millennium Drought (Lintermans 2013). Within the ACT, occasional individuals are caught within the Murrumbidgee and lower Cotter Rivers, but the only viable population of Macquarie Perch is found in the stretch of the Cotter River from Cotter Dam to Bendora Dam (ACT Government 2018).

The Vanitys Crossing causeway demonstrates the effect of fragmentation on a fish species. Lintermans (2002), describing the distribution of Macquarie Perch in the Cotter River noted that “the species is restricted to the lower section of the river from its junction with the Murrumbidgee up to Vanitys Crossing”. He added that “Anecdotal reports indicate that the species did occur further upstream on the Cotter but has now disappeared from this area and appears unable to pass the high concrete causeway built at Vanitys Crossing in the late 1970s.”

In 2001, a fishway was installed at the crossing, designed specifically for Macquarie Perch (Ebner and Lintermans 2007). It has allowed a significant expansion in the species’ range in the lower Cotter River with both adults and juveniles found above the crossing (Broadhurst et al. 2012, 2013). Macquarie Perch is now established up to 7.7 km above the crossing (to Pipeline Crossing) and recorded as far as Burkes Creek Crossing (approximately 3.9 km further upstream)(ACT Government 2018). Another fishway specifically designed for Macquarie Perch was constructed at Pipeline Crossing in 2011 by ACTEW Water.

Despite these improvements, further fragmentation of the population may at times still be a problem. The flow of the Cotter River downstream of Bendora Dam is significantly reduced as water is captured and piped to Canberra for domestic water supply. As a result of these low flows, natural in-stream barriers that would have drowned out in winter and spring now present movement barriers that block upstream spawning migrations by Macquarie Perch (Broadhurst et al. 2016). This can be ameliorated either by the construction of further fishways, modification of barriers, or more sensibly, the release of environmental flows from Bendora Dam to drown-out the barriers.

The Cotter River population of Macquarie Perch remains fragmented and isolated as there is no connection with downstream populations in the Murrumbidgee River or ability to colonise habitats upstream beyond Bendora Dam. The population is likely small in number and restricted in spatial extent and thus vulnerable to stochastic events. It has also been demonstrated that the population is vulnerable to inbreeding due to its small size and isolation (Farrington et al. 2014; Pavlova et al. 2017). Attempts to expand the distribution of Macquarie Perch within the Cotter catchment have been ongoing since 2006 with annual translocations of fish from Cotter Dam to the upper Cotter River upstream of Corin Dam (Lintermans 2017). To date, this has not resulted in successful establishment.

In response to the isolation of the existing Cotter population, a genetic rescue project has commenced, bringing individuals from Cataract Dam and releasing them into the Cotter River between Bendora and Cotter dams. Thirty-two individuals were transferred in 2017 and 28 in 2018 (Environment, Planning and Sustainable Development Directorate 2017, 2018). Cataract Dam contains a Macquarie Perch population derived from fish originally translocated from the Murray-Darling Basin and is significantly more genetically diverse than the Cotter River population (Pavlova et al. 2017).

DESCRIPTION AND ECOLOGY

Definition

This advice identifies as a Key Threatening Process *any unnatural fragmentation of habitat that disrupts biological processes/biological organisation and significantly increases the likelihood of extinction of flora and fauna beyond that due to natural processes.*

As a threatening process, unnatural fragmentation applies, at different scales, to flora, fauna and ecological communities; terrestrial and aquatic species and habitats; suburban and rural areas; and reserves. It implies a loss of ecological connectivity.

The research and management literature on this subject is very extensive. General texts providing an Australian perspective include Burgman and Lindenmayer (1998), New (2000), Lindenmayer and Fischer (2006), Lintermans (2013) and Fraser et al. (2014). Research overviews of the subject can be found in MacLeod (2002), Fahrig (2003), Ries et al. (2004), Tschardt et al. (2012), Amos et al. (2014) and elsewhere, and the references included therein.

Key concepts:

- Habitat fragmentation is an umbrella term describing the complete process by which habitat loss or artificial barriers result in the division of large, continuous habitats into a greater number of smaller patches of lower total area, isolated from each other by a matrix of dissimilar habitats and is not just the pattern of spatial arrangement of remaining habitat (Didham 2010). Lindenmayer and Fischer (2006) and others argue that there can be dangers in such sweeping terms because they obscure the identification of multiple underlying processes. They suggest that the way forward is to focus on the component causes of fragmentation.
- Habitat loss and habitat fragmentation are not independent drivers of ecological change – habitat loss acts via the change in habitat arrangement, not independently of it (Didham 2010).

