

# NSW Threatened Species Scientific Committee

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## Conservation Assessment of *Nitella parooensis* M.T.Casanova & J.L.Porter (family Characeae)

J Scott, 7 November 2018

<sup>1</sup>NSW Threatened Species Scientific Committee

### ***Nitella parooensis* M.T.Casanova & J.L.Porter (family Characeae)**

Distribution: Endemic to NSW

Current EPBC Act Status: unlisted

Current NSW *Biodiversity Conservation Act 2016* (BC Act) status: unlisted

Proposed BC Act status: Critically Endangered

### Conservation Advice: *Nitella parooensis*

### **Summary of Conservation Assessment**

*Nitella parooensis* is found to be eligible for listing as a Critically Endangered species under IUCN B1ab(iii)+2ab(iii). The main reasons for the species being eligible for listing in the Critically Endangered category are that: i) the species has a highly restricted geographic range with EOO and AOO = 8 km<sup>2</sup>; ii) its habitat continues to be threatened by exotic pests and changes to flooding regimes; and iii) it is only known from one location.

### **Description and Taxonomy**

*Nitella parooensis* M.T.Casanova & J.L.Porter (family Characeae) is a short lived annual green alga. The plants are described as “dioecious, scarcely heterocleamous, to 10 cm high, internodes to 3 cm long, c. 0.4 mm wide, sterile branchlets to 3 cm long, unevenly 0–3 × furcate, monopodial or nearly so, in whorls of 5–7 at the axis nodes, with an occasional 0 × furcate accessory branchlet at the base of the whorl. Primary branchlet segments to 40 mm long, ranging from 50 to 100% of total branchlet length. Secondary branchlet segments 2 to 3 mm long. Branchlets have the potential to be 3 or more × furcate, but sometimes the development of segments is suppressed and the terminal segments appear to be pluricellulate (up to 5 cells long including the end cell). Dactyls are essentially bicellulate, to 1.5 mm long. Accessory branchlets where present are 0 × furcate (i.e. dactyls). End cells short, conical and acute, the end of the penultimate cell distinctly narrowed so that the base of the end cell is confluent with it. Fertile parts without mucus, whorls on the female plant somewhat contracted, on the male plant in distinct heads. Fertile branchlets 6 in a whorl, 2 × furcate, oogonia from 0.4 to 0.6 mm long, at first and second branchlet furcations, antheridia terminal, to 400 µm in diameter. Oospores 290–350 µm long × 250–290 µm wide, with 4–5 striae of low flanges, dark to chestnut brown. The shape differs from all other species seen so far, rather than being a flattened sphere, oospores of this species appear twisted. Oospore wall ornamentation is coarsely reticulate, with walls of the reticulum c. 8 µm wide, 3–4 meshes across the fossa. In mature oospores minute, sparse papillae occur on the walls and cavities of the reticulum. Antheridia to 0.4 mm in diameter. Chromosome number not known.” (Casanova & Porter 2013).

*Nitella parooensis* is unique among all species of Characeae in the highly unusual twisted shape of the oospore (Casanova & Porter 2013).

### **Distribution and Abundance**

*Nitella parooensis* is endemic to New South Wales and occurs in claypan wetlands in the Paroo region of northwestern NSW (Casanova & Porter 2013). It is currently known from three sites in Nocoleche Nature Reserve where it occurs in small freshwater temporary wetlands within the

# NSW Threatened Species Scientific Committee

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Paroo River catchment (J. Porter *in litt.* February 2016). The river system has a highly erratic flooding regime, and rainfall is highly variable averaging 276mm per year.

The largest site, Woolshed Swamp (WS) is a temporary lignum swamp on the edge of the Paroo River floodplain that fills after minor flooding from the Paroo River via a distributary creek or from local runoff.

