APPENDIX 2

Submission to the Independent Planning Commission on Thunderbolt Wind Farm SSD-10807896

Via submissions@ipcn.nsw.gov.au

12th April 2024

Contents

Introduction

This submission is made in response to the NSW Independent Planning Commissions request dated 22 March 2024 for further information from the Department of Planning, Housing, and Infrastructure ('the Department'), and the Applicant, Neoen.

This submission is being made by Bimbi Pastoral Pty Ltd as trustee for its related entities, and on behalf of their respective directors and beneficiaries. These parties are referred to as 'we', 'us' or 'our' throughout this submission.

The authors of this submission, between us, hold a BSc (Hon 1) from Griffith University's School of Australian Environmental Studies with 26 years' experience delivering Landcare projects in northern NSW and 3.5 years' experience on the board of the NSW Biodiversity Conservation Trust; and a BSc (Hon) in Geology from the University of New England with 10 years' experience in geological and hydrogeological survey in northwest NSW and Queensland.

Water Resources

a) The estimated capacity of the Pine Creek Dam

Neoen's answer to this question fails to provide a volume, the accepted way of expressing capacity, offering only that it is 32 ha in area and that the water required for the project is 100 ML.

The Department's response to this question also fails to provide a volume, instead adding that the dam has depths up to 1.5m. If, this were the case across an area of this size, the dam would in fact be a wonderful 'upland wetland' or swamp. This is very, very misleading of the Department and we offer information and evidence to the contrary.

The following are facts:

- The dam is located on a 5th order stream
- Surface area approx. 32 ha
- Catchment area approx. 5000 ha
- Dam wall is 17 m in height from base, length is 300 m, base of wall is 150 m wide and height above spillway is 2 m (Pine Creek Dam construction worker, pers comm, April 2024)
- Depth is quite possibly 15+ m deep based on contour mapping by M. Dillon, Northern Tablelands Local Land Services (NTLLS) attached.
- The dam is the largest privately owned dam in this region, much larger than Kentucky Creek Dam located 18km to the northeast, which is Uralla's water supply.

Neoen could have determined the capacity of the dam using engineers and depth sounders, but they have failed to do so in preparation of their EIS.

The Department could have determined the capacity of the dam using details provided to Water NSW at the time of its construction approval, but they have failed to do this.

We are left wondering why there has been a coordinated failure to present a volume of the dam to the IPC.

Is it because of the high likelihood of a significant population of endangered Bell's Turtles in the Pine Creek Dam which are protected under the *Environment Protection and Biodiversity Conservation Act (1999) and the Biodiversity Conservation Act (2016)*, and the clear bias of the Department in favour of this development proceeding?

Please see Appendix 1 containing emails from Martin Dillon at NT LLS on 11.4.2024, which indicate the high likelihood of a significant population in Pine Creek Dam and its tributaries which flow through the wind farm proposal site, just like the population found in the Kentucky Creek Dam.

These failures of the Applicant and the Department indicate a total lack of due diligence, significant bias towards the developer, and deliberate attempts to mislead the Commission and the public.

We have no confidence in the Department's ability to remain neutral and assess this proposal in the best interests of the people and the environment of NSW.

Is this misleading behaviour maladministration? We feel this should be investigated by the relevant regulatory authority.

We concur with recommendations provided by Martin Dillon (NT LLS) in his attached email and recommend the following:

We recommend the Applicant and the Department address the IPCs question by providing an estimate of of the capacity of the dam through an assessment of Pine Creek Dam's depth and bathymetry, and that this is conducted by independent experts.

We insist that a Bell's Turtle trapping survey is conducted by qualified turtle specialists within Pine Creek Dam and its tributaries to determine whether M. bellii is present, and if so, whether the dam holds a significant population like that of the Kentucky reservoir near Uralla.

We recommend the depth, batter and volumetric capacity of the dam be properly measured so that appropriate confidence can be placed on the design and stipulation of engineering and environmental requirements for water extraction.

We recommend the annual flow of water that would normally flow over/past the dam wall in Pine Creek (in ML) needs to be quantified so that downstream downstream impacts of water extraction and subsequent lost water flow and pool depth in Carlisles gully downstream of the dam can be confidently assessed.

b) Details on what arrangements are in place for the Applicant to access the dam water. Does this arrangement involve the holder of Water Access Licence 36029?

Has the IPC or the Department determined what conditions on the use of the water were put in place when the dam's construction was approved?

General knowledge among community members is that the dam was only ever to be used for irrigating the Eucalyptus plantation on 'Bannalasta' or for firefighting. If this is the case, this requirement should remain in place.

The Pine Creek dam is a significant asset to our region and our community for *at least* two reasons:

1. It has proven to be indispensable during the Black Summer bushfires when TWO water bombing helicopters could fill from it AT THE SAME TIME.
2. It's likely that Pine Creek Dam is now important habitat for a significant population of endangered Bell's Turtle.

Neoen estimates their construction water use to be 100 ML and notes that the unregulated water allocation under the licence is 420 ML. As Neoen have not given a volume of the dam at the IPC's first question, it is difficult to work out what percentage of the dam volume Neoen are proposing to extract.

The lack of clarity around the volume of the dam and the impacts of the proposed extraction are concerning for several reasons:

1. It assumes that the 420 ML licence is realistic. We know that water allocations in NSW were historically over allocated. It is possible that the 420 ML allocation in this case is an over allocation, which if used under the licence, would significantly deplete downstream water availability, the volume available for Bell's Turtles and the volume available for firefighting.
2. It is unclear whether the 100 ML is only for the batching plant or all water use on site, such as for dust suppression on roads on a daily basis, and even potential accommodation dongas. We know from Table 12 in information submitted in their Response to Questions on Notice (6 March), that Neoen estimates 3,774 water truck movements (external) but this does not include internal water truck movements. If internal water truck movements are also to be drawn from the dam on

Pine Creek, is this included in the 100 ML estimate, or will that be added to what is taken from the dam? This should be clarified.

3. Martin Dillon (NTLLS) raises serious concerns about the impact of extracting 100ML on the actual dam levels based on a rudimentary study of the levels from satellite imagery (see attached map). This raises serious concerns about impacts on the Bell's Turtle population because of impacts adult hibernation conditions, and hatchling and juvenile habitat availability and predation. Further detail is provided in the attached emails.

We recommend Water NSW is required to make clear to the public, any original conditions associated with approval of the Pine Creek Dam's construction, including any requirements regarding use of the water for environmental and firefighting purposes.

We recommend Water NSW re-assess the appropriateness of the 420 ML unregulated water extraction allocation associated with water Licence 36029 for the Pine Creek dam in view of historical over allocations.

We recommend that any formal agreement reached between Neoen and the owner and water access license holder WAL 36029 should be required to adhere to all original conditions of use for the water under the original licencing.

c) Advise whether the Department is satisfied that use of water from the Pine Creek Dam as well as any potential erosion into waterways associated with the Project would not negatively impact the Namoi River Snapping Turtle (Bell's Turtle) on Site, downstream or in Pine Creek Dam.

The Department supports Neoen's claims that none of the creeks or drainage lines present within the development corridor of the site support the deep waterholes required for the Bell's Turtle, and that the project is not expected to impact suitable habitat for the species within the project site.

We strongly disagree that this is an appropriate assessment, based on:

- local site-specific knowledge
- tertiary level ecological and geological training
- the fact that no aquatic biodiversity surveys were conducted as part of the EIS
- the fact that no Bell's Turtle experts were consulted during the process to date
- information provided by Martin Dillon (NT LLS), which is attached in the Appendices.

Studies thwarted

The Northern Tablelands Bell's Turtle project has previously requested access to the Pine Creek Dam for the purpose of studying the turtle population in the dam, however, they have not yet been successful as the property owners (a Chinese company) have required payment for this access (see attached email from Martin Dillon, NTLLS).

According to NT LLS, most farmers are happy to allow access for studies on Bell's Turtles.

Refusing access to a government entity or demanding payment for access for the purposes of studying an endangered species protected under the EPBC Act (1999) or the Biodiversity Conservation Act (2016) is surely against the law?

We recommend the landholder be required to provide fee free access to government authorities to conduct aquatic biodiversity surveys associated with this State Significant Development.

Bell's turtle most likely present

The view held by Neoen and the Department that Bell's Turtle require deep waterholes greater than 1.5 m deep all the time and therefore they are not present on the site, is far too simplistic.

There is evidence that Bell's Turtles exist in ephemeral streams and farm dams on properties immediately adjacent to the project site. We have seen evidence of Bell's Turtles in Looanga Creek on our own and our neighbour's property, which is a direct tributary to Carlisle's Gully. We would be happy to facilitate surveys of these areas.

The science tells us they use underground caverns to hibernate so it may look dry on top, but they are there. This implies they would also be present in similar ephemeral streams and farm dams on the project site, especially upstream of the Pine Creek Dam.

Information in the attached emails and references provided by Martin Dillon, NT LLS, supports our views, and refutes the view of Neoen and the Department that Carlilse's Gully is not an important consideration for the project's impacts.

Extraction impacts

While the proposed pipeline is overland, installation of the pipe suction point would cause additional disturbance and sedimentation in the dam.

Extraction could reduce the volume of Pine Creek Dam by up to one third, according to a preliminary assessment by NTLLS turtle expert Martin Dillon (see attached emails). The reduced water level caused by extraction would leave adult turtles vulnerable to unsuitable conditions during their hibernation period, and leave hatchlings who require grassy shallows for protection, vulnerable to predation. Please refer to information provided in emails by Martin Dillon (NT LLS) attached.

Pollution impacts

Soil disturbance caused by road and turbine pad construction and use all over the project site would impact numerous water courses through sedimentation and turbidity. All these drainage lines are potential habitat for Bell's Turtle as per the attached information.

The Department's note that it is a strict liability offence to pollute any waters off the site under the *Protection of the Environment Operations Act 1997*, would unfortunately be too little too late once such an iconic and unique species is impacted in this way.

Historically an exemplary property

We would like to draw the IPC's attention to outcomes of the 'Land Water & Wool Northern Tablelands project 2002-2007' project. 'Kyabra', the property on which the Thunderbolt Wind Farm is proposed, was a significant participant in this action research led by Professor Nick Reid at the University of New England.

Kyabra was considered 'exemplary' as a biodiverse, productive wool growing property. The owner at the time, went on to become the Chairperson of Southern New England Landcare Ltd, and the UNE lead researcher is the current Chairperson of that organisation.

Outcomes of the research showed that well run wool production properties supported healthy biodiverse environments, and indeed supported many endangered species and ecosystems.

Relevant publications resulting from the research can be found at this link:
https://snelandcare.org.au/resources/publications/630-land-water-wool-northern-tablelands-project-2002-2007.html

We recommend the Federal Department of Climate Change, Energy, Environment & Water be consulted regarding this development application given it triggered the EPBC Act under which Bell's Turtle is protected. A second assessment of this debacle is necessary.

Fire Fighting Operations

d) The potential for the turbines to restrict aerial firefighting in the locality has been raised in multiple submissions to the Commission. Is the Department confident that the development will not restrict aerial firefighting in the locality?

The Department appears confident that the development will not restrict aerial firefighting in the locality.

We strongly disagree with this assessment.

The Department states they consulted with the RFS during the assessment process and assumes the information they received is adequate.

However, how much experience does the RFS overall, and especially our local RFS, really have with aerial firefighting in the vicinity of wind farms? Very little, if any.

We argue that they have minimal experience so far, and that it is unfair on our community to rely on assumed, untested protocols to protect us.

The *RFS's Planning for Bushfire Protection 2019* predates most large-scale wind farm installations across NSW and is unlikely to adequately address the specific issues created by turbines – large, deadly obstacles which would be obscured by thick black smoke changing its location under sudden wind changes associated with fire and this landscape. All this, despite being 'switched off' and 'parked in the rabbit-ear position'.

A comprehensive Emergency Plan in consultation with RFS was a requirement in the development consent, however, there was no requirement to provide this plan to everyone in the district. This is the equivalent of printing your building's emergency evacuation map but filing it in the bottom drawer so no one can see it!

The Black Summer Bushfires occurred at the end of the worst drought in living memory. **This will happen again**. The fear felt by our community as fires raged around us for months on end was palpable. We were personally impacted with the loss of life, and the loss of property among peers and acquaintances. Most farmers in our district were for months, only moments away from implementing their evacuation plan which likely involved loading several horses and all the dogs into an overcrowded horse float in which they could flee.

It is well known that we lost innumerable native animals during those fires. It is also well accepted that native fauna that can travel when under threat of fire, will do so, taking safe harbour in adjoining well-timbered farmland, which is often protected by local brigades, thus allowing wildlife to re-establish in the burnt areas once recovery begins.

Our district is one such area, providing climate and fire refuge for many endangered species and ecosystems. We have already seen the incidence of increased koala populations for example, and this is recognised by the NSW Koala Strategy and the Armidale and Walcha Areas of Koala Significance.

We insist the NSW Government does not impede aerial firefighting across our property with an inappropriately located wind farm, placing us at risk of a catastrophic outcome.

We recommend the Federal Department of Climate Change, Energy, Environment & Water be given the opportunity to assess this proposal, given the risks posed to Critically Endangered Grassy Box Woodlands protected under the EPBC Act (1999).

e) Please clarify whether the proposed water tank capacity of 20,000L is sufficient for the firefighting needs of a wind farm development, including in times of drought and limited surface water access.

The provision of a 20,000L water tank for firefighting purposes on a 15,000-acre property containing 32 wind turbines seems ludicrous – this is such a tiny amount of firefighting water for a state significant development.

Our own farm has more than 240,000 L of tank storage for firefighting across just 500 acres. In addition, we can top up these storages up from farm dams via underground pipe systems, increasing our firefighting supply substantially. The comparison between the two situations beggars' belief.

We can only assume the RFS provided this recommendation as a 'standard' statement they perhaps apply to housing developments? This further demonstrates the RFS's inexperience with the risks involved in large wind farm developments.

Has the Department asked where this 20,000L firefighting water tank is to be located? On such a large site, location of this small supply is critical.

In the Black Summer Bushfires, our district was supported aerially with two helicopters able to fill from the Pine Creek Dam AT THE SAME TIME – such is the size and capacity of the dam. This development WILL prevent those helicopters from filling from that dam due to proximity to the turbines and the 3 km no fly zone around the turbines.