Impacts

The process of Unnatural habitat fragmentation includes:

- reduction in the total area of the habitat
- decrease of the interior/edge ratio, with concomitant increase in edge effects
 - Species that are habitat specialists may avoid areas close to the edge of patches because of greater exposure to, for example, different temperatures, light or wind.
 - Patches that are circular have lower edge effects relative to narrow or convoluted shapes.
- isolation of one habitat fragment from other areas of the habitat
- breaking up of one patch of habitat into several smaller patches
- decrease in the average size of each patch of habitat
- differential removal of particular sub-habitats.

These processes may lead to a general reduction in the resilience of the system through the consequences of isolation, reduction in population size and the increasing effects of external influences. For example:

- loss of individuals from the fragments, and in extreme cases species
- reduced chances of recolonisation
- loss of genetic diversity through genetic drift and panmictic (random mating) limitation
- increased mortality due to climate modification, e.g. temperature or wind regimes
- increased predation, e.g. from introduced animals
- increased competition e.g. from weeds and 'overabundant' native species
- reduced possibilities for dispersal (e.g. of young of the year)
- reduced possibilities for movement (e.g. for movements between feeding, breeding and refuge areas)
- reduced possibilities for reproduction
- reduced possibilities for feeding/foraging
- reduced resilience to extreme climatic events
- increased exposure to pathogens and diseases
- increased likelihood of an extinction debt (time-delayed loss)
- edge effects.

CAUSES

Unnatural fragmentation can be the direct or indirect consequence of, often interactive, impacts from anthropogenic factors such as:

- inappropriate fire regimes
- overgrazing (by feral animals, livestock or 'overabundant' native species)
- undergrazing (through loss or exclusion of natural grazers)
- weed, pest animal and pathogen invasion
- urban development
- establishing inappropriate vegetation
- clearing
- inappropriate application of pesticides and herbicides
- unnatural disturbance or compacting of soil
- changes to water flows/hydrology
- lowered water quality (e.g. effluent discharge poses a chemical barrier discouraging movement through affected areas)
- climate change
- monoculture development such as plantations
- physical barriers to movement, e.g. vegetation removal, roads, weirs, and poorly placed urban parks
- removal of ground cover, including rocks, logs and leaf litter
- smothering of aquatic habitat through sedimentation and sand slugs

In the ACT, one or more of these processes and activities have been identified as causing reduction and fragmentation of woodlands (ACT Government 2019), grasslands (ACT Government 2017) and riparian zones and aquatic habitats (ACT Government 2018). Habitat loss and fragmentation are considered to be threats to almost every species and ecological community currently listed as threatened in the ACT under the *Nature Conservation ACT 2014* (Table 1).

Table 1. Species and Ecological Communities listed as threatened within the ACT or nationally in which fragmentation is invoked as a threat in either the listing advice, conservation advice or recovery plan.

Common name	Scientific name	ACT status	EPBC
Canberra Spider Orchid	<i>Caladenia actensis</i>	CR	CR
Kiandra Greenhood	<i>Pterostylis oreophila</i>	CR	CR
Northern Corroboree Frog	<i>Pseudophryne pengilleyi</i>	CR	CR
Regent Honeyeater	<i>Anthochaera phrygia</i>	CR	CR
Swift Parrot	<i>Lathamus discolor</i>	CR	CR
Yellow-spotted Bell Frog	<i>Litoria castanea</i>	CR	CR
Golden Sun Moth	<i>Synemon plana</i>	EN	CR
Silver Perch	<i>Bidyanus bidyanus</i>	EN	CR
Australian Painted Snipe	<i>Rostratula australis</i>	EN	EN
Baeuerlen's Gentian	<i>Gentiana baeuerlenii</i>	EN	EN
Button Wrinklewort	<i>Rutidosia leptorrynchoides</i>	EN	EN
Grassland Earless Dragon	<i>Tympanocryptis pinguicolla</i>	EN	EN
Macquarie Perch	<i>Macquaria australasica</i>	EN	EN
Small Purple Pea	<i>Swainsona recta</i>	EN	EN
Smoky Mouse	<i>Pseudomys fumeus</i>	EN	EN
Southern Brown Bandicoot	<i>Isoodon obesulus obesulus</i>	EN	EN
Tarengo Leek Orchid	<i>Prasophyllum petilum</i>	EN	EN
Trout Cod	<i>Maccullochella macquariensis</i>	EN	EN
Tuggeranong Lignum	<i>Muehlenbeckia tuggeranong</i>	EN	EN
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>	EN	VU
Ginninderra Peppercress	<i>Lepidium ginninderrense</i>	EN	VU
Murrumbidgee Bossiaea	<i>Bossiaea grayi</i>	EN	NL
Black Gum	<i>Eucalyptus aggregata</i>	VU	VU
Broad-toothed Rat	<i>Mastacomys fuscus mordicus</i>	VU	VU
Greater Glider	<i>Petauroides volans</i>	VU	VU
Green and Golden Bell Frog	<i>Litoria aurea</i>	VU	VU
Southern Bell Frog	<i>Litoria raniformis</i>	VU	VU
Koala	<i>Phascolarctos cinereus</i>	VU	VU
New Holland Mouse	<i>Pseudomys novaehollandiae</i>	VU	VU
Painted Honeyeater	<i>Grantiella picta</i>	VU	VU
Pale Pomaderris	<i>Pomaderris pallida</i>	VU	VU
Pink-tailed Worm-lizard	<i>Aprasia parapulchella</i>	VU	VU
Striped Legless Lizard	<i>Delma impa</i>	VU	VU
Superb Parrot	<i>Polytelis swainsonii</i>	VU	VU