The second site, Cricket Pitch Claypan (CPC) is a very small, shallow temporary wetland adjacent (120m) to the floodplain with a massive (non-cracking) red clay substrate. This wetland fills from local runoff after heavy rain (> 50 mm). Despite its proximity to the floodplain it does not fill from riverine flooding.

The third site, Claypan 17 (C17) is a small, shallow temporary wetland 2.5 km from the floodplain that fills from local runoff after heavy rain and is hydrologically isolated from the Paroo River and its floodplain (J. Porter *in litt.* February 2016).

The geographic distribution of *Nitella parooensis* is very highly restricted. The area of occupancy was estimated to be 8 km<sup>2</sup>, based on the species' occupying two 2 x 2 km grid cells, the spatial scale of assessment recommended by IUCN (2017). The extent of occurrence (EOO) was also 8 km<sup>2</sup>. The EOO is reported as equal to AOO, despite the range of the species, measured by a minimum convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2017). Searches have been undertaken within Nocolche Nature Reserve and outside the reserve in the broader area of northwestern NSW and southern Queensland in the Wanaaring - Tibbooburra - Hungerford areas, but no further occurrences of *N. parooensis* have been located (J. Porter *in litt.* February 2016; Casanova & Porter 2013).

At each known site, *Nitella parooensis* is very uncommon with only scattered individuals seen (J. Porter *in litt.* February 2016). There are no quantitative estimates of numbers of mature individuals as the abundance of *N. parooensis* is difficult to quantify due to the ephemeral nature of the species (J. Porter *in litt.* February 2016).

## Ecology

*Nitella parooensis* is a macroscopic green alga superficially similar to a submerged flowering plant, with flexible stems and whorls of branch like structures that carry the reproductive organs (J. Porter *in litt.* February 2016). It is a short-lived annual. The tiny sexual propagules (oospores) can survive prolonged desiccation remaining dormant in the soil until water is available (J. Porter *in litt.* February 2016). The temporary wetlands where it is found fill infrequently and sporadically, perhaps every 5-7 years. They are shallow (c. 20-30 cm deep) and the water is typically turbid such that, at times, the algae cannot be located visually (Casanova & Porter 2013). While water birds are highly likely to play an important role in dispersal of propagules (J. Porter *in litt.* February 2016; Soons *et al.* 2016), the geographic distribution of the species remains very highly restricted.

The habitat of the three known wetlands where *Nitella parooensis* occurs vary with their distance from the Paroo River. The wetland closest to the river (WS) is on heavy grey cracking clay and is fringed by *Eucalyptus ochrophloia* (Yapunya) and *E. largiflorens* (Black Box) with an understorey of *Duma florulenta* (Lignum) and *Acacia stenophylla* (River Coobah). Herbaceous species can include *Eleocharis plana*, *Marsilea* spp., *Alternanthera denticulata*, *Cyperus gilesii*, *Aponogeton queenslandicus* and *Eragrostis australasicus*. Submerged species include the charophytes *Chara*

# NSW Threatened Species Scientific Committee

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*braunii*, *Nitella sonderi* and *Nitella cristata*. The second site (CPC) is a small temporary shallow wetland adjacent to the floodplain and is on massive red clay substrate with fringing vegetation of tall open shrubland dominated by *Eremophila sturtii*, *Dodonaea angustifolia*, *Senna* spp., and an understorey of chenopods *Osteocarpum* sp., *Chenopodium* sp. and *Scleroleana* sp. The third and most distant wetland (C17) site from the Paroo River, is also on massive red clay with sparse vegetation including *Eragrostis australasicus*, and *Marsilea* sp. (J. Porter *in litt.* February 2016).

## Threats

The wetlands of the Paroo River system are highly vulnerable to alterations to the river flow regime resulting from water resource development upstream and the impacts of climate change. These are threats that affect much of the habitat of the floodplain and are long-term and ongoing. Immediate threats to the three known sites where *Nitella parooensis* occurs are from feral pigs and weed encroachment, which are leading to adverse effects on the species and its habitat at a local level.