Again, where is the Department of Planning's critical thinking and analysis of the information they are being fed?

Clearly, those in the Department making these assessments have not spent much time outside the city limits and have very little rural or regional experience. Clearly, they are not qualified for the job. Their assessment and their responses lack credibility. We have no confidence in the Department's assessment.

We STRONGLY recommend that this development be **refused** based on the inability to fight fires aerially and the inadequate provisions made for water supply to fight fires.

We recommend that wind farm developments be placed on already cleared land where population density and biodiversity values are lower, resulting in a lower fire risk rating.

Accommodation

f) The Commission is aware that EnergyCo operates a housing and accommodation working group. Is the Department aware of any policies, strategies, or guidance available in relation to managing accommodation impacts associated with renewable energy projects?

We do not understand the Department's statement on page 4 of their response, that 'While the additional work would assist future projects, this work cannot be applied to the Thunderbolt Wind Farm.' Why?

Is this development already determined? Is it because the new regulations concerning wind farms do not apply to this development? This is not clear.

It is not fair to our community and our landscape if good information and knowledge that is still being developed is not applied in this situation. This course of action is inequitable and discriminatory.

Such is the impact of the renewables 'rush' that our State Government is pursuing. Again, where is the State Government's due diligence? This raises the question of corruption within the Department.

We strongly recommend the project is delayed until such time as the department has completed working with Energy Corporation of NSW to conduct cumulative impact studies for the NSW REZs and the findings of these can be implemented in this project.

VPA Recommended Conditions of Consent Changes

We still disagree strongly with the updated conditions of consent relating to the Voluntary Planning Agreement, for the same reasons given in our submission made by 25th March 2024.

We also note that sections of the document provided by Neoen to Toni Averay, General Manager of Uralla Shire Council and entitled Thunderbolt Wind Farm – Benefit Sharing, Uralla Shire Council, dated 6th March, is illegible. It is unfair that the public cannot understand this statement.

We stand by the **recommendations** we made in our submission to the IPC on 25 March 2024.

Community Engagements

The following relate to Neoen's answers to the Questions on Notice asked by the IPC dated 6 March.

1. **What was the approximate number and method of community engagements the Applicant undertook during 2023? Please also provide an outline of any ongoing engagement plans for the Project.**

Neoen's 2023 community engagement can only be considered minimal and certainly far from best practice. The answer provided by Neoen did not list the number of community engagements undertaken in 2023 because this would have made their efforts look very weak. In summary, in a 12-month period there were 7 engagements:

- 4 meetings with personnel from Uralla Shire Council and Tamworth Regional Council
- 1 Community Consultative Committee meeting
- 1 update to the project website
- 1 project newsletter

Meetings with Councils could be considered 'stakeholder' meetings, with no guarantee that the content would be communicated back to the broader community.

The Community Consultative Committee are not representative of the community around this development. The CCC has not actively engaged with the community at any time. The community would be hard pressed to name one member. We know that it contained members who had potential and perceived pecuniary interests in the Thunderbolt Wind Farm Stage 2.

The website is stale and one update for a 12-month period cannot be counted as community engagement as there is no way the community can feed back into the website.

One newsletter in a 12-month period is also weak and does not 'engage' the community, rather, it is simply a one-way exchange of information to a broad audience with no method of monitoring whether or not the target audience was reached.

Opening a shop front should have occurred any time during the last 5 years to improve engagement but this was clearly not a priority for Neoen.

Vehicle movements

The following relate to Neoen's answers to the Questions on Notice asked by the IPC dated 6 March.

2. **During the proposed construction phase and with regard to worker numbers and potential noise and traffic impacts, at what point/s in this period are the most intensive activities intended to take place and approximately over what period of time?**

Traffic movements predicted by Neoen in Table 12 may be significantly underestimated. The table does not seem to include light vehicle movements during the peak of onsite personnel period in the middle of the project as per Figure 1. This figure predicts approximately 250 personnel on site daily during this period. Assuming 4 people per light vehicle, this would be at least 63 light vehicles per day to deliver them to the workplace. This would mean the per day vehicles listed in Table 12 is grossly underestimated.

Bird and Bat Strike Management Plan

The following relate to Neoen's answers to the Questions on Notice asked by the IPC dated 6 March.

3. Please set out a typical monitoring process associated with a Bird and Bat Strike Management Plan along with any information as to how the Plan is proposed to be developed.

Neoen's answer to this question is nonsense. The carcass search survey program has no detail – who, when, where, how? It is completely inadequate. To make the answer look more than it is, they have simply repeated information stated for birds and bats.

Neoen's suggestion that Bird and Bat monitoring would occur only in years 1, 3 and 5 post operation is significantly inadequate. It is possible that species that are rare or endangered could be impacted to the point of local extinction in this time, making it too late to take any adaptive management actions.

Carcass search surveys being conducted seasonally for the first two years is also significantly inadequate. Based on advice from a local ecologist who prefers to remain anonymous, **bird and bat strike surveys should be undertaken monthly for the life of the project once the wind farm is operational.**

There is no indication in the monitoring process outlined, of how the monitoring data will be made publicly available for scrutiny. What is the use of monitoring if the information it provides is not put to positive, productive use or used to scrutinise and modify the impactor's behaviour?

We recommend an independent organisation (even citizen scientists) to monitor bird and bat strike monthly (fee for service) and make this data available to the general public through an independent web site.

We recommend a financial penalty be payable by the wind farm operator for every bird and bat struck by the turbines, where this fee is payable to a local not for profit environmental organisation, or the NSW Biodiversity Conservation Trust philanthropic trust fund.

Again, is it not the job of the Department of Planning to critique the information provided to them by Neoen on behalf of NSW taxpayers? Where are the skills our State Government Departments used to possess?

Conclusion

We thank the IPC for the opportunity to comment on this new information. We are shocked at the high level of misinformation and the low quality of information provided to the IPC by Neoen, and their willingness to 'guestimate' when it comes to answering questions asked by the IPC.

We are also extremely concerned about the following in relation to the NSW Department of Planning, Housing and Infrastructure:

- The bias they clearly demonstrate towards the developer
- Their clear lack of skills to assess the proposals they are presented with
- Their lack of critical thinking in assessing this proposal
- Their lack of due diligence in assessing this proposal
- Their clear conflict of interest in relation to the EPBC Act (1999) which at no time has been recognised or managed
- Their clear lack of concern for communities in rural and regional NSW, for whom they work, and by whom they are paid.

We can see the IPC also shares at least some of these concerns.

We only hope the IPC can navigate a way to help us out of this mess and towards a common, shared, and accepted vision and implementation plan for the NSW energy transition.

We recommend an investigation into maladministration by the Department of Planning, Housing, and Infrastructure.

List of attachments

The following attachments are referred to in this document and included below.

1. Email from Martin Dillon, NT LLS, 11 April 2024. Information on Bell's Turtle and perspectives on proposed extraction of water from Pine Creek Dam. Refers to the following references (attached):
    a. Reference: Chessman 2015, Distribution and Abundance of Bells Turtle PDF
    b. Reference: DCEEW Conservation Advice for Western Saw-shelled turtle Myuchelys bellii PDF
    c. Reference: Fielder D et al 2015 Bells Turtle Chelonian Research Monographs PDF
2. Email from Martin Dillon, NT LLS, 11 April 2024. Further Information – summary of key actions to be implemented if the public is to have confidence that suitable environmental impact assessment and mitigation planning has been conducted before use of Pine Creek dam is considered for approval.
3. Email from Martin Dillon, NT LLS, 11 April 2024. North West Ecological Services contact information (redacted).

Gmail [redacted]

Further information

2 messages

Marty Dillon <martin.dillon@lls.nsw.gov.au>
To: [redacted]
Cc: [redacted]

Hi [redacted]

As discussed, here is some further information,

Firstly, I have looked at the topography and elevation contours around Pine Creek dam. As is evident in the screenshot below (and attached as a .jpg file), the extent of the water's edge of the dam of the creek immediately below the dam wall is lower than the 860 metre contour. This suggests that the depth of water in the dam is at least 10 metres near the dam wall, and likely at least 15 metr metres high. If during the construction of the dam any excavation took place upstream of the dam wall – as seems likely to have been required to construct such a significant and appropriately engir dam can reach around 20 metres deep - or more - around the reservoirs most its downstream end.

Here are my thoughts on key actions that I think should be implemented if the public is to have confidence that suitable environmental impact assessment and mitigation planning has been conduct from Pine Creek dam is considered for approval.

1. It is imperative that a turtle trapping survey by qualified turtle specialists is conducted within Pine Creek Dam to determine whether *M. bellii* is present, and if so, whether the dam holds a sigr reservoir near Uralla.
2. The proponents and the Departments response to RFI Question 1 "Clarify the estimated capacity of the Pine Creek Dam" needs to actually address the question by providing an estimate of t estimate an assessment of the dam's depth and bathymetry is required.
3. I believe it is imperative that the depth, batter and volumetric capacity of the dam needs to be properly measured so that appropriate confidence can be placed on the design and stipulation c water extraction.
4. The annual flow of water in Pine Creek in Megalitres that would normally flow over/past the dam wall needs to be quantified so that downstream impacts of water extraction and subsequent l downstream of the dam can be confidently assessed.

Best regards,

Martin Dillon

Project Manager, Turtles Forever – securing Australia's population of Bell's Turtle

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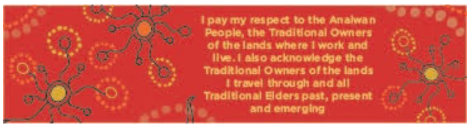

Pine Creek Dam 10-metre contours.jpg
163K

[redacted]

11 April 2024 at 18:31

Brilliant Marty,

This information fully supports the anecdotal evidence of the **Pine Creek Dam holding deep water**. This is not a good look for the DPE.

And totally agree, catchment and dispersal calculations of the Pine Creek Dam are imperative.

As I mentioned by separate email, I will try and have a chat with [redacted] tomorrow before finalising my submission.

Kind regards,

[redacted]

[Quoted text hidden]

Pine Creek Dam 10-metre contours.jpg
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Gmail [redacted]

information on Bell's turtle and perspectives on proposed extraction of water from Pine Creek dam

Marty Dillon <martin.dillon@lls.nsw.gov.au> 11 April 2024 at 14:43
To: [redacted]
Cc: [redacted]

Hi [redacted]

As discussed yesterday here is some information about endangered Bell's turtles and my perspectives around the proposed extraction of water from Pine Creek dam during the construction phase of the Thunderbolt windfarm.

The Namoi River snapping turtle (*Myuchelys bellii*) (also referred to as Bell's turtle or Western saw-shelled turtle, and previously with the scientific name *Wollumbinia bellii*) is listed as 'Endangered' under both the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999, and the NSW Biodiversity Conservation Act 2016.

M. bellii is endemic to (i.e. only occurs in) the New England region, and in particular the species only occurs in high elevation headwaters of the Murray Darling Basin in the Namoi, Gwydir, and Border Rivers catchments. Therefore, the species holds special significance as a rare and unique species in the Northern Tablelands.

A summary of the ecology of *M. bellii* and the threats to the species are provided in DCCEEW (2023) 'Conservation Advice for *Myuchelys belli* (western saw-shelled turtle)'

https://www.environment.gov.au/biodiversity/threatened/species/pubs/86075-conservation-advice-15032023.pdf (also see attached copy).

The following is an excerpt from DCCEEW (2023): "The western saw-shelled turtle lives in habitat that often forms deep pools (~ 2 m deep) characterised by granite boulders and bedrock, separated by either riffles or dry beds (Chessman 2015; Fielder et al. 2015). The aquatic habitat is complex with underwater caverns, aquatic macrophytes and coarse granite sand substrate (Fielder et al. 2014). Overhanging banks are common throughout the species' range (Fielder et al. 2014). Western saw-shelled turtles do not appear to inhabit lentic waterbodies (Chessman 2015; Fielder et al. 2015). Adult western saw shell turtles have not been observed in shallow water during the day but may move into shallow waters overnight (Chessman 2015). Juvenile turtles preferentially occupy vegetated littoral regions of rivers and do not become displaced during moderate floods (Streeting 2021, pers comm, 30 November 2021). Western saw-shelled turtles are highly aquatic and leave the water only to bask and lay eggs. Basking occurs on exposed logs and rocks during the active months and increases during spring when average water temperatures are < 20°C (Fielder 2012)."

The above information is largely based on early work of Dr Bruce Chessman (2015) and Dr Darren Fielder et al. (2015), and I have attached copies of those studies for your information. However, since their initial studies, we now know that *M. bellii* can inhabit lentic waterbodies like dams and reservoirs that are fed by streams, and the species can occur in areas that do not necessarily have deep waterholes, and the species definitely forages in shallow areas. The largest and most significant population of the species known to occur is located within Kentucky reservoir, which is a water-supply dam a few km south-west of Uralla, and is similar in size to Pine Creek dam. The Kentucky reservoir is an extremely important refuge for *M. bellii*. Kentucky reservoir is on Kentucky Creek, a 5^{th} order stream. Notably, the section of Pine Creek that is occupied by Pine Creek Dam is also a comparable 5^{th} order stream. The section of Carlisle Gully near Pine Creek dam in which Bell's Turtles have been confirmed to be present is a 6^{th} order stream, not a 7^{th} order stream as stated in Neoen's response to RFI Question 3, presumably referring to its maximum Strahler stream order further downstream. Carlisle gully provides high quality habitat for *M. bellii* and the species is very likely to occur in tributaries of Carlisles gully within the proposed Thunderbolt wind-farm project area.

Note: Strahler stream order information is publicly available online from “NSW Map. ArcGIS World Geocoding Service” https://www.arcgis.com/apps/View/index.html?appid=63fa2b441c2c49e4b726cffa89629e46

Pine Creek dam has never been surveyed for *M. bellii* and so it is unknown whether the species occurs in the dam.

I believe it is imperative that a turtle trapping survey by qualified turtle specialists is conducted within Pine Creek Dam to determine whether *M. bellii* is present, and if so, whether the dam holds a significant population similar to the Kentucky reservoir.