Common name	Scientific name	ACT status	EPBC
Brown Treecreeper	<i>Climacteris picumnus</i>	VU	NL
Glossy Black-cockatoo	<i>Calyptorhynchus lathami</i>	VU	NL
Hooded Robin	<i>Melanodryas cucullata</i>	VU	NL
Little Eagle	<i>Hieraaetus morphnoides</i>	VU	NL
Murray River Crayfish	<i>Euastacus armatus</i>	VU	NL
Perunga Grasshopper	<i>Perunga ochracea</i>	VU	NL
Scarlet Robin	<i>Petroica boodang</i>	VU	NL
Two-spined Blackfish	<i>Gadopsis bispinosus</i>	VU	NL
Varied Sittella	<i>Daphoenositta chrysoptera</i>	VU	NL
White-winged Triller	<i>Lalage tricolor</i>	VU	NL
Eastern Bettong	<i>Bettongia gaimardi</i>	R-CD	NL
Natural Temperate Grassland		EN	CR
Yellow Box/Red Gum Grassy Woodland		EN	CR

* National status refers to the category on the threatened species list under the *Environment Protection and Biodiversity Conservation Act (1999) (EPBC)*.

CR = Critically Endangered

EN = Endangered

VU = Vulnerable

R-CD = Regionally Conservation Dependent

NL = Not Listed

CURRENT PROTECTION AND MANAGEMENT IN THE ACT

Legislative and other provisions

The *Nature Conservation Act 2014* notes that its main objective of conserving biodiversity is to be achieved in part by protecting, conserving, enhancing, restoring and improving ecological connectivity. The Act requires the development, and implementation by the Conservator of Flora and Fauna (the Conservator), of a Nature Conservation Strategy which must consider, amongst other factors, restoration of habitats and landscape connectivity.

The *Nature Conservation Act 2014* contains a range of provisions to protect the habitat of native plants and animals and threatened ecological communities with more severe penalties for more serious damage. In particular it interacts with the *Planning and Development Act 2007* via the Conservator's role in land development applications.

If the planning and land authority is to decide the development application, development approval must not be given unless the development proposal is consistent with the Conservator's advice. The Conservator must consider the impacts on threatened species and ecological communities, the offsets policy and any other guideline, plan or policy relating to protected matters. As noted in Table 1 (above), the majority of listing advices, conservation advices, actions plans and/or recovery plans for threatened species and ecological communities in the ACT invoke fragmentation as a threat and thus many will contain guidance on avoiding or ameliorating the effects of fragmentation.

However, if the Minister is to decide the development application (using the Minister's call-in power), the development approval may be inconsistent with the Conservator's advice if the Minister is satisfied that the approval is consistent with the offsets policy. Offsets policy

requires that habitat connectivity be considered in evaluating offsets but provides little specific guidance.

MAJOR CONSERVATION OBJECTIVE

The priority management objective is to prevent further fragmentation and, where feasible, to improve connectivity between habitat fragments within the Australian Capital Territory.

CONSERVATION ISSUES

As described above, unnatural fragmentation applies, at different scales, to flora, fauna and ecological communities; terrestrial and aquatic species and habitats; suburban and rural areas; and reserves. It is not possible here to provide a comprehensive set of actions (these will be developed subsequently in an Action Plan for the KTP).

Below are a set of principles to guide thinking about avoidance and amelioration of fragmentation. Where readers are considering activities that may impact on identified species or communities, they should ensure that they also consider the appropriate conservation advice, action plan and/or recovery plan for those species or communities.