## Altered flow regime

The Paroo River currently has a largely natural flow regime as it is one of the only unregulated rivers in the Murry Darling Basin. However, it is influenced by regulated flow activities further upstream and from the Warrego River system in southern Queensland. Water diverted for irrigation reduces the natural flow to river systems downstream, leading to reduced flooding of the wetlands of the Paroo River system. Proposed irrigation and river development projects for the Warrego River in Queensland would alter the flow regimes experienced by *Nitella parooensis* and could be a threat to the species and its habitat, at the site (WS) that is closest to the river. Altered flow regimes are likely to result in changes to flood size, frequency and duration on the floodplain. Changes to the flooding regime may also reduce floristic diversity (Roberts & Ludwig 1991), encourage invasive weed species such as *Phyllanthus nodiflorus* (Lippia) (Stroud 1994), reduce recruitment of floodplain eucalypts (Bacon *et al.* 1993; Walker & Thoms 1993) and eliminate key structural components of the habitat such as River Coobah and Lignum (McCosker & Duggin 1993) (J. Porter *in litt.* February 2016). Less frequent flooding will reduce riverine connectivity and may affect recruitment and dispersal of *N. parooensis*, particularly at the largest known site nearest the river (J. Porter *in litt.* February 2016; Hood & Naiman 2000; Stokes *et al.* 2010). 'Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands' is listed as a Key Threatening Process on the NSW BC Act.

## Climate change

Increased aridity due to climate change may adversely affect *Nitella parooensis* and its habitat. Climate change has the potential to alter rainfall patterns and river flows and reduce habitat availability and persistence (J. Porter *in litt.* February 2016). Predictions show that under a changing climate, mean temperatures in the north west of NSW around Burke are projected to rise by 2.1 °C by the year 2070, with over 40 additional hot days occurring per year by 2070 (OEH 2014). The predicted change in seasonal rainfall patterns for the region containing Nocolleche NR (OEH 2014), with a shift from a relatively aseasonal pattern to one more dominated by rain in summer, is likely to affect the germination and recruitment capacity of the species because evaporation rates are substantially higher in summer. 'Anthropogenic Climate Change' is listed as a Key Threatening Process on the NSW BC Act.

# NSW Threatened Species Scientific Committee

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## Weeds

While currently not present in the wetlands containing *Nitella parooensis*, invasive weeds recorded in similar habitats in Nocolèche Nature Reserve include *Rumex crispus* (Curled Dock), *Heliotropium curassavicum* (Smooth Heliotrope), *Polypogon monspeliensis* (Annual Beardgrass), *Carthamus lanatus* (Saffron Thistle), and *Xanthium occidentale* (Noogoora Burr). These species can compete with native species in wetlands. Noogoora Burr is apparently restricted to a few wetland locations on Nocolèche and may be affecting the survival of native plants through competition. Noogoora Burr proliferates when water is drying up in small depressions and channels (NSW NPWS 2000; Catford *et al.* 2011).

## Feral pigs

There has been evidence of Feral Pigs (*Sus scrofa* Linnaeus 1758) digging the soils in the habitat where *Nitella parooensis* occurs (J. Porter pers. comm. Oct 2017). The disruption to the soil damages the seed banks and increases the likelihood for the spread of weeds through increased nutrients and dispersal of weed seeds. During wet times, Feral Pigs alter the local environment by wallowing and rooting within the wetlands leading to increased turbidity. These changes to the local habitat are likely to cause a decline in populations of *Nitella parooensis* and its displacement by other species. 'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758', is listed as a Key Threatening Process on the NSW BC Act.

A threat-defined location refers to a "geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present" (IUCN 2017). The presence of feral pigs throughout the area where *Nitella parooensis* occurs indicates there is one location for the species.

## **Assessment against IUCN Red List criteria**

For this assessment it is considered that the survey of *Nitella parooensis* has been adequate and there is sufficient scientific evidence to support the listing outcome.