I believe that Neoen’s response to RFI Question 1 “Clarify the estimated capacity of the Pine Creek Dam” does not actually address the question by providing an estimate of the Dams capacity in Megalitres. They do provide an estimate of the surface area of the dam (32 ha), however they do not state the average or maximum depth of the dam, or its volumetric capacity.

The letter from the Department of Housing Planning and Infrastructure (ref: SSD-10807896) addressed to Mr Stephen Barry, Planning Director – Independent Planning Commission (3 April 2024) with the Subject: “Thunderbolt Wind Farm – Response to Request for Information” states that Pine Creek dam is a maximum of 1.5 m deep, but the department does not specify the source of this information nor how it was measured/derived. From my reading of the ‘Additional case material available for public submission’ the 1.5m depth estimate for Pine Creek dam does not appear to be something that Neoen has provided. This apparent unsupported inclusion by DHPI, and the apparent omission by Neoen is significant, because in Neoen’s response to RFI question 3 they state that *M. bellii* requires habitats greater than 1.5 m deep. Note: the origin of the above-mentioned department’s letter is ambiguous, because the first page has a header stating “Department of Planning, Housing & Infrastructure” but subsequent pages have the heading “Department of Planning and Environment”.

Neoen’s response to RFI Question 3 states “Water extraction from the Pine Creek Dam has the potential to lower water levels within the Pine Creek Dam. Pine Creek Dam is a large dam (with surface area of approximately 32 hectares), the water volume required for the Project (100 ML) will not significantly impact the water volume within a dam this size (i.e., the dam can sustainably supply the Project’s water requirements and the water within the dam will not be exhausted”

I believe this response lacks sufficient quantitative information to provide confidence that water extraction would not negatively impact the Namoi River Snapping Turtle (Bell’s Turtle) on-site, downstream or in Pine Creek Dam. For example, as the dam has a surface area of 32 ha, this represents 320,000 metres-squared. Given that a megalitre is 1000 cubic metres, extracting 100 ML from the dam has the potential to reduce the water level by around one third (320,000 cubic metres minus 100,000 cubic metres), and likely more than a third if the dam has a shallow batter or if the water is extracted during dry times when the water levels are already low. I believe one third is a significant amount. Furthermore, Neoen’s statement that “water within the dam will not be exhausted” begs the question exactly how much water will be left in the dam following extraction.

The DCCEEW (2023) document describes critical habitat required by Bell’s turtle. Given that adult *M. bellii* require deep water, especially during their winter underwater brumation (hibernation), such lowering of water levels are significant because they may expose turtles to unsuitable conditions. Furthermore, hatchling and juvenile *M.bellii* are reliant on aquatic and fringing riparian vegetation to protect them from predation by fish, birds and other predators. If dam water levels are significantly lowered, small juveniles can be left exposed and without access to protective aquatic or fringing vegetation. Lastly, irrespective of whether *M. bellii* occur in Pine Creek dam, removing approximately 100 ML of water during construction will presumably prevent or substantially reduce flow from Pine creek and its upper tributaries from flowing downstream of the dam, thereby reducing water flow and pool depths in known *M. bellii* habitat in Carlisles gully downstream of its confluence with Pine Creek. As above, reductions in water flow may expose turtles to unsuitable condition and prevent access to critical habitat.

I believe that it is imperative that the depth, batter and volumetric capacity of the dam needs to be properly measured so that appropriate confidence can be placed on the design and stipulation of engineering and environmental requirements for water extraction. Furthermore, I believe an estimate of the annual flow of water in Pine Creek in

Megalitres that would normally flow over/past the dam wall should be quantified so that downstream impacts of water extraction can be confidently assessed.

References

DCCEEW (2023) ‘Conservation Advice for *Myuchelys belli* (western saw-shelled turtle)’

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Best regards,

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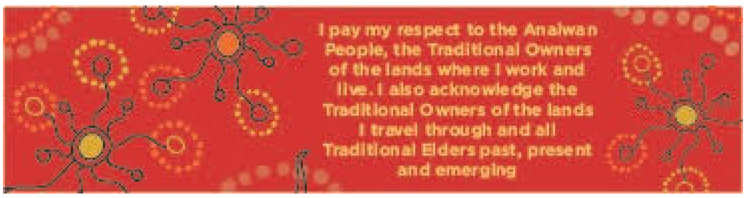

3 attachments

DCCEEW Conservation Advice for Western Saw-shelled turtle Myuchelys bellii 15032023.pdf
2166K

Chessman 2015 Distribution and abundance of Bells Turtle.pdf
601K

Fielder D et al 2015 Bells Turtle Chelonian Research Monographs.pdf
2206K

Distribution, abundance and population structure of the threatened western saw-shelled turtle, *Myuchelys bellii*, in New South Wales, Australia

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Distribution, abundance and population structure of the threatened western saw-shelled turtle, *Myuchelys bellii*, in New South Wales, Australia

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Abstract. The western saw-shelled turtle is listed as threatened globally, nationally, and within the Australian state of New South Wales. Although nearly all of the geographic range of the species lies within New South Wales, little information has been available on the distribution, abundance and structure of New South Wales populations. Through a survey of 60 sites in 2012–15, I established that *M. bellii* is much more widely distributed in New South Wales than has previously been recognised, comprising four disjunct populations, including two in the New South Wales portion of the Border Rivers basin. It occurs mainly in larger, cooler rivers upstream of barriers to dispersal of the Macquarie turtle, *Emydura macquarii macquarii*. Although *M. bellii* is locally abundant, its populations are greatly dominated by large adults and recruitment appears to be low. Eye abnormalities are common in some populations but do not necessarily impair body condition or preclude long-term survival. The species is threatened by competition with *E. macquarii*, which appears to be expanding its range through translocation by humans, and possibly by predation, disease and drought. Long-term monitoring of *M. bellii* is needed to assess population trends and responses to threats, and active management to restrict the further spread of *E. macquarii* is probably required to ensure the persistence of *M. bellii* throughout its current range.

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Introduction

Globally, turtles and tortoises are one of the most imperilled vertebrate groups, with ~60% of all modern species either extinct or threatened (van Dijk *et al*. 2014). Their characteristic life-history traits of late maturation, modest fecundity and high mortality of eggs and hatchlings make population persistence reliant on great adult longevity (Klemens 2000). If the mortality of adults increases, population reduction may be rapid, but if adult mortality remains low yet recruitment falls, adult longevity may disguise impending population decline. Causes of diminishing turtle populations and threats to those that remain are varied and include overharvesting, as either target species or by-catch, habitat loss or degradation, disease, effects of introduced species and climate change (Turtle Conservation Fund 2002; Ihlow *et al*. 2012).

Coastal Australia has been identified as a global priority area for turtle conservation (Buhlmann *et al*. 2009). One of the species inhabiting this area is the western saw-shelled turtle, *Myuchelys bellii* (Gray, 1844), also known as Bell's turtle and the Namoi River snapping turtle, a riverine species endemic to the New England region of north-eastern New South Wales and the Darling Downs region of southern Queensland. In Queensland it is probably confined to 8 km of a single stream but in New South Wales it is distributed more widely (Fielder *et al*. 2014). It is listed as endangered on the International Union for Conservation of Nature's Red List of Threatened Species (under the name *Elseya bellii*: www.iucnredlist.org/details/40758/0), as nationally vulnerable under Australia's *Environment Protection and Biodiversity Conservation Act* (under the name *Wollumbinia belli*: www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=86071) and as vulnerable in New South Wales under that state's *Threatened Species Conservation Act* (under the name *Elseya belli*: www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10266).

The distribution and abundance of *M. bellii* in Queensland have been thoroughly assessed (Fielder *et al*. 2014), but comparable information has not hitherto been available for New South Wales. Consequently, the status of the species in New South Wales and its vulnerability to threatening processes are poorly understood. Here I report the results of an extensive survey for *M. bellii* in New South Wales, undertaken in the years 2012–15. My aims were to establish the current geographic range, local abundance and population structure of the species in New South Wales, and relate its distribution and abundance to abiotic environmental variation and the occurrence of other turtle species. I hoped to thereby gain some insight into its population status, the factors limiting its distribution, and its susceptibility to threats.

Materials and methods

Study species

M. bellii is a medium-sized, short-necked chelid turtle with a maximum straight-line carapace length of ~230 mm in males and ~300 mm in females. Males take ~9 years to reach sexual maturity and females ~19 years, mean fecundity is low (14 eggs per female per annum) and longevity is estimated to exceed 40 years (Fielder *et al*. 2014). The species appears to be confined to running waters and is well adapted for aquatic respiration, enabling it to remain submerged in deep water for long periods, especially in winter (Fielder 2012). It has an omnivorous diet, including algae and aquatic and terrestrial plant material and invertebrates (Fielder *et al*. 2014). In New South Wales it has been regarded as being confined to the upper reaches of the Namoi and Gwydir River drainages (e.g. Georges and Thomson 2010; Cogger 2014).

Study area

Sixty sampling sites in the New England region were selected with the aim of broad geographic coverage, concentrated within and surrounding the previously reported distribution of *M. belli* in New South Wales and including a few outlying locations (Fig. 1). Sites were chosen primarily on the basis of availability of road access for transport of equipment, occurrence of pools deeper than 1 m, and permission from land owners and managers. One site was in a reservoir but the remainder were in streams.

The study region comprises flat and undulating terrain on the New England Plateau and steeper slopes to the east and west. Much of it has been cleared of its original vegetation to support livestock grazing and cropping, but substantial areas of native forest remain. The climate is temperate with cold winters (mean daily minimum of –2 to 3°C in July) and warm–hot summers (mean daily maximum of 25 to 34°C in January). Mean annual rainfall ranges from 650 to 900 mm with the highest monthly average falls in summer. The Great Dividing Range runs across the region from north to south, dividing the river systems into those that flow west within the Murray–Darling Drainage Division and those that flow eastward to the Pacific Ocean (Fig. 1). The larger western streams have been impounded by major dams to support downstream irrigation development.

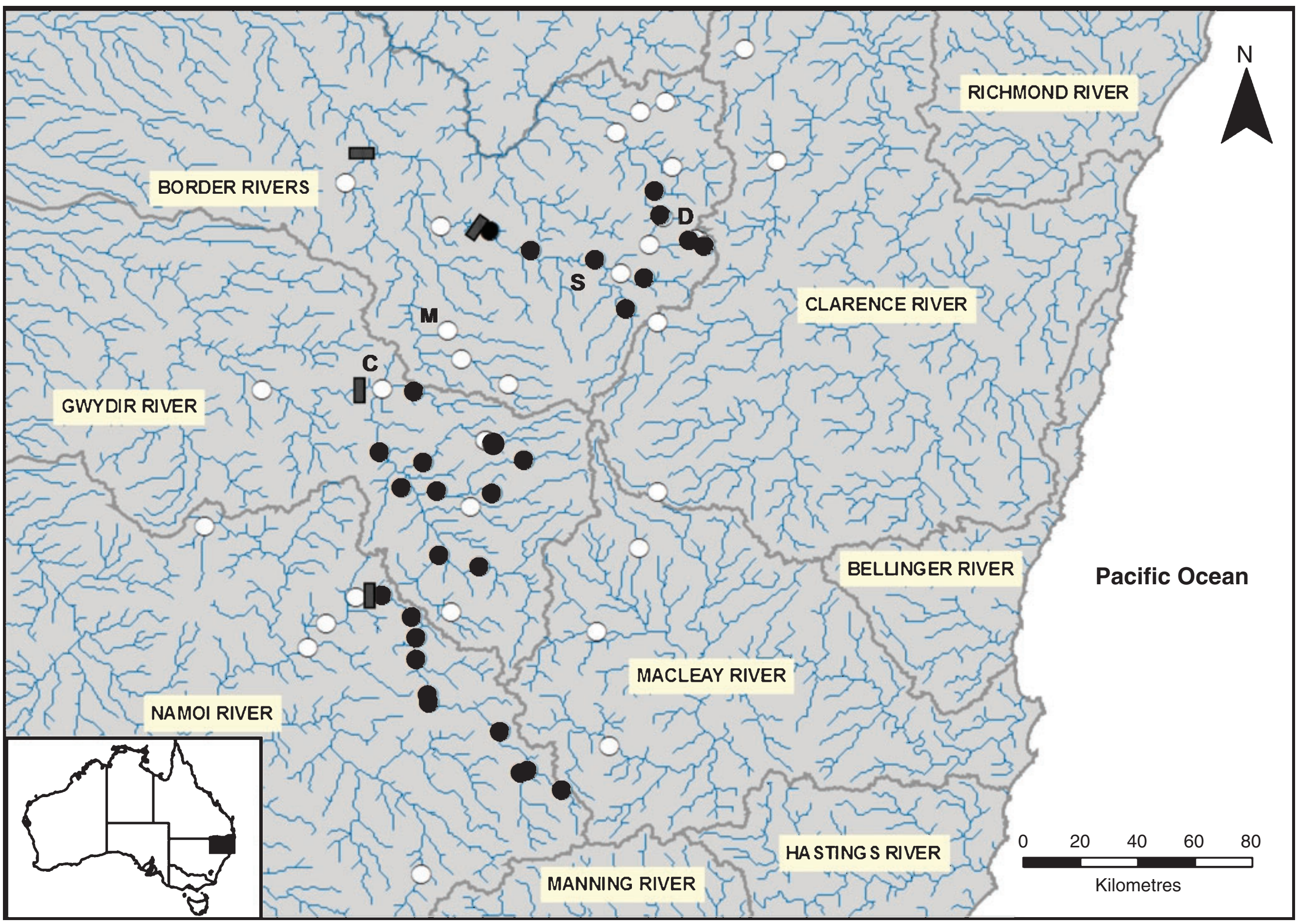

Fig. 1. Map of river basins in north-eastern New South Wales (bounded by thick lines) and major streams (thin lines) showing survey sites where *Myuchelys bellii* was recorded (black circles) and not recorded (white circles). Some site symbols overlap. Symbols D, S and M indicate the Deepwater, Severn and Macintyre rivers and symbol C shows the location of Copeton Dam and Lake Copeton. Stippled bars show the locations of potential barriers to turtle dispersal created by large cascades and waterfalls.