Principles to address fragmentation

1. **Avoidance** – It is far preferable to avoid fragmentation than to attempt to ameliorate it or recreate connectivity after a development. Where possible fragmentation should be avoided by considering re-locating or re-positioning any activity. If that cannot be done, then original habitat should be retained within the development footprint to the greatest extent possible, adhering to the principles listed below.
2. **Shape and edge effects** – Ensure that terrestrial habitat patches are approximately circular in shape, while avoiding the creation of patches that are narrow and linear or have a convoluted outline. Many species exhibit avoidance of the edges of a habitat. This might be related to a wide range of factors, such as exposure to higher temperatures, more light or noise or the risk of predation. It is best to minimize the amount of edge habitat relative to interior habitat.
3. **Scale** – Bigger is better. Avoid creating patches that are small. These will support fewer individuals of the species of interest and thus the population of that patch will be less resilient to other impacts.
4. **Proximity** – Minimize the distance between patches created. This may allow mobile individuals to move between patches, such that individuals lost to impacts on one patch may be replaced by immigration from a neighbouring patch. This increases resilience across all patches that are linked.
5. **Restoration** – Habitat loss need not be permanent. In areas that will be disturbed during the activity but not permanently alienated, avoid disturbing soil and long-lived features (e.g. large mature trees) and plan to re-instate previous topography, vegetation etc.

6. **Reconnection** – Ideally any patches created by the activity should be re-connected via the restoration of habitat (above) but where this is not feasible, patches can occasionally be reconnected via design features tailored to the species of concern. There are a multitude of methods available to ameliorate barriers and improve connectivity (faunal overpasses/underpasses, rope bridges, fishways, habitat rehabilitation, etc.). It is important that the method is appropriate to the species of concern. This may require multiple methods to be used. For example, connectivity for some birds may be re-established by the planting of trees tens of metres apart, while ground dwelling mammals may require continuous, low vegetation or road underpasses to bridge the same gap.
7. **Plants are affected by fragmentation too** – Plants can be susceptible to edge effects and may also need to “move” via the dispersal of seeds and pollen. For example, dams may prevent downstream dispersal of water borne seeds (hydrochory) and this is reflected in different riparian plant communities downstream of dams in comparison to free-flowing rivers (Merritt and Wohl 2006, Merritt et al. 2010). It is important to consider the full range of flora and fauna that might be affected by an activity and to evaluate the potential for fragmentation separately for each.
8. **Barriers may be subtle** – The factors that prevent movement may not be readily apparent to the human eye. The nature of a barrier depends on a range of factors such as the method of dispersal and the size and physiology of the organism. For example:
 - a. A small terrestrial reptile may be unable to cross only a metre or so of open space for fear of predation.
 - b. A gliding possum (Sugar Glider, Greater Glider) may be able to cross relatively wide barriers (open space), but this is dependent on the height of trees either side of the barrier.
 - c. A change in water temperature may be a barrier to fish movement.
9. **Adaptive management** – The effectiveness of any given method to improve (or maintain) connectivity is likely to be context dependent. It is important to apply an adaptive management approach, collecting data on how a method is utilized by the target species, and modifying the method where necessary to ensure its efficacy.

LISTING BACKGROUND

A nomination of the threatening process *Unnatural fragmentation of habitats* was made the Scientific Committee and was assessed against the eligibility criteria outlined in the [Nature Conservation \(Key Threatening Processes Eligibility\) Criteria 2016 \(DI2016-256\)](#).

Public consultation on the nomination was undertaken 24 April 2018 — 8 June 2018. Four submissions were received and these have been considered in the listing assessment and preparation of this advice.

OTHER RELEVANT ADVICE, PLANS OR PRESCRIPTIONS

For activities where the species or ecological communities likely to be affected have been identified, consult the relevant conservation advice, action plan and/or recovery plan.

Commonwealth

- Land Clearance
<http://www.environment.gov.au/biodiversity/threatened/key-threatening-processes/land-clearance>

New South Wales

- Clearing of Native Vegetation (nominated as “Loss of biodiversity as a result of loss and/or degradation of habitat following clearing and fragmentation of native vegetation”).
<https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/2000-2003/clearing-of-native-vegetation-key-threatening-process-listing>

Victoria

- Alteration to the natural flow regimes of rivers and streams.
https://www.environment.vic.gov.au/_data/assets/pdf_file/0020/32483/Alteration_to_the_natural_flow_regimes_of_rivers_and_streams.pdf
- Alteration to the natural temperature regimes of rivers and stream
https://www.environment.vic.gov.au/_data/assets/pdf_file/0019/32482/Alteration_to_the_natural_temperature_regimes_of_rivers_and_streams.pdf
- Habitat fragmentation as a threatening process for fauna in Victoria.
https://www.environment.vic.gov.au/_data/assets/pdf_file/0012/50241/201612-FFG-Processes-list.pdf

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FURTHER INFORMATION

Further information can be obtained from the Environment, Planning and Sustainable Development Directorate (EPSDD)

Phone: (02) 132281 EPSDD Website: <http://www.environment.act.gov.au/cpr>