### **Criterion A Population Size reduction**

Assessment Outcome: Data Deficient.

Justification: To be listed as threatened under Criterion A the species must have experienced a population reduction of  $\geq 30\%$  (VU threshold) over three generations or 10 years (whichever is longer). There is a lack of specific data for population reduction to assess *Nitella parooensis* against this criterion.

### **Criterion B Geographic range**

Assessment Outcome: Critically Endangered under B1ab(iii)+2ab(iii).

Justification: *Nitella parooensis* has an extremely restricted geographic range, with a maximum distance between the three known sites of 3.65 km.

Extent of Occurrence: The estimated the extent of occurrence (EOO) for *Nitella parooensis* is 8 km<sup>2</sup>. (EOO is reported as equal to AOO, despite the range of the species measured with minimum convex polygon being less than AOO, to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2017)). To be listed as Critically Endangered under Criterion B1, a species must have an EOO of  $< 100$  km<sup>2</sup>. *Nitella parooensis* meets the EOO threshold for Critically Endangered under Criterion B1.

Area of Occupancy: The area of occupancy (AOO) for *Nitella parooensis* is 8 km<sup>2</sup> (based on the species occupying two 2 km x 2 km cells, the scale of measurement recommended by IUCN 2017).

# NSW Threatened Species Scientific Committee

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To be listed as Critically Endangered under Criterion B2, a species must have an AOO of  $< 10 \text{ km}^2$ . *Nitella parooensis* meets the AOO threshold for Critically Endangered under Criterion B2.

In addition to these thresholds, at least two of three other conditions must be met. These conditions are:

- a) The population or habitat is observed or inferred to be severely fragmented or number of locations = 1 (CR),  $\leq 5$  (EN) or  $\leq 10$  (VU).

Assessment Outcome: Subcriterion met at Critically Endangered threshold.

Justification: *Nitella parooensis* is found at one location. This assessment of number of locations is based on the potential impact on habitat and soil propagule banks from the damage caused by feral pigs, the most serious plausible threat, across the habitat of *Nitella parooensis*.

- b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals

Assessment Outcome: Subcriterion met for (iii) Continuing decline is inferred for quality of habitat.

Justification: Projected and continuing decline is inferred in the habitat quality as the result of damage to propagule banks from pest species (mainly pigs) disturbing the soil, and the spread of invasive weeds including *Xanthium occidentale* (Noogoora Burr) into the habitat. Across a broader area, reduced flooding due to the alteration of river flows may also be a factor contributing to habitat quality decline.

- c) Extreme fluctuations.

Assessment Outcome: Data deficient.

Justification: Currently there is no available data to assess the likelihood of extreme fluctuations in *Nitella parooensis*.

## **Criterion C Small population size and decline**

Assessment Outcome: Data deficient.

Justification: Whilst *Nitella parooensis* has been surveyed in Nocolche Nature Reserve, estimates of the population size are not available. Only scattered individuals were found at each of the three wetlands where it occurred. Opportunistic wetland sampling when the conditions of water availability were right, and the sampling of the soil propagule banks led to the only known records of the species (J. Porter *in litt.* February 2016).

To be listed under Criterion C, a species must have  $< 250$ ,  $< 2500$  or  $< 10\,000$  mature individuals and meet either of two subcriteria. As *Nitella parooensis* is data deficient for the number of mature individuals, the subcriteria are not applicable.

## **Criterion D Very small or restricted population.**

Assessment Outcome: Data deficient under D1, Vulnerable under D2

D1 Justification: D1 is data deficient as there are no estimates available for the number of mature individuals of *Nitella parooensis*.

D2 justification: For a species to qualify for D2, it must have a very restricted area of occupancy (AOO) (typically  $< 20 \text{ km}^2$ ) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and thus be capable of becoming Critically Endangered or even extinct in a very short time period (IUCN 2001).