Turtle sampling and environmental data

Sampling was undertaken in the warmer months from November to March, when the species is active and feeding. Turtles were captured primarily in 'cathedral' traps – telescoping vertical cylindrical nets 1 m wide and 2 m high when fully extended, constructed of 13- and 25-mm mesh, with three entrance funnels near the base measuring 300 mm wide and 40 mm high at their centres. These traps were baited with beef or sheep liver and deployed in still or slowly flowing water 1–2 m deep, with their bases resting on the stream bed and their tops floating so that captured animals could breathe air. Unbaited fyke nets (13-mm mesh; 1 m high and 3 m long, with two wings 10 m long) were also used at some sites where bedform, substrata and current velocity were suitable, placed at a depth of ~0.8 m to allow breathing by captured animals. Nets were placed ~15 m or farther apart and were cleared at a mean interval of ~3 h during daylight hours but left for ~12 h overnight. Intersite variation in the total length of stream over which traps were distributed (mean = 264 m; range = 20–1140 m) and trapping effort (mean = 5.9 trap-days; range = 0.3–21.8 trap-days; >1 trap-day at 92% of sites) resulted from access limitations (private property boundaries; cliffs), logistical factors (time constraints; availability of equipment), limited pool areas for placing traps at some sites, and more protracted or repeated sampling at some locations to boost sample sizes. A few additional turtles were captured opportunistically by hand, including by diving. The number of days between first and last sampling at a site ranged from <1 to 1120 (mean 303).

Captured turtles were identified and sexed by external examination unless smaller than the threshold of sexual dimorphism, as expressed by differences in tail morphology and, for *Chelodina longicollis*, plastron shape (Chessman 1978). They were examined for external abnormalities, measured with vernier calipers for straight-line medial carapace length, weighed with digital scales in most cases, marked with varying combinations of notches in marginal scutes so that they could be identified if recaptured, and released as soon as possible near the point of capture.

Three variables describing the physical environment of the sampling sites were extracted from the Australian stream and nested catchment database (Stein *et al*. 2014). This database associates numerous environmental attributes with defined stream segments, mostly bounded by tributary or distributary junctions and having a mean length of 2.4 km. This spatial scale was considered the appropriate order of magnitude at which to characterise habitat of *M. bellii*, because individuals range over stream lengths of up to ~8 km (Fielder *et al*. 2014). The chosen variables were the mean annual air temperature of the stream segment and its immediate environs, the modelled mean annual runoff at the stream segment, and the segment's average slope (Table 1). Temperature was selected because of its importance to ectothermic animals and because *M. bellii* is a high-elevation species and hence possibly intolerant of high temperatures. Air temperature was used as a surrogate for water temperature because of insufficient data on the latter and the strong relationship between the two (Webb *et al*. 2003). Runoff and slope were considered important as predictors of in-stream physical habitat (Hubert and Kozel 1993; Buffington *et al*. 2002). In some cases the sampling site overlapped two segments in the database, in which case values of the environmental variables for the two segments were averaged.

Data analysis

Relative body condition of *M. bellii* was calculated by dividing observed mass by the mass predicted from a regression of mass (M) on carapace length (L) for all weighed individuals ($n = 531$), of the form $M = aL^b$, where a and b are constants. A condition value >1 thus signified a mass higher than expected for the turtle's carapace length.

Routine statistical tests were applied to compare mean values (t-test; analysis of variance; Tukey's test) and proportions (Chi-square tests) for various attributes of turtle populations. Separate-variance t-tests were used if variances were significantly different between the two groups being compared (F-test, $P < 0.05$); otherwise, pooled-variance tests were employed. In the interests of independence of observations, recaptures were excluded from these tests, except for comparisons of recapture rates.

A general linear model (GLM) was used to test whether the site-specific catch per unit effort (CPUE) of *M. bellii* could be related to environmental variables – both physical (temperature, runoff and slope) and biotic (CPUE of other turtle species). CPUE of each species was calculated as the number of specimens caught in traps (including recaptures) divided by the number of trap-days. Trap-days with cathedral and fyke nets were considered equivalent and combined, because the two methods had similar average returns of 4.7 and 4.2 turtles per trap-day respectively. Hand captures were excluded from the calculation. All variables in the model except temperature had strong positive skew (>1), which was removed by logarithmic (runoff, slope) or fourth root (CPUE) transformation before analysis. Model residuals were examined to see whether they were normally distributed.

Table 1. Ranges of values of abiotic and biotic variables for sites west and east of the Great Dividing Range

Variable	Units	Range (western sites)	Range (eastern sites)
Mean annual air temperature	°C	11.8–17.6	11.6–16.7
Stream segment slope	%	0.02–1.65	0.08–1.11
Mean annual runoff	ML	745–187984	9205–76783
CPUE of *C. expansa*	No. trap-day^{-1}	0–0.5	0–0
CPUE of *C. longicollis*	No. trap-day^{-1}	0–18.0	0–19.0
CPUE of *E. macquarii*	No. trap-day^{-1}	0–9.5	0–17.0
CPUE of *M. bellii*	No. trap-day^{-1}	0–15.3	0–0

Results

Altogether, the survey yielded 1656 captures (including recaptures) from 1443 individual turtles, 88% of which were effected with cathedral traps, 11% with fyke nets and <1% by hand. The captures comprised four species: the broad-shelled turtle, *Chelodina expansa* Gray, 1857 (7% of sites; <1% of captures); the eastern long-necked turtle, *Chelodina longicollis* (Shaw, 1794) (77% of sites; 37% of captures); the Macquarie turtle, *Emydura macquarii macquarii* (Gray, 1830) (33% of sites; 24% of captures); and *M. bellii* (48% of sites; 39% of captures). *M. bellii* was represented by four separate populations in the Namoi, Gwydir, Severn and Deepwater river systems, the last two being within Border Rivers basin (Fig. 1). It was not recorded at any site east of the Great Dividing Range or in the most downstream sites on the western rivers.

Among sites at which *M. bellii* was recorded, its CPUE varied substantially (mean 2.8 turtles per trap-day; range = 0.2–15.3), as did the proportion of the total turtle catch that it represented (mean 58%; range = 2–100%). *M. bellii* was frequently recorded as coexisting with *C. longicollis* but never with *C. expansa* and only rarely with *E. macquarii*. The distributions of *M. bellii* and *E. macquarii* were sharply demarcated in the Namoi River, with *E. macquarii* found only downstream of a steep river section with large cascades in Warrabah National Park, whereas *M. bellii* was found only upstream of this section (Fig. 1). A similar segregation occurred in the Severn River, with *E. macquarii* not recorded upstream of a steep, cascading reach in the Severn River Nature Reserve, whereas *M. bellii* was not recorded downstream of this reach. In the Gwydir River, a steep river section containing large cascades lies immediately downstream of Copeton Dam, and *M. bellii* was not recorded downstream of this section (Fig. 1). However, in this case *E. macquarii* was found above the cascades, but only immediately upstream in Lake Copeton and not at any other upstream site. Individuals of *E. macquarii* sampled from the lake were mostly juveniles, suggesting a population that is rapidly increasing and possibly derived from a recent translocation such as a release of unwanted pet turtles. In the Deepwater River, *E. macquarii* was apparently absent from the most upstream reaches sampled, but its range substantially overlapped that of *M. bellii*. The Deepwater River lacks a section with large cascades but is somewhat isolated because the Mole River, which is formed by the junction of the Deepwater and Bluff rivers, is mostly a shallow, braided, sandy river with few deep pools. The Macintyre River, within the Border Rivers Basin, has a steep section, including the Macintyre Falls, immediately upstream of its junction with the Severn River (Fig. 1). However, *E. macquarii* was recorded at three of four sites sampled upstream from the falls whereas *M. bellii* was not found at any site in the Macintyre River system.

The frequency distribution of carapace length of *M. bellii* was bimodal because of the substantial size difference between adult males and females in this species (Fig. 2). Excluding recaptures, 4% of *M. bellii* were below the size at which sexual dimorphism develops, compared with 6% of the *C. longicollis* and 10% of the *E. macquarii* caught at sites west of the Great Dividing Range (Fig. 2). The difference from *M. bellii* was highly significant for *E. macquarii* (Chi-square test, $P < 0.001$) but not for *C. longicollis* ($P = 0.11$). The proportion of *M. bellii* below the size of sexual dimorphism differed significantly among river systems (Chi-square test, $P = 0.003$), being highest in the Deepwater (9%), followed by the Severn (8%), Gwydir (6%) and Namoi (1%).

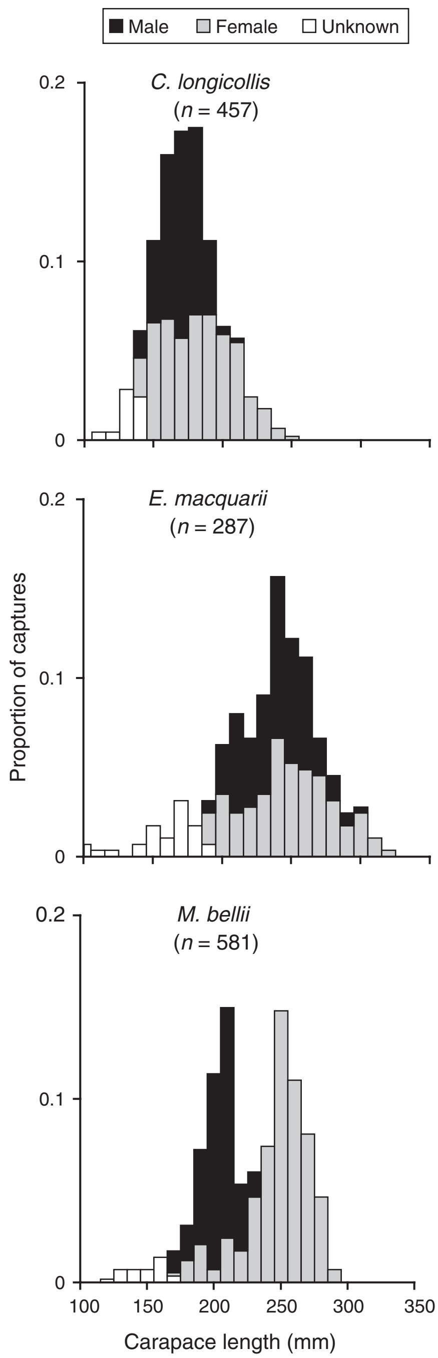

Fig. 2. Frequency distributions of carapace lengths (rounded to the nearest 10 mm) of *Chelodina longicollis*, *Emydura macquarii* and *Myuchelys bellii* captured from all sites west of the Great Dividing Range, excluding recaptures.

Of those *M. bellii* larger than the threshold of dimorphism, 62% were females – a highly significant departure from a 1 : 1 sex ratio (Chi-square test, $P < 0.001$). This skew may have been a consequence of unequal capture probability because the recapture rate (% of all captures that were recaptures) was significantly higher for females (12%) than for males (6%) (Chi-square test, $P = 0.02$). The recapture rate for turtles smaller than the threshold of dimorphism was intermediate (7%), and not significantly different from the rate for larger turtles with both sexes combined (Chi-square test, $P = 0.65$). The proportion of females differed significantly among river systems (Chi-square test, $P = 0.01$), being highest in the Namoi (67%), followed by the Gwydir (60%), Severn (41%) and Deepwater (40%).

The size distribution of *M. bellii* differed significantly among the four river systems in which the species occurred for both males (ANOVA, $P < 0.001$) and females ($P = 0.002$) larger than the threshold of dimorphism (Fig. 3). Males from the Severn River system were significantly larger than those from each of the other river systems (Tukey's tests, $P < 0.001$), and females from the Deepwater River were significantly smaller than those from each other system (Tukey's tests, $P < 0.01$).

Excluding recaptures, 8% of *M. bellii* had visible abnormalities in one or both eyes, including cataracts, darkening, swelling, shrunken pupils and missing eyes. These abnormalities were not observed in turtles smaller than the threshold of sexual dimorphism, and above the threshold were significantly and substantially more frequent in females (12%) than in males (3%) (Chi-square test, $P < 0.001$). The incidence of eye abnormalities differed significantly among river systems (Chi-square test, $P < 0.001$), being greatest in the Namoi (15%), followed by the Severn (8%), Gwydir (2%) and Deepwater (0%). Carapace length and body condition did not differ significantly between turtles with and without eye abnormalities for either females (*t*-tests, $P = 0.15$ and 0.13 respectively) or males ($P = 0.51$ and 0.15). Turtles with ocular abnormalities may survive for many years, because a female *M. bellii* captured and marked in 2006 (Fielder *et al*. 2014), when it was apparently blind in both eyes (D. Fielder, pers. comm.), was recaptured in the present study in 2015 in the same state. Obvious disease other than eye problems was rare, but several individuals had varying degrees of healed shell damage.

The GLM of CPUE of *M. bellii* was restricted to the 53 sites west of the Great Dividing Range because eastern sites appeared to be beyond the potential range of the species. The CPUE of *C. expansa* was not included as a predictor in the model because that species was so rarely captured. The overall model explained a substantial proportion of variation in CPUE of *M. bellii* ($R^2 = 0.48$) and was highly significant ($P < 0.001$). Mean annual air temperature and abundance of *E. macquarii* had significantly negative effects on abundance of *M. bellii*, while mean annual runoff had a significantly positive effect (Table 2). The distribution of model residuals was not significantly different from normal (Shapiro–Wilk test, $P = 0.43$).