# NSW Threatened Species Scientific Committee

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Assessment Outcome: D2 is met for Vulnerable.

Justification: With an AOO of 8 km<sup>2</sup>, only one location, and immediate threats due to damage to propagule banks from pest species (mainly pigs) disturbing the soil, the spread of invasive weeds including *Xanthium occidentale* (Noogoora Burr) into the habitat; and the broader threat of reduced flooding due to the alteration of river flows, *Nitella parooensis* meets all the criteria for listing under D2.

## **Criterion E Quantitative Analysis.**

Assessment Outcome: Data Deficient.

Justification: Currently there is not enough data to undertake a quantitative analysis to determine the extinction probability of *Nitella parooensis*.

## **Conservation and Management Actions**

There is no NSW Saving our Species management program for this species. Information below has been derived from the Nocolèche Nature Reserve Plan of Management (NSW NPWS 2000) and associated actions and the threat information above.

### Habitat loss, disturbance and modification

- Maintain adequate fencing in Nocolèche Nature Reserve to protect plants and habitat from domestic stock, pigs and other feral or domestic animals.
- Consider possibility of fencing known sites to protect them from pig damage.
- Control pig numbers

### Invasive species

- Assess the need for weed control within known habitat. If weed control is required, assess whether herbicide use may be detrimental to *Nitella parooensis* and its habitat. For the small areas of the known sites for *N. parooensis*, careful manual weed control may be more appropriate.

### Ex situ conservation

Establish an ex situ seed (oospore) bank in collaboration with Mt Annan Botanic Gardens.

### Stakeholder Management

Ensure pig control is a key priority in Nocolèche Nature Reserve and in surrounding areas that may act as a source of pigs into the reserve.

## **Survey and Monitoring priorities**

- Monitoring should be conducted to assess the presence and abundance of the species at sites at an appropriate time based on local rainfall or local flooding.
- Monitor known sites and nearby areas for weed invasion or pig activity.

## **Information and Research priorities**

- To understand the ecology of *Nitella parooensis* and how it responds to different flood timing, depth, extent, duration and season.
- Oospore biology – germination and dormancy mechanisms, oospore viability and longevity, propagule dispersal (waterbirds) and predation. Effects of different seasons of flooding and altered hydrology on germination and abundance.

# NSW Threatened Species Scientific Committee

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- Recruitment and establishment – survival rates of recruits, causes of mortality, population modelling (e.g., impact of sporeling loss), growth and development rates.
- Assess Translocation options – determining optimal numbers of plants or oospores for translocation sites, determining any appropriate new sites, ensuring survival of plant is maximised by weed and pig control.
- Ex-situ cultivation to understand growth and oospore production requirements
- To understand the habitat of *Nitella parooensis*
  - Defining commonly co-occurring species.
  - Defining environmental characteristics.This would also provide a baseline against which to monitor future change.
- Ongoing research and monitoring associated with the translocation program.

## References

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# NSW Threatened Species Scientific Committee

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## Expert Communications

Dr John Porter – Senior Scientist, NSW Office of Environment and Heritage.

Approved for public exhibition



Dr Marco Duretto  
Chairperson  
NSW Threatened Species Scientific Committee



# NSW Threatened Species Scientific Committee

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Exhibition period: 30/11/18

Listing date: 30/11/18 – 25/01/19

## Notice of and reasons for the Final Determination

The Scientific Committee, established under the *Biodiversity Conservation Act 2016* (the Act), has made a Final Determination to list the alga *Nitella parooensis* M.T.Casanova & J.L.Porter as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act. Listing of Critically endangered species is provided for by Part 4 of the Act.

### Summary of Conservation Assessment

*Nitella parooensis* is eligible for listing as Critically endangered, as the highest threat category met by the taxon across all categories, under Clause 4.3(a) (d) (e iiiii) because: i) the distribution of the species is very highly restricted with an area of occupancy of 8 km<sup>2</sup> and an extent of occurrence of 8 km<sup>2</sup>; ii) the species is only known to occur at a very small number of locations; and iii) there is a projected continuing decline in the species' habitat area and quality.

The NSW Threatened Species Scientific Committee has found that:

1. *Nitella parooensis* M.T.Casanova & J.L.Porter (family Characeae) is a short lived annual charophyte (an alga) and was described by Casanova and Porter (2013) as “dioecious, scarcely heteroclemous, to 10 cm high, internodes to 3 cm long, c. 0.4 mm wide, sterile branchlets to 3 cm long, unevenly 0–3 × furcate, monopodial or nearly so, in whorls of 5–7 at the axis nodes, with an occasional 0 × furcate accessory branchlet at the base of the whorl. Primary branchlet segments to 40 mm long, ranging from 50 to 100% of total branchlet length. Secondary branchlet segments 2 to 3 mm long. Branchlets have the potential to be 3 or more × furcate, but sometimes the development of segments is suppressed and the terminal segments appear to be pluricellulate (up to 5 cells long including the end cell). Dactyls are essentially bicellulate, to 1.5 mm long. Accessory branchlets where present are 0 × furcate (i.e. dactyls). End cells short, conical and acute, the end of the penultimate cell distinctly narrowed so that the base of the end cell is confluent with it. Fertile parts without mucus, whorls on the female plant somewhat contracted, on the male plant in distinct heads. Fertile branchlets 6 in a whorl, 2 × furcate, oogonia from 0.4 to 0.6 mm long, at first and second branchlet furcations, antheridia terminal, to 400 µm in diameter. Oospores 290–350 µm long × 250–290 µm wide, with 4–5 striae of low flanges, dark to chestnut brown. The shape differs from all other species seen so far, rather than being a flattened sphere, oospores of this species appear twisted. Oospore wall ornamentation is coarsely reticulate, with walls of the reticulum c. 8 µm wide, 3–4 meshes across the fossa. In mature oospores minute, sparse papillae occur on the walls and cavities of the reticulum. Antheridia to 0.4 mm in diameter. Chromosome number not known.”
2. *Nitella parooensis* is endemic to New South Wales (NSW) and occurs in claypan wetlands in the Paroo region in the north west of the state (Casanova and Porter 2013). It is currently known to occur in three small freshwater temporary wetlands within the Paroo River catchment in Nocoleche Nature Reserve. Searches have been undertaken in areas of similar freshwater wetland habitat within Nocoleche Nature Reserve and outside the reserve in the broader area of northwestern NSW and southern Queensland in the Wanaaring – Tibooburra – Hungerford areas, but no further occurrences of *N. parooensis* have been located (Casanova and Porter 2013; J. Porter *in litt.* February 2016).
3. The geographic distribution of *Nitella parooensis* is very highly restricted. The area of occupancy (AOO) is estimated to be 8 km<sup>2</sup>, based on the species occupying two 2 x 2 km grid cells, the spatial scale of assessment recommended by IUCN (2017). The extent of occurrence (EOO) was also estimated to be 8 km<sup>2</sup>. The EOO is reported as equal to AOO, despite the range of the species, measured by a minimum

# NSW Threatened Species Scientific Committee

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convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2017).