The typical reach from which *M. bellii* was collected consisted of deep pools (maximum depth >2 m) separated by shallow sections with dry beds (for less perennial rivers in drier climatic periods) or riffles (for more perennial rivers and in wetter periods). The pools typically contained abundant underwater cover in the form of boulders, logs and macrophyte beds. *M. bellii* was never observed in shallow water during the day, but overnight captures and recaptures indicated that it often moved into shallows and between pools overnight, presumably while foraging. During dry periods, many long reaches of the study rivers lacked any

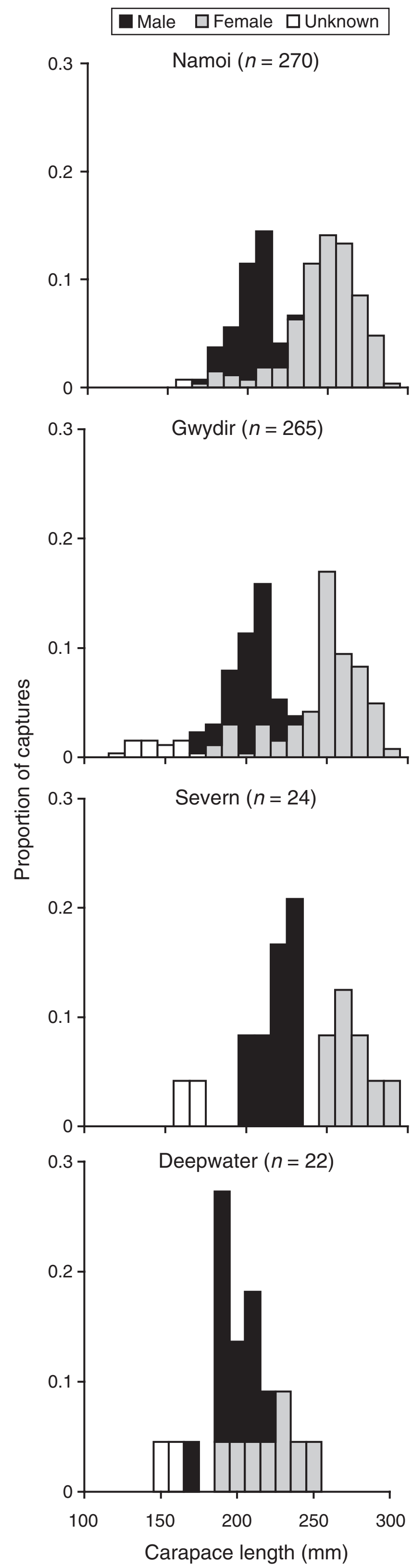

Fig. 3. Frequency distributions of carapace lengths (rounded to the nearest 10 mm) of *Myuchelys bellii* captured from the Namoi, Gwydir, Severn and Deepwater river systems, excluding recaptures.

Table 2. Results of the GLM of CPUE of *Myuchelys bellii* for all sites west of the Great Dividing Range

Effect	Coefficient	s.e. of coefficient	Tolerance	*t*	*P*
Constant	0.850	0.902		0.942	0.351
Mean annual air temperature	–0.154	0.070	0.500	–2.208	0.032
Log_e(segment slope)	–0.103	0.072	0.872	–1.441	0.156
Log_e(mean annual runoff)	0.200	0.068	0.670	2.929	0.005
4th root CPUE of *Chelodina longicollis*	0.008	0.127	0.866	0.065	0.949
4th root CPUE of *Emydura macquarii*	–0.360	0.129	0.580	–2.793	0.008

suitable daytime habitat and *M. bellii* was confined to the remaining deep pools.

Discussion

This study has clarified the geographic range of *M. bellii* in the Namoi and Gwydir river systems, establishing its downstream limits and showing that it is widely distributed in larger waterways upstream of those limits. It has also increased the number of recognised populations of the species from three (Fielder *et al.* 2014) to five, and narrowed the apparent gap between the New South Wales and Queensland ranges of the species (Cogger 2014; Fielder *et al*. 2014), by demonstrating the widespread occurrence of *M. bellii* in the New South Wales portion of the Border Rivers basin.

M. bellii was the turtle species most commonly captured at sites west of the Great Dividing Range and, on average, made up the majority of catches at those sites where it was recorded. However, the current distribution of *M. bellii* in New South Wales and Queensland is fragmented. Its five populations in separate river systems seem unlikely to interchange by terrestrial dispersal across drainage divides, because *M. bellii* was never observed on land apart from one female on a river bank that was probably preparing to nest. In addition, *M. bellii* was not found in any river east of the Great Dividing Range, even where suitable habitat was present and *E. macquarii* was absent, although some eastern and western river systems on the New England Plateau are separated by only a few kilometres of gently sloping or undulating terrain.

Captures of *M. bellii* in New South Wales were greatly dominated by large adults, suggesting a low rate of recruitment, possibly due to losses of eggs and hatchlings to a variety of terrestrial and aquatic predators (Fielder *et al*. 2014). Sampling predominantly with baited traps may have biased against the capture of juveniles (Ream and Ream 1966), but any such bias appeared to be limited because the recapture rate did not differ significantly between turtles smaller and larger than the threshold of sexual dimorphism. A low proportion of juveniles may not signal population decline if adult survivorship is very high, but any rise in mortality could threaten population persistence because of infrequent recruitment and the long time taken by *M. bellii* to reach maturity. No dead individual or remains of *M. bellii* was found during the present study, but Fielder *et al.* (2014) reported some deaths in New South Wales due to recreational fishing. Eye abnormalities have been reported previously for *M. bellii* with a comparable incidence to that found in the present study (Fielder *et al*. 2014), and may contribute to adult mortality, but the current results suggest that they do not impair body condition or preclude long-term survival.

Statistically significant differences among rivers systems were found for the proportion of *M. bellii* below the threshold of sexual dimorphism, the sex ratio of *M. bellii* above this threshold, the mean body sizes of males and females, and the incidence of eye abnormalities. However, values for the Deepwater and Severn River systems may be unreliable because of low sample sizes. The population in the Namoi River system stands out for its high incidence of eye abnormalities, as also reported by Fielder *et al*. (2014), and low proportion of small individuals, attributes that may signify an ageing population. A significantly biased sex ratio has been reported previously for the Namoi River system (Fielder *et al*. 2014) but, as noted above, may be an artefact of unequal capture probabilities.

M. bellii was captured in large numbers at several sites whereas elsewhere it appeared to be quite rare. The GLM results indicated that it was more abundant in river reaches with lower mean annual air temperatures and greater mean annual flow. The former relationship reflects its high-elevation distribution and the latter is probably due to the tendency for rivers with greater flow to have larger and deeper pools (Hubert and Kozel 1993; Buffington *et al*. 2002), which provide daytime and refuge habitat for the species. The reduction in availability of deepwater habitat that occurs during drought could have adverse effects on *M. bellii*, particularly if drought becomes more prevalent in the future as climatic modelling suggests (Wanders and Wada 2015; Zhao and Dai 2015).

The strong negative association between *M. bellii* and *E. macquarii* could conceivably reflect either different habitat requirements or interspecific competition. However, the observed distribution of the two species in relation to natural physical barriers to turtle dispersal (large cascades and waterfalls) suggests that competition has played a major role, likely resulting from dietary overlap between the two genera (Spencer *et al*. 2014). The fragmented current distribution of *M. bellii*, and the lack of strong genetic differentiation between northern and southern populations (Fielder *et al*. 2012), suggest that it was formerly more widely and continuously distributed and has suffered range contraction, most likely caused by range expansion of *E. macquarii*. Three of the four *M. bellii* populations in New South Wales are confined to higher elevations where barriers appear to have naturally prevented access by *E. macquarii* (those in the Namoi, Gwydir and Severn River systems). In the Macintyre River system, *E. macquarii* has somehow been able to reach areas upstream of Macintyre Falls, and *M. bellii* is apparently absent from the entire system, even though it contains suitable habitat and lies between other rivers inhabited by *M. bellii*. The two species do coexist in the Deepwater River, where upstream dispersal of *E. macquarii* is not prevented by any major barrier although it is perhaps constrained by the shallowness of the Mole River. However, *E. macquarii* is numerically dominant over *M. bellii* in the Deepwater River except in the farthest upstream section, and may still be in the process of displacing *M. bellii*. Range expansion of *E. macquarii* has possibly been facilitated by anthropogenic habitat alteration (Spencer *et al*. 2014) and by climatic warming since the last glacial period.

E. macquarii may be a superior competitor because of greater fecundity than *M. bellii*, faster maturation and larger maximum size. Populations of *E. macquarii macquarii* within the Murray–Darling drainage division have a mean clutch size of ~20, with some females producing two and possibly three clutches per annum (Chessman 1978; Thompson 1983; Judge 2001; Spencer 2002), thereby exceeding the reproductive output of *M. bellii* reported by Fielder *et al*. (2014). In addition, female *E. macquarii* mature at ~10 years (Chessman 1978; Spencer 2002), about half the maturation age of *M. bellii* (Fielder *et al*. 2014). Continued range expansion by *E. macquarii*, facilitated by translocation, is likely to be a serious risk to *M. bellii* populations, although low temperatures might perhaps exclude *E. macquarii* from the most elevated areas where *M. bellii* occurs.

In summary, *M. bellii* is more widely distributed and abundant in New South Wales than has previously been appreciated, but nevertheless faces several potential threats. While its geographic range is now well established, additional studies are necessary to assess its status against IUCN Red List criteria relating to population size and trend (IUCN 2012). No data exist on past trends for New South Wales populations but the present study and that of Fielder *et al*. (2014) can form a baseline for future monitoring. Research on population dynamics is needed to assess recruitment and mortality rates and develop demographic models of New South Wales populations, while the risks imposed by competition, predation, disease and drought need to be better understood. Molecular genetic analysis would probably shed further light on the origin of the population of *E. macquarii* in Lake Copeton. If this population is left unchecked, it is highly likely that *E. macquarii* will eventually invade the entire upper Gwydir River system, reducing or even eliminating the *M. bellii* population.

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Conservation Advice for *Myuchelys belli* (western saw-shelled turtle)

In effect under the *Environment Protection and Biodiversity Conservation Act 1999* from 15 March 2023.

This document combines the approved Conservation Advice and Listing Assessment for the species. It provides a foundation for conservation actions and further planning.

Adult female *Myuchelys belli* (western saw-shelled turtle) from Roumalla Lagoon, Gwydir Drainage.

Conservation status

Myuchelys belli (western saw-shelled turtle) is listed in the Endangered category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwth) (EPBC Act) effective from 15 March 2023.

The western saw-shelled turtle was assessed by the Threatened Species Scientific Committee to be eligible for listing as Endangered under Criteria 1 and 2. The Committee's assessment is at Attachment A. The Committee's assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: A2bce + A3bce + A4bce: Endangered.
- Criterion 2: B2ab(ii,iii,v): Endangered.
- Criterion 3: Ineligible.
- Criterion 4: Ineligible.
- Criterion 5: Insufficient data.

The main factors that make the western saw-shelled turtle eligible for listing in the Endangered category are its restricted Area of Occupancy, distribution fragmented into six isolated populations, potential for populations to be impacted by disease, continuing decline in Area of Occupancy, habitat quality, and ongoing high nest predation rates by *Vulpes vulpes* (red foxes).

Species can also be listed as threatened under state and territory legislation. For information on the current listing status of this species under relevant state or territory legislation, see the Species Profile and Threat Database.

Species information

Taxonomy

There are two widely used genus names for the saw-shelled turtles; *Wollumbinia* and *Myuchelys.* The genus name *Myuchelys* (Cann 1978) is accepted by the scientific community and used in NSW Assessments and Saving Our Species Profiles. Further, the species is also known as the western sawshell turtle but is referred to below as the western saw-shelled turtle based on the Australian Society of Herpetologists' Official List of Australian Species (30 June 2022).

The western saw-shelled turtle was initially described from a single specimen of unknown provenance as *Phrynops belli* in 1844 and presumed to have come from South America. A distinctive turtle was collected from the headwaters of the Namoi River in the 1970s which was regarded as a unique new species by Cann (1978). Thomson and Georges (2009) later described the genus as *Myuchelys*. This assignment was confirmed by mitochondrial sequencing of the type specimen and sequence comparisons with that of extant individuals (Kehlmaier et al. 2019). The western saw-shelled turtle is well defined and no subspecies are recognised, though it is currently distributed in three disjunct headwaters of the Namoi, Gwydir and Border Rivers subdrainages of the Murray-Darling Basin (Fielder 2013). There may be additional population-genetic structure within the Border Rivers.

Description

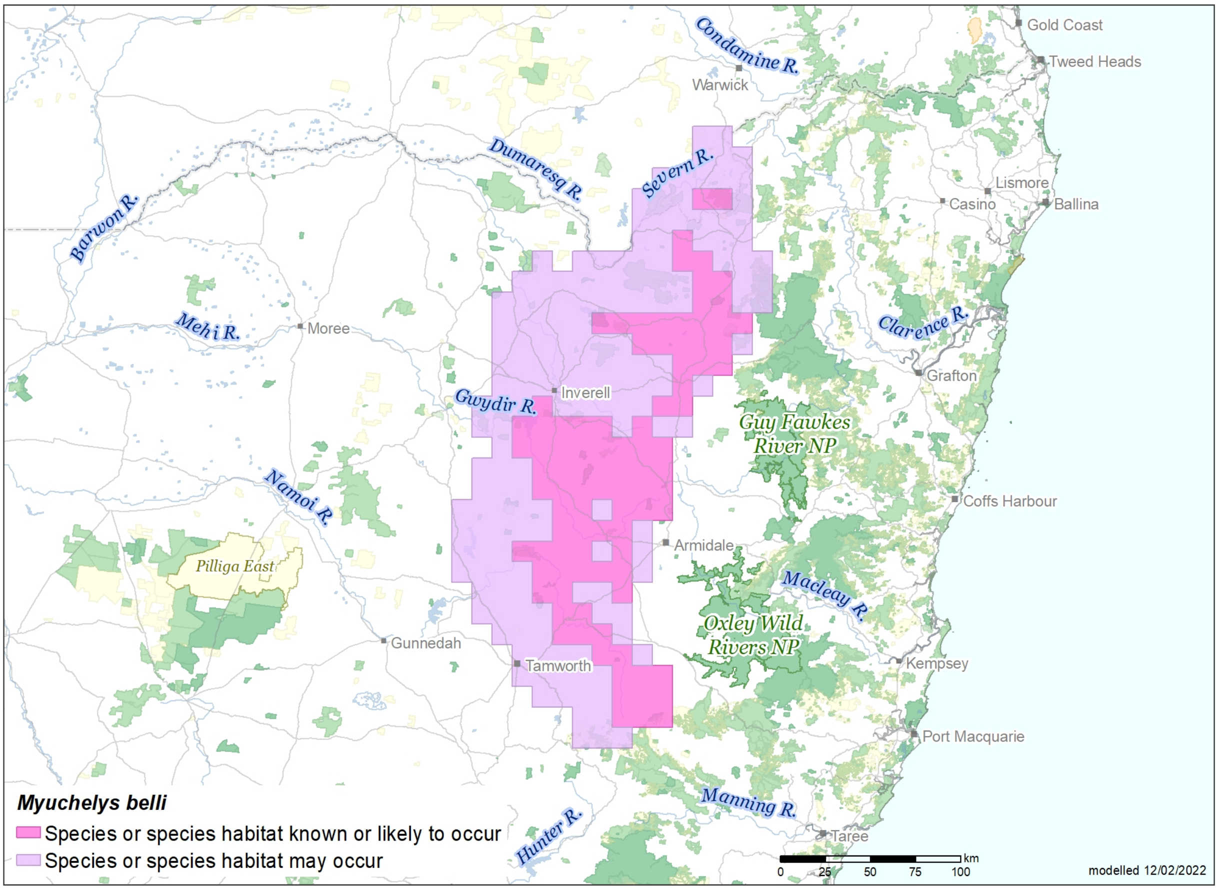
The western saw-shelled turtle (family Chelidae) is a medium-sized, short-neck freshwater turtle, with a maximum carapace length of 30 cm for females and 22.7 cm for males (Fielder 2013; Fielder et al. 2015). The carapace of adults is light to dark brown in colour, oval-shaped with a serrated edge of the hind marginal scutes (Fielder et al. 2015; Cann & Sadlier 2017). The plastron of adults is predominately black with cream or pale yellow blotches on the anterior section (Fielder et al. 2015; Cann & Sadlier 2017). In juveniles, the carapace is brown with patches of yellow-olive-green, and plastron is black with pale patches (Fielder et al. 2015; Cann & Sadlier 2017). A ridge along the centre of the carapace and serrated outer edge of the hind marginal scutes are prominent in juveniles (Cann & Sadlier 2017). The crown of the head has a shield that extends to the tympanum. Two to four barbels are present under the lower jaw (Cann & Sadlier 2017). A distinct cream-yellow band extending from the angle of the jaw down the neck is common in juveniles, but fades is near non-existent in adults (Cann & Sadlier 2017). The neck is slate grey dorsally with prominent tubercules (Fielder et al. 2015). The iris of the eye is dull olive green (Cann & Sadlier 2017). Males are smaller than females and can be distinguished by the precloacal part of the tail, which is deeper, longer and more developed in males than females (Legler & Georges 1993).

Distribution

The western saw-shelled turtle occurs in three catchments of the New England region of north-eastern New South Wales and the Darling Downs region of southern Queensland (Chessman 2015). Each of these are subdrainages of the Murray-Darling Basin. The western saw-shelled turtle inhabits the Macdonald River in the Namoi catchment, the Gwydir River system upstream of Copeton Dam, and Border Rivers subdrainage, in particular the Deepwater River upstream of its confluence with Bluff River and the Severn River within and upstream of the Severn River Nature Reserve (Chessman 2015; Fielder et al. 2015). Within the Border Rivers subcatchment, the western saw-shelled turtle is absent from the Macintyre River system (Chessman 2015). In Queensland, the western saw-shelled turtle is restricted to an 8 km stretch of Bald Rock Creek in Girraween National Park (Fielder et al. 2014). The western saw-shelled turtle has only been detected to the west of the Great Dividing Range, despite the presence of suitable habitat in the east (Chessman 2015). An anecdotal report from the 1970's states western saw-shelled turtles were in the Macquarie Marshes, New South Wales (Fielder et al. 2012); however, this has not been verified.

There are six subpopulations recorded of western saw-shelled turtles. In New South Wales they occur in the upper Namoi River and tributaries, upper Gwydir River and tributaries, upper Severn River and tributaries, the Deepwater River and Copes Creek, and Bald Rock Creek in Queensland (Chessman 2015; Chessman 2021, pers comm, 2 December 2021). Bald Rock Creek, the Deepwater River and upper Severn River and tributaries all lie in the Border Rivers basin of the Murray-Darling Drainage Division (Chessman 2021, pers comm, 2 December 2021). Surveys from 2012 to 2015 did not detect any western saw-shelled turtles in streams between these subpopulations (Chessman 2015). Western saw-shelled turtles are unlikely to move between rivers owing to the lack of river connectivity with suitable habitat and their disinclination to migrate over land (Chessman 2015).

Map 1 Modelled distribution of the western saw-shelled turtle



Source: Base map Geoscience Australia; species distribution data Species of National Environmental Significance database.
Caveat: The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything containing herein.
Species distribution mapping: The species distribution mapping categories are indicative only and aim to capture (a) the habitat or geographic feature that represents to recent observed locations of the species (known to occur) or habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

Cultural and community significance

The cultural, customary and spiritual significance of species and the ecological communities they form are diverse and varied for Indigenous Australians and their stewardship of Country. This section describes some examples of this significance but is not intended to be comprehensive or applicable to, or speak for, Indigenous Australians. Such knowledge may be held by Indigenous Australians who are the custodians of this knowledge and have the rights to decide how this knowledge is shared and used.

The Anaiwan, Banbai, Bundjalung, Dhanggati, Kamilaroi and Ngoorabul nations occupy the Northern Tablelands region (Duncan & White 2015). The New England Tablelands lacks the abundance and diversity of freshwater fish that occurs on the coast and downstream inland rivers. Therefore, as one of the turtle species at the time and the largest in biomass, western saw-shelled turtles and their eggs were probably a significant food source to Indigenous people who once obtained food from creeks and waterholes in the New England Tablelands (Walker 1966). Heavy agriculture and European occupation of the New England Tablelands in the 1800's caused a dramatic retraction in the Indigenous population (Clayton-Dixon 2020). Indigenous nations in the Northern Tableland region may refer to turtles as Bingihng (Bundjalung language), Dhawarr, Yiwaang, Yurra (Dhanggati language) or Yiwanga (Nganyaywana language; Duncan & White 2015). However, it is unknown to what extent the western saw-shelled turtle specifically is culturally significant.

Relevant biology and ecology

Habitat

Western saw-shelled turtles occur in the temperate region of the New England Tableland, in Queensland and New South Wales, Australia (Fielder et al. 2014). The New England Tableland is characterised by flat and undulating terrain on the New England plateau, covering elevations between 600 and 1500 m, and steep slopes in the east and west (NSW National Parks and Wildlife Service 2003). The climate is temperate, with wet summers and cold dry winters (Fielder et al. 2014). Open forests and woodlands are common throughout the New England Tableland (NSW National Parks and Wildlife Service 2003).

The three catchments that the western saw-shelled turtle occupies — the Namoi, Gwydir and Border Rivers subdrainages of the Murray-Darling Drainage Basin — have each been subjected to habitat modification through land clearing for agricultural practices and water extraction. European settlement occurred in the catchments in the 1830s and 1840s. Cattle and sheep grazing are the dominant land use in the area (Murray-Darling Basin Authority 2021a, b & c).

Water infrastructure such as dams and weirs are common throughout the New England Tableland, diverting water to the lower catchment and other tributaries (Murray-Darling Basin Authority 2021a, b & c). In the Gwydir River catchment, the main dam —Copeton Dam on the Gwydir River (1364 GL) — regulates 93 per cent of inflows to the catchment, and western saw-shelled turtles only occur upstream of the dam (Murray-Darling Basin Authority 2021b). Anderson Weir marks the downstream extent of western saw-shelled turtles in Bald Rock Creek (Fielder et al. 2014). In the Namoi River, Warrabah National Park marks the downstream extent (Chessman 2015).

The western saw-shelled turtle lives in habitat that often forms deep pools (~ 2 m deep) characterised by granite boulders and bedrock, separated by either riffles or dry beds (Chessman 2015; Fielder et al. 2015). The aquatic habitat is complex with underwater caverns, aquatic macrophytes and coarse granite sand substrate (Fielder et al. 2014). Overhanging banks are common throughout the species' range (Fielder et al. 2014). Western saw-shelled turtles do not appear to inhabit lentic waterbodies (Chessman 2015; Fielder et al. 2015). Adult western saw shell turtles have not been observed in shallow water during the day but may move into shallow waters overnight (Chessman 2015). Juvenile turtles preferentially occupy vegetated littoral regions of rivers and do not become displaced during moderate floods (Streeting 2021, pers comm, 30 November 2021). Western saw-shelled turtles are highly aquatic and leave the water only to bask and lay eggs. Basking occurs on exposed logs and rocks during the active months and increases during spring when average water temperatures are < 20°C (Fielder 2012).

Life-history and reproduction

The western saw-shelled turtle is long-lived, has high mortality early in life and a delayed onset of sexual maturity (Iverson 1991). The estimated age at sexual maturity is 10.6 years for females and 6.1 years for males based on growth rings, and ~19 years for females and ~9 years for males (Fielder et al. 2014). Growth models developed by Chessman (2021) for the Gwydir River system suggest sexual maturity may be reached at 11 years for females and 7 years for males. Estimated life expectancy is predicted at over 40 years (Fielder et al. 2014). The generation length estimated here following IUCN principles as age at first reproduction + z * length of reproductive period, where age at first reproduction has been calculated as 15 years, midway between the estimates proposed by Chessman (2021) and Fielder et al. (2014), and z has been specified as 0.4 (Fung & Waples 2017). The generation length is therefore estimated as 15 + 0.4*(40-15) = 25 years.

Western saw-shelled turtles travel across land to lay their eggs, excavating loose soil to bury their eggs on the stream bank between September and January (Cann 1998; Fielder et al. 2014). These egg laying sites (nests) often consist of sand, soil in rock benches, loamy substrates and shingle substrates (Nesbitt & Austin 2018; Nesbitt et al. 2019; Nesbitt et al. 2020; Streeting et al. 2021). They tend to bury their eggs on bare areas of banks, often in disturbed areas where livestock access water from the river (Streeting et al. 2021). The median distance that they lay their eggs from the water's edge is 2.5 m (range 0.3 –11 m, n =258) and the median height above water level that they nest is 1.0 m (range 0 –5 m, n = 234) (Streeting 2021, pers comm, 30 November 2021). One disturbed natural nest located in 2007 on the banks of the Macdonald River was ~8 m from the water's edge, on a steep slope and in loamy granite soil (Fielder et al. 2014). The nest had a depth of ~200 mm (Fielder et al. 2014). Average clutch size is 19.1 ± 4.2 (range 11 – 30, n = 29 clutches) and mean egg mass is 8.3 ± 1.3 g (range 5 – 11.8, n = 553) (Streeting 2021, pers comm, 30 November 2021). Annual fecundity is estimated as 14.3 eggs per adult female (Fielder et al. 2014). Fielder et al. (2014) estimated that on average approximately 78 per cent of females in Bald Rock Creek are gravid in any one season, however confidence on this number is low due to small sample sizes.

In the Namoi River, sex ratios are biased towards females. Neither Border nor Gwydir River subpopulations have a sex ratio bias (Fielder et al. 2014). Adult western saw-shelled turtles dominated the size structure of the subpopulations sampled in New South Wales between 2012 and 2015, suggesting low rates of recruitment (Chessman 2015). Additionally, survey data from Redleaf Environmental (2021), Spark (2020) and Chessman (2021) show populations across their range are skewed toward older individuals, with few juveniles captured. Sampling in these surveys were predominately conducted with baited traps and may have been biased towards the capture of adults, however Chessman (2015) suggests any bias would be limited as the recapture rate did not differ significantly between smaller and larger turtles. The skew towards older individuals suggests a lack of recruitment owing to low embryo, hatchling or juvenile survival (Chessman 2021; Redleaf Environmental 2021). Sampling in the Gwydir River system between 2012 and 2021, suggests survival to age three (well before maturity) is only 0.2 per cent (Chessman 2021). The Deepwater River subpopulation also shows signs of a lack of recruitment (Redleaf Environmental 2021).

Western saw-shelled turtles undertake aquatic hibernation and submerge at a depth of > 3 m when ambient water temperatures are between 5 – 8 °C (Fielder 2012). They are one of two recorded pleurodiran species undertaking aquatic hibernation as an overwintering strategy (Fielder 2012).

Respiration

Western saw-shelled turtles can respire aquatically (Fielder 2012). Using cloacal bursae , water is taken in and expelled periodically (Fielder 2012), similar to *Myuchelys georgesi* (Bellinger River sawshell turtle) (King & Heatwole 1994). Aquatic respiration through cloacal breathing extends the dive duration of freshwater turtles (Priest & Franklin 2002). In winter, western saw-shelled turtles have extended dive times of three to four days in length, with a maximum dive time of 15.5 days (Fielder 2012). Diving behaviour in spring and autumn is characterised by longer resting dives during the night and shorter dives in the day. Conversely, in summer, dives become longer and deeper in the day, with increased activity in shallow water at night (Fielder 2012). Generally, acute exposure to increased suspended-sediment concentrations may result in greater reliance on aerial breathing and shorter dive durations in freshwater turtles (Schaffer et al. 2016). Thus, changes to aquatic habitat, such as dams and weirs, that lead to more still water or increase sedimentation may lower habitat quality.

Diet

Western saw-shelled turtles are omnivorous and do not appear selective in their diet (Fielder et al. 2014; Fielder et al. 2015). Examination of faecal matter showed they ingest vegetation including aquatic plants, filamentous algae, freshwater sponges, leaves and stems, and terrestrial fruits such as blackberry seeds (Fielder et al. 2014). Faecal matter also included *Euastacus suttoni* (freshwater spiny crayfish), aquatic and terrestrial windfall insects (Fielder et al. 2014). *Daphnia* spp. (water fleas) were also reported in stomach contents of two wild western saw-shelled turtles from the Macdonald River (Hughes et al. 2020a).

Movement and dispersal

Capture-recapture data suggests that adult male western saw-shelled turtles may move long distances (tens of kilometres in the river), while adult females tend to show high site fidelity with some being recaptured in the same pool after a decade (Chessman 2021, pers comm, 2 December 2021). Two male western saw-shelled turtles have been recaptured over 40 km from their original location of capture (Northern Tablelands Local Land Services 2018). Radio-tracked hatchling turtles moved between 108 – 2834 m over 14 days (Streeting 2021, pers comm, 30 November 2021). Shallow rivulets flowing through grass and sedge were used by hatchling turtles to move between deeper pools in the stream and they moved in both upstream and downstream directions (Streeting 2021, pers comm, 30 November 2021). Activity of the radio-tracked hatchlings was primarily diurnal and individuals were not displaced during a moderate sized flood (Streeting 2021, pers comm, 30 November 2021).