4. *Nitella parooensis* is very uncommon at the three sites where it is currently known to occur with only scattered individuals seen (J. Porter *in litt.* February 2016). The abundance of *N. parooensis* is difficult to quantify due to its life history and the ephemeral nature of its habitat (J. Porter *in litt.* February 2016).
5. *Nitella parooensis* is a macroscopic green alga superficially similar to a submerged flowering plant, with flexible stems and whorls of branch-like structures that carry the reproductive organs (J. Porter *in litt.* February 2016). The tiny sexual propagules (oospores) can survive prolonged desiccation, remaining dormant in the soil until water is available (J. Porter *in litt.* February 2016). The river system has a highly erratic flooding regime, and rainfall is highly variable averaging 276 mm per year. The temporary wetlands fill infrequently and sporadically, perhaps every 5–7 years. They are shallow (c. 20–30 cm deep) and the water is typically turbid such that at times *N. parooensis* cannot be located visually (Casanova and Porter 2013). Water birds are likely to play an important role in the dispersal of propagules (J. Porter *in litt.* February 2016; Soons *et al.* 2016).
6. The largest site where *Nitella parooensis* is known to occur is a temporary lignum swamp on the edge of the Paroo River floodplain that fills either after minor flooding from the Paroo River (via a distributary creek) or from local runoff. It occurs on heavy grey cracking clay and is fringed by *Eucalyptus ochrophloia* (Yapunyah) and *E. largiflorens* (Black box) with an understorey of *Duma florulenta* (Lignum) and *Acacia stenophylla* (River Coobah). Herbaceous species include *Eleocharis plana*, *Marsilea* spp., *Alternanthera denticulata*, *Cyperus gilesii*, *Aponogeton queenslandicus* and *Eragrostis australasicus*. Submerged species include the charophytes *Chara braunii*, *Nitella sonderi* and *Nitella cristata*. The other two known sites are shallow temporary wetlands adjacent to the floodplain on massive (non-cracking) red clay substrate. These wetlands fill from local runoff after heavy rain and are hydrologically isolated from the Paroo River and its floodplain. One is fringed by a tall open shrubland dominated by *Eremophila sturtii*, *Dodonaea angustifolia*, *Senna* spp., and an understorey of chenopods including *Osteocarpum* sp., *Chenopodium* sp. and *Scleroleana* sp. The other wetland site is more distant from the Paroo River and is associated with sparse vegetation including *Eragrostis australasicus* and *Marsilea* sp. (J. Porter *in litt.* February 2016).
7. Threats to *Nitella parooensis* include feral pigs, weeds, an altered river flow regime, and the impacts of climate change. Feral pigs (*Sus scrofa* Linnaeus 1758) damage the habitat of *N. parooensis* by disturbing the soil leading to damage of the oospores and increasing the likelihood of the spread of weeds through increased nutrients and dispersal of weed seeds. Although weed species are not currently recorded from the wetlands containing *N. parooensis*, the weeds *Rumex crispus* (Curled Dock), *Heliotropium curassavicum* (Smooth Heliotrope), *Polypogon monspeliensis* (Annual Beardgrass), *Carthamus lanatus* (Saffron Thistle) and *Xanthium occidentale* (Noogoora Burr) are present in similar habitats elsewhere in the Nocoleche Nature Reserve. Altered flow regimes of the floodplain caused by water extraction and altered flow regimes upstream may result in changes to flood size, frequency and duration and adversely affect the habitat of *N. parooensis* and its ability to persist in the largest known site. Less frequent flooding will reduce riverine connectivity and may affect recruitment and dispersal of *N. parooensis* (J. Porter *in litt.* February 2016; Hood and Naiman 2000; Stokes *et al.* 2010). Changes to the flooding regime may also reduce floristic diversity (Roberts and Ludwig 1991), encourage invasive weed species such as *Phyla nodiflora* (Lippia) (Stroud 1994), reduce recruitment of floodplain eucalypts (Bacon *et al.* 1993; Walker & Thoms 1993) and eliminate key structural components of the habitat such as River Coobah and Lignum (McCosker and Duggin 1993; J. Porter *in litt.* February 2016). Climate change has the potential to alter rainfall patterns and river flows and reduce habitat availability and persistence (J. Porter *in litt.* February 2016). The predicted change in seasonal rainfall patterns for the region containing the Nocoleche Nature Reserve (OEH 2014) suggests a shift from a relatively aseasonal pattern to one more dominated by rain in summer. This may affect germination and recruitment capacity of *N. parooensis* because evaporation rates are

# NSW Threatened Species Scientific Committee

substantially higher in summer. 'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758', 'Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands' and 'Anthropogenic Climate Change' are listed as Key Threatening Processes under the Act.