Habitat critical to the survival

The habitat critical to the survival of the western saw-shelled turtle in New South Wales is the upper Namoi River and tributaries, upper Gwydir River and tributaries, upper Severn River and tributaries, the Deepwater River and Copes Creek, and Bald Rock Creek in Queensland with these characteristics:

- Deep (~ 2 m deep) pools separated by riffles or dry beds on a range of rock geologies and stream morphologies. Overhanging banks are common throughout the species range. Connectivity between such waterholes must also be maintained to allow turtles to move along and between each waterway in the catchment.
- Sand, soil in rock benches, loamy substrates and shingle substrate adjacent to rivers and streams, and access to them, to provide the major nesting requirements for the species.
- Riparian vegetation that acts as a buffer against high water temperatures by providing instream shade, contributes to the influx of energy, nutrients and other resources (e.g., invertebrate cases) in the form of organic matter (i.e., leaves, bark and twigs), and provides river snags for basking and refugia, and nesting sites. Aquatic and riparian vegetation also provides shelter for hatchlings and small juveniles.

Habitat critical to the survival or important habitats of a species or ecological community refers to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal;
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species/subspecies or ecological community, such as pollinators);
- To maintain genetic diversity and long-term evolutionary development; or
- For the reintroduction of populations or recovery of the species or ecological community.

Any breeding or foraging habitat in areas where the species is known or likely to occur and any newly discovered breeding or foraging locations should be considered habitat critical to the survival. Areas that are not currently occupied by the species, but which may become suitable in the future, should also be considered habitat critical to survival.

No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat.

Important populations

In this section, the word population is used to refer to subpopulation, in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

All populations of western saw-shelled turtle are important for the conservation of the species across its range.

Threats

Table 1 Threats

Threats in Table 1 are noted in approximate order of highest to lowest impact, based on available evidence.

Threat	**Status and severity** [a]	**Evidence**
Invasive species		
Predation by *Vulpes* (red fox)	• Timing: current and future • Confidence: known • Likelihood: almost certain • Consequence: catastrophic • Trend: static • Extent: across the entire range	Predation by the red fox is a significant threat to freshwater turtles in Australia (Van Dyke et al. 2019). Red foxes destroy turtle nests and kill nesting females, with 93% of turtle nests destroyed at localities of other Australian freshwater turtle populations (Thompson 1983). Red foxes destroy the nests of western saw-shelled turtles (Spark 2020; Streeting 2021, pers comm, 30 November 2021). Between 2017 and 2021, 499 western saw-shelled turtle nests were found preyed on by red foxes, an estimated nest predation rate of 97.8% (Streeting 2021, pers comm, 30 November 2021). In 2018-19 the dog survey team' Canines for Wildlife' discovered 104 out of 114 western saw-shelled preyed on turtle nests in the Namoi River catchment; 57 out of 67 nests were raided in the Gwydir River catchment, and 11 out of 13 in the Border Rivers catchment (Nesbitt et al. 2019). The high nest predation rates experienced in the range of western saw-shelled turtles has likely contributed to the skew towards older individuals observed across their range (Spark 2020, Redleaf Environmental 2021, Chessman 2021). During sampling of the Beardy Waters and Severn River between 2017 and 2021, no immature turtles or smaller adult turtles were detected (Redleaf Environmental 2021). The Deepwater River subpopulation also shows signs of a lack of recruitment (Redleaf Environmental 2021). Sampling in the Gwydir River system between 2012 and 2021, suggested survival from oviposition to age 3 years was only 0.2% (Chessman 2021).
Habitat modification and predation by introduced fish species	• Timing: current • Confidence: inferred • Likelihood: likely • Consequence: moderate • Trend: unknown • Extent: across part of its range	Although, the threat of introduced aquatic species to western saw-shelled turtles is not quantified, Chessman (2021, pers comm, 2 December 2021) suggests introduced trout and redfin (*Perca fluviatilis*) may prey on turtle hatchlings. Stocking of Australian native predatory species such as Murray cod and golden perch beyond their natural ranges may also be a significant threat to juvenile turtles (Chessman 2021, pers comm, 2 December 2021). In Bald Rock Creek, high numbers of invasive *Carassius auratus* (goldfish) are present (Fielder et al. 2014) and potentially contribute to habitat modification as they increase sedimentation and water turbidity.

Threat	**Status and severity** [a]	**Evidence**
Disease		
Novel disease	• Timing: current/future • Confidence: suspected • Likelihood: possible • Consequence: catastrophic • Trend: unknown • Extent: unknown	In February 2015, a novel nidovirus (now known as the Bellinger River Virus, BRV) caused mass mortality of *Myuchelys georgesi* (Bellinger River sawshell turtle) (Zhang et al. 2018; Spencer et al. 2018; Chessman et al. 2020), a sister species to the western saw-shelled turtle (Le et al. 2013). At least 433 Bellinger River sawshell turtles died, the majority of which were adults (Zhang et al. 2018; Chessman et al. 2020). It is unknown whether BRV could affect western saw-shelled turtles. However, given that turtles can be translocated across the landscape, this is a possible threat. Coupled with increased susceptibility of adult turtles to BRV (Zhang et al. 2018; Chessman et al. 2020) and the skew towards adults in the western turtle population (Spark 2020; Redleaf Environmental 2021; Chessman 2021), an outbreak of BRV could be detrimental to western saw-shelled turtle survival. Additionally, the same virus is suspected to have caused signs of disease and death in a captive collection of Australian freshwater turtles in Queensland (Wildlife Health Australia 2021a). In 2021, the fungus *Nannizziopsis barbatae* was detected in the Sydney Region, in two wild freshwater turtles (one *Chelodina longicollis* (eastern long-neck turtle) and one *Emydura macquarii* (Macquarie River turtle)). This was the first detection of the fungus in turtles globally and neither turtle survived (Wildlife Health Australia 2021b). This fungus could also impact the western saw-shelled turtle. A study conducted by Fielder et al. (2015) found that 10% of turtles collected in the Gwydir and Namoi River catchments suffer from an unknown eye disease that can cause blindness in adults.

Threat	Status and severity [a]	Evidence
Climate change		
Increase in the intensity and frequency of drought and flooding events	• Timing: current/future • Confidence: suspected • Likelihood: almost certain • Consequence: major • Trend: increasing • Extent: across the entire range	In the north coast region of NSW, there are projected increases in both minimum and maximum temperatures (maximum 0.4–1.0°C by 2039 and 1.5-2.4°C by 2060–2079) and an increase in the number of hot days (days above 35°C). Rainfall is projected to decrease in winter and increase in autumn and spring (NSW Government 2014). The threat of increasing climate change is likely to affect nesting success of the species as changes in temperature will negatively impact hatchling survival. This may be one of the most difficult threats to manage. The western saw-shelled turtle appears to prefer river reaches with low mean annual air temperatures, and high mean annual flow (Chessman 2015). Increasing drought as a result of climate change may reduce the availability of suitable deep-water habitat for western saw-shelled turtles. Furthermore, receding water levels due to drought in 2019-20, coincided with western saw-shelled turtles laying nests lower down the bank than previously recorded (Streeting 2021, pers comm, 30 November 2021). This became problematic when high rainfall in January caused river levels to rise and inundate nests. Lower nests which were inundated for longer by flooding were unsuccessful (Streeting 2021, pers comm, 30 November 2021). Flood events can also lead to scouring of stream banks and beds, incision of the stream bed and removal of aquatic and littoral vegetation which can decrease habitat quality. Flooding may also lead to increased sedimentation and in-filling of pools, reducing pool depth and therefore reducing habitat quality. *Threat interactions* Poor management of grazing pastures during drought that reduce ground cover below 100% may lead to increased sediment transport during these rainfall events.

Threat	Status and severity [a]	Evidence
Disturbance regimes		
Fire regimes that cause declines in biodiversity†	• Timing: current/future • Confidence: suspected • Likelihood: almost certain • Consequence: major • Trend: increasing • Extent: across the entire range	*Fire regimes that cause biodiversity decline* are included on the EPBC Act list of Key Threatening Processes (DAWE 2022). Fires regimes vary across Australia between landscapes and climate types. The mechanisms that underpin fire-related threats are diverse - different fire regimes have been shown to disrupt life cycles or degrade habitats in diverse ways, depending on the characteristics of different species, ecological communities and climate types. While some fire regimes threaten species directly by reducing their survival and/or reproduction, many impacts of fire regimes on biodiversity are indirect, either because they alter habitats, disrupt dependencies among species, or exacerbate impacts of other threats (i.e., promote feral animal incursion, pathogen spread) (DAWE 2022). Anthropogenic fragmentation of ecosystems, alteration to ignition patterns, and climate change are causing major alterations to the core elements of fire regimes, in particular increasing the frequency (number of fires per unit time at a point in the landscape), intensity (heat release at a point in the landscape during a specified fire event), and fire severity (impacts of the fire on vegetation) (DAWE 2022). Australia experienced the warmest and driest year on record in 2019, with the average mean temperature 1.52°C above average (Bureau of Meteorology 2020). NSW experienced a mean temperature 1.95°C above average and total rainfall below average in 2019 (Bureau of Meteorology 2020). Dry conditions and reduced rainfall experienced in south-eastern Australia since 2017 contributed to drought conditions experienced in 2018 and 2019 and the subsequent 2019-2020 summer fires (Hughes et al. 2020b). Fires may burn the banks and stream bed, leaving sparse understorey and loss of riparian vegetation which is relied upon by the western saw-shelled turtle. Rainfall after fire events can also cause ash and silt to wash into streams, causing a spike in turbidity, altering river substrate and removing deep pools (Kemter et al. 2021). A recent expert elicitation of the 2019-2020 fires predicted a 24% decline in the western saw-shelled turtle population, with much uncertainty (80% CL: 11-57%), over three generations (Legge et al. 2022). Current climate projections predict an increase in the scale, frequency, and intensity of bushfires (CSIRO & BOM 2020).

Threat	**Status and severity** [a]	**Evidence**
Habitat degradation and modification		
Water extraction	• Timing: current • Confidence: known • Likelihood: almost certain • Consequence: moderate • Trend: static • Extent: across the entire range	Water extraction for agriculture, particularly during drought conditions is a threat to western saw-shelled turtles. A large waterhole on the Macdonald River was subjected to water extraction during drought conditions during which 43 western saw-shelled turtles were rescued from the waterhole due to the lack of water (Northern Tablelands Local Land Services 2020). Most channels of the upper Gwydir River and major tributaries dried during the 2019-2020 drought. Western saw-shelled turtles did not congregate in residual pools but were caught in previously dry reaches soon after flow returned, which suggests that western saw-shelled turtles may be able to survive short periods of river drying by aestivation (Chessman 2021, pers comm, 2 December 2021).
Removal of instream boulders and riparian vegetation	• Timing: historical • Confidence: known • Likelihood: likely • Consequence: moderate • Trend: unknown • Extent: across part of its range	Loss of core daytime habitat due to infilling of deep pools by mobile sediment as a result of bank and catchment erosion may be a long-term threat to western saw-shelled turtles. Fielder et al. (2012) reports the subpopulation at Bald Rock Creek (fewer than 400 individuals in an 8 km stretch), has experienced significant habitat modification through the mechanical removal of riparian vegetation and instream boulders reducing the structural habitat complexity for aquatic animals. Large parts of the Macdonald River and the upper Gwydir River and some of its tributaries are geomorphologically unstable, which is aggravated by tree clearing and grazing by hard-hoofed livestock, generating large quantities of mobile sediments (Chessman 2021, pers comm, 2 December 2021).
Human activities		
Recreational fishing	• Timing: current/future • Confidence: suspected • Likelihood: almost certain • Consequence: minor • Trend: unknown • Extent: unknown	Freshwater turtles may be caught on fishing lines by fishers. Several turtle deaths from recreational fishing have been recorded (Fielder et al. 2014). The species may be illegally killed by recreational fishers, and they are also likely to drown in illegal yabbie traps. The number of turtles killed due to recreational fishing impacts is likely to be underestimated because carcasses do not persist for long and are not readily found or observed. Mortality due to fishing impacts is problematic because it disproportionally kills large adult turtles that can swallow baited hooks, and long-lived adult turtles are a critically important component of threatened turtle populations. It is unknown the extent to which the species is caught on fishing lines but highlights the potential impact of freshwater turtles caught as bycatch (Dillon 2022).

Threat	**Status and severity** [a]	**Evidence**
Translocation of other freshwater turtle species		
Introduction of *Emydura macquarii* (Macquarie River turtle) outside of their normal range and potential displacement of western saw-shelled turtles.	• Timing: current • Confidence: known • Likelihood: likely • Consequence: moderate • Trend: unknown • Extent: across part of its range	The distribution of western saw-shelled turtles had no or minimal overlap with Macquarie River turtles until the 1990s (Chessman 2021). Chessman (2021) identified that Macquarie River turtles in the Gwydir River system were introduced, potentially from the release of unwanted pets. Chessman (2015) found a strong negative association between numbers of western saw-shelled turtles and Macquarie River turtles. In the Deepwater River where the western saw-shelled turtle appears to occur naturally, Macquarie River turtles have become numerically dominant and Chessman (2015) suggests Macquarie River turtles may be in the process of displacing western saw-shelled turtles. Further range expansion of Macquarie River turtles is likely a serious risk to western saw-shelled turtles, particularly as Macquarie River turtles have faster maturation and higher fecundity than western saw-shelled turtles. However, the magnitude of this impact on the total distribution and population size of western saw-shelled turtles is not known. Human-mediated translocation of the turtles may be ongoing as individual Macquarie River turtles were caught in Beardy Waters at the Glen Innes water supply dam in 2020, marking the first record of this species in the Severn/Beardy waters catchment upstream of Pindari Dam (Dillon 2021, pers comm, 6 December 2021) Introduced Macquarie River turtles hybridise with the Bellinger River sawshell turtle (Georges et al. 2018) and may also hybridise with western saw-shelled turtles, in which case genetic swamping by the Macquarie River turtle could be a threat to the western saw-shelled turtle.
Movement of other freshwater turtle species into the range of western saw-shelled turtles	• Timing: future • Confidence: suspected • Likelihood: possible • Consequence: moderate • Trend: unknown • Extent: across part of its range	*Myuchelys latisternum* (saw-shelled turtle) has been reported in Girraween National Park, within the range of western saw-shelled turtles. Saw-shelled turtles are not native to the Murray-Darling Basin and may threaten western saw-shelled turtles through competition and interbreeding (Fielder et al. 2015).