8. *Nitella parooensis* M.T.Casanova & J.L.Porter is eligible to be listed as a Critically endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing an extremely high risk of extinction in Australia in the immediate future as determined in accordance with the following criteria as prescribed by the *Biodiversity Conservation Regulation 2017*:

Clause 4.2 – Reduction in population size of species

(Equivalent to IUCN criterion A)

Assessment Outcome: Data deficient

(1) - The species has undergone or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon:			
	(a)	for critically endangered species	a very large reduction in population size, or
	(b)	for endangered species	a large reduction in population size, or
	(c)	for vulnerable species	a moderate reduction in population size.
(2) - The determination of that criteria is to be based on any of the following:			
	(a)	direct observation,	
	(b)	an index of abundance appropriate to the taxon,	
	(c)	a decline in the geographic distribution or habitat quality,	
	(d)	the actual or potential levels of exploitation of the species,	
	(e)	the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.	

Clause 4.3 - Restricted geographic distribution of species and other conditions

(Equivalent to IUCN criterion B)

Assessment Outcome: Critically endangered under Clause 4.3 (a) (d) (e iii)

The geographic distribution of the species is:			
	(a)	for critically endangered species	very highly restricted, or
	(b)	for endangered species	highly restricted, or
	(c)	for vulnerable species	moderately restricted,
and at least 2 of the following 3 conditions apply:			
	(d)	the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations,	
	(e)	there is a projected or continuing decline in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	habitat area, extent or quality,
		(iv)	the number of locations in which the species occurs or of populations of the species,
	(f)	extreme fluctuations occur in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	the number of locations in which the species occur or of populations of the species.

# NSW Threatened Species Scientific Committee

Clause 4.4 - Low numbers of mature individuals of species and other conditions  
(Equivalent to IUCN criterion Clause C)  
Assessment Outcome: Data deficient

The estimated total number of mature individuals of the species is:			
	(a)	for critically endangered species	very low, or
	(b)	for endangered species	low, or
	(c)	for vulnerable species	moderately low,
and either of the following 2 conditions apply:			
	(d)	a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species):	
		(i)	for critically endangered species very large, or
		(ii)	for endangered species large, or
		(iii)	for vulnerable species moderate,
	(e)	both of the following apply:	
		(i)	a continuing decline in the number of mature individuals (according to an index of abundance appropriate to the species), and
		(ii)	at least one of the following applies:
		(A)	the number of individuals in each population of the species is:
		(I)	for critically endangered species extremely low, or
		(II)	for endangered species very low, or
		(III)	for vulnerable species low,
		(B)	all or nearly all mature individuals of the species occur within one population,
		(C)	extreme fluctuations occur in an index of abundance appropriate to the species.

Clause 4.5 - Low total numbers of mature individuals of species  
(Equivalent to IUCN criterion D)  
Assessment Outcome: Data deficient

The total number of mature individuals of the species is:			
	(a)	for critically endangered species	extremely low, or
	(b)	for endangered species	very low, or
	(c)	for vulnerable species	low.

Clause 4.6 - Quantitative analysis of extinction probability  
(Equivalent to IUCN criterion E)  
Assessment Outcome: Data deficient

The probability of extinction of the species is estimated to be:			
	(a)	for critically endangered species	extremely high, or
	(b)	for endangered species	very high, or
	(c)	for vulnerable species	high.

# NSW Threatened Species Scientific Committee

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Clause 4.7 - Very highly restricted geographic distribution of species—  
vulnerable species

(Equivalent to IUCN criterion D2)

Assessment Outcome: Vulnerable via Clause 4.7

For vulnerable species,	the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period.
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Dr Marco Duretto  
Chairperson  
NSW Threatened Species Scientific Committee

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