†Fire regimes that cause declines in biodiversity include the full range of fire-related ecological processes that directly or indirectly cause persistent declines in the distribution, abundance, genetic diversity or function of a species or ecological community. 'Fire regime' refers to the frequency, intensity or severity, season, and types (aerial/subterranean) of successive fire events at a point in the landscape.

[a]Timing—identifies the temporal nature of the threat
Confidence—identifies the nature of the evidence about the impact of the threat on the species
Likelihood—identifies the likelihood of the threat impacting on the whole population or extent of the species
Consequence—identifies the severity of the threat
Trend—identifies the extent to which it will continue to operate on the species
Extent—identifies its spatial context in terms of the range of the species

Each threat has been described in Table 1 in terms of the extent that it is operating on the species. The risk matrix (

Table 2) provides a visual depiction of the level of risk being imposed by a threat and supports the prioritisation of subsequent management and conservation actions. In preparing a risk matrix, several factors have been taken into consideration, they are: the life stage they affect; the duration of the impact; the spatial extent, and the efficacy of current management regimes, assuming that management will continue to be applied appropriately. The risk matrix and ranking of threats has been developed in consultation with experts and using available literature.

Table 2 Risk Matrix

Likelihood	Consequences				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain		**Recreational fishing**	**Water extraction**		**Predation by red foxes**
Likely			**Removal of instream boulders and riparian vegetation** **Habitat modification and predation by introduced fish species** **Range expansion by Macquarie River turtles**	**Fire regimes that cause biodiversity decline** **Increased intensity and frequency of droughts and floods**	
Possible			**Translocation of other freshwater turtle species**		**Susceptibility to novel diseases**
Unlikely					
Unknown					

Risk Matrix legend/Risk rating:

Low Risk	Moderate Risk	High Risk	Very High Risk

Priority actions have then been developed to manage the threat particularly where the risk was deemed to be 'very high' or 'high'. For those threats with an unknown or low risk outcome it may be more appropriate to identify further research or maintain a watching brief.

Categories for likelihood are defined as follows:
Almost certain – expected to occur every year
Likely – expected to occur at least once every five years
Possible – might occur at some time
Unlikely – known to have occurred only a few times
Unknown – currently unknown how often the threat will occur
Categories for consequences are defined as follows:
Not significant – no long-term effect on individuals or populations

Minor – individuals are adversely affected but no effect at population level
Moderate – population recovery stable or declining
Major – population decline is ongoing
Catastrophic – population trajectory close to extinction

Conservation and recovery actions

Primary conservation objective

The western saw-shelled turtle population is sustained throughout the Gwydir, Namoi and Border Rivers subdrainages, with all age classes represented, due to successful breeding and recruitment, and the area of occupancy and extent of occurrence have increased.

Conservation and management priorities

Invasive species (predation by red foxes, introduced fish; and range expansion by introduced Macquarie River turtles)

- Control the impact of red foxes at high priority nesting sites through baiting, shooting, trapping and/or den fumigation.
- Continue to monitor nesting beaches for turtle nests and continue installation of fox-exclusion fencing at key nesting areas to reduce impact of red fox predation, in addition to protecting intact nests with a low-profile steel mesh cage, or by staking wire rabbit/chicken mesh over individual nests with a mesh size of at least 40 mm that excludes predators but still allow hatchlings to escape when they emerge from their nest (Streeting et al. 2021).
- Remove Macquarie River turtles from outside of their range in the Gwydir River system and Severn River.
- Monitor the genetic diversity of western saw-shelled turtles, paying particular attention to erosion of genetic diversity within each of the fragmented populations, inbreeding, and levels of genetic diversity in the context of potential hybridisation with other species.
- Monitor the impact from invasive fish species such as trout, redfin and goldfish. If the impact on the western saw-shelled turtle increases, prevent any further introductions or stockings. This should include a public education program to ensure no further species are introduced.

Disease

- Continue to restrict and discourage translocation between catchments of turtles and other species that may be reservoirs for disease.
- Continue to implement suitable biosecurity protocols including washing and sterilisation of aquatic equipment used in the catchments. Continue to restrict the use of equipment to single catchments to avoid the risk of transmitting pathogens and parasites between catchments. Issue a public recommendation for the management of hygiene, washing and sterilisation of aquatic equipment.
- Continue to monitor western saw-shelled turtles for the presence of pathogens (through targeted or passive surveillance), including, but not limited to, the Bellinger River Virus and unknown eye disease that is currently causing blindness in the population.

Fire regimes that cause biodiversity decline

- Consult with and engage cultural knowledge custodians and land rights holders with the intention to enable knowledge sharing and Caring for Country practices. This should include trials of cultural burning to assess how it modifies habitat suitability for the species.
- Conduct broadscale monitoring of the western saw-shelled turtle to detect potential impacts of fire events on populations and their habitat, in particular increased water temperature, riparian habitat zones, and effects of post-fire ash and sediment run off.
- Develop and implement fire management plans and actions within, or affecting, areas within the species distribution, including:
  - Identify and map suitable habitat areas.
  - Avoid physical damage to identified habitat during fire management operations.
  - Implement immediate and ongoing red fox control in burnt habitat.
  - Manage unburnt areas within or adjacent to recently burnt areas from further fire, in order to provide refuge sites, as well as unburnt areas that are not adjacent to burnt areas.
  - Include an adaptive management approach to adjust management actions as new information comes to light about the resilience or susceptibility of the species to fire and interacting threat impacts.

Increased intensity and frequency of droughts and floods

- Conduct broadscale monitoring of western saw-shelled turtle to detect impacts of drought and flood on populations and habitats, in particular increased short-term nutrification and long-term sedimentation/substrata effects.

Habitat loss disturbance and modifications

- Consult with landholders to implement management actions to limit the loss of riparian vegetation and instream boulders.
- Continue to implement riparian restoration strategies, including ongoing involvement of private land managers in the protection and management of riparian vegetation, removal of weed species.
- Implement suitable water extraction protocols for periods of low flow to maintain refugia pools during times of drought. Liaise with water management authorities to create triggers around cease-to-flow actions in the event of drought and prolonged low flow.

Ex situ recovery action

- Continue to induce turtle eggs from gravid females for artificial incubation to bypass fox predation on turtle nests and limit potential exposure to disease.
- Continue to release artificially incubated western saw-shelled turtle hatchlings, noting that biosecurity and genetic integrity are important. Western saw-shelled turtle hatchlings from different catchments should be kept separately in captive conditions and hatchlings released back to the catchment from which eggs were collected.

Stakeholder engagement/community engagement

- Continue to educate and encourage stakeholders (land managers and Indigenous Rangers) to monitor turtle populations and nesting sites, and to implement nest protection measures where possible.
- Encourage stakeholders to report any sightings of western saw-shelled turtles via the TurtleSAT citizen science program (http://www.turtlesat.org.au), NSW BioNet (https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/nsw-bionet) and WildNet (https://www.qld.gov.au/environment/plants-animals/species-information/wildnet).
- Educate communities in the catchment to identify predated nests and protect intact nests as instructed in the '1 Million Turtles' program (https://1millionturtles.com/). This work needs to be done in close collaboration with relevant local community groups.
- Expand participation by landholders in spatially coordinated annual and seasonal fox control programs.
- Actively engage the Anaiwan, Banbai, Bundjalung, Dhanggati, Kamilaroi and Ngoorabul people in the conservation of western saw-shelled turtles and its habitat, working with them to develop conservation actions, including the implementation of Indigenous fire management and other survey, monitoring and management actions. Enable the sharing of knowledge, while ensuring the processes and protocols to record, store, and share any knowledge are agreed and appropriately resourced. Information on the application of cultural burning and integrated Caring for Country practices to protect and enhance habitat is of critical importance.

Survey and monitoring priorities

- Monitor population change in western saw-shelled turtles throughout their range by ongoing surveying of sites, with a focus on understanding population sizes and demographics, and the causes of changes in these measures. Priority areas should be chosen in the context of current and future threats.
- Determine the population trends of the western saw-shelled turtle populations using new techniques at representative locations and extrapolated to cover the whole catchment. Distinction needs to be made between an index of abundance (useful for monitoring trends) and estimates of actual abundance (useful for assessing extinction risk). Sampling should be repeated at least every 5 years with appropriate precision to enable assessment of trends.
- Support and enhance existing programs targeted at monitoring nesting areas and protecting western saw-shelled turtle nests.
- Monitor and assess the effectiveness of conservation actions and interventions and develop methods for monitoring juvenile turtles that are not readily surveyed using traps

Information and research priorities

- Determine the range expansion of Macquarie River turtles and whether hybridisation or displacement is occurring between the Macquarie River turtle and the western saw-shelled turtle in their overlapping distributions.

- Determine if variation in water quality has significant impacts on the western saw-shelled turtle.
- Investigate the micro-habitats used and required by hatchling and juvenile western saw-shelled turtles.
- Conduct research into the potential impacts of a temperature increase of 1.5 °C
- Investigate the cause/s of eye disease identified in western saw-shelled turtles.
- Further develop techniques and strategies to increase egg harvest, improve incubation success and captive husbandry.
- Investigate the impacts of flooding and inundation on western saw-shelled turtle nest and egg survival.
- Determine the incidence of turtle mortality and injury related to recreational fishing bycatch or entanglement in discarded nylon fishing line.

Recovery Plan decision

As an approved, updated, and detailed Conservation Advice for the species would provide sufficient direction to implement priority conservation actions, mitigate against key threats, enable recovery and provide foundation for further planning, a national Recovery Plan is not required at this time.

Consequently, the Threatened Species Scientific Committee has not recommended that a Recovery Plan be required (see Attachment A for TSSC recommendations regarding the need for a recovery plan).

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The Threatened Species Scientific Committee finalised this assessment on 7 September 2022.

Attachment A: Listing Assessment for *Myuchelys belli*

Reason for assessment

The devastating bushfires that burnt more than 10 million hectares across southern and eastern Australia in 2019-20 severely impacted native wildlife and habitat. This created an urgent need for hundreds of species and ecological communities (ECs) to be assessed against EPBC Act criteria for threatened listing status, so that the recovery and future resilience of fire-affected species and ECs could be supported by statutory protection commensurate with their post-fire status, and to ensure EPBC Act lists are as current and accurate as possible, helping improve environmental resilience and preparedness for future fire events.

As part of the Australian Government's bushfire response the Department engaged scientific experts to deliver a number of Species Expert Assessment Plans (SEAPs) for groups of fire-affected and non-fire affected of species and ECs that were affected by the 2019-20 fires, or could be affected by similar fire events in the future, to enable hundreds of species and ECs to be assessed against EPBC Act criteria for threatened listing status and improve the currency of EPBC Act lists in a timely manner.

This assessment follows evaluation of the conservation status of the western saw-shelled turtle through the SEAP project.

Assessment of eligibility for listing

This assessment uses the criteria set out in the EPBC Regulations. The thresholds used correspond with those in the IUCN Red List criteria except where noted in criterion 4, sub-criterion D2. The IUCN criteria are used by Australian jurisdictions to achieve consistent listing assessments through the Common Assessment Method (CAM).

Key assessment parameters

Table 3 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria. The definition of each of the parameters follows the Guidelines for Using the IUCN Red List Categories and Criteria.

Table 3 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	>20,000	20,000	80,000	The subpopulation size of western saw-shelled turtles in Bald Rock Creek, Queensland for the period 2002 to 2009 was estimated at <400 individuals (Fielder et al. 2014). Based on sampling by Chessman (2015), 581 western saw-shelled turtles were captured across the NSW subpopulations, excluding Copes Creek. A total of 270 individuals were captured from Namoi River, 265 from Gwydir River, 24 from Severn River and 22 from Deepwater River (Chessman 2015). Given that adult western saw-shelled turtles dominated the size structure of all NSW subpopulations sampled, the number of mature individuals likely correlates closely to sample records. Based on capture-mark-recapture analysis by Chessman (2021), an estimate of 15,000 individuals was reported for the Gwydir River catchment. Therefore, it can be assumed that the capture sizes from Chessman (2015) underestimates the total subpopulation size. Hence, the minimum plausible value was estimated by adding the Chessman estimates from 2015 and 2021, assuming some increases due to underestimates. Given these underestimates in Chessman (2015), the estimate used in the assessment was >20,000 mature individuals. Extrapolating the number of individuals recorded in Chessman (2021) to the capture rates in 2015 gave a maximum plausible value of 80,000 for the number of mature individuals.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	contracting			Survey data from Fielder et al. (2014), Chessman (2015), Redleaf Environmental (2021) and Spark (2020) show populations across the western saw-shelled turtle's range are skewed toward larger individuals, with few juveniles captured. This suggests a lack of recruitment due to low embryo/hatchling/juvenile survival. In some subpopulations, there appears to be no recruitment (Redleaf Environmental 2021). This severe lack of recruitment is inferred to have impacted the past and will impact in the future total number of mature individuals in these subpopulations. Additionally, a recent expert elicitation of the 2019-2 wildfires predicted a 24% decline in the western saw-shelled turtle population, with much uncertainty (80% CL: 11-57%), over three generations (Legge et al. 2022). Chessman (2021) did not detect a significant change in the average density of western saw-shelled turtles in the Gwydir River system between 2012 and 2021, suggesting this subpopulation may be stable.
Generation time (years)	25	23	27	The generation length of the western saw-shelled turtle is not known and has been estimated here following IUCN principles as age at first reproduction + z * length of reproductive period, where z has been specified as 0.4 (Fung & Waples 2017). First reproduction has been calculated as 15 years, midway between the estimates proposed by Chessman (2021) (19 years) and Fielder et al. (2014) (11 years). The generation length is therefore estimated as 15 + 0.4*(40-15) = 25 years. We have assumed the minimum plausible value for generation length is 22.6 years (rounded to 23), based on a minimum age of reproduction of 11 years. We have assumed the maximum plausible value for generation length is 27.4 years (rounded to 27 years), based on a maximum age of first reproduction of 19 years.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Extent of occurrence	12 333 km^2	9 660 km^2	12 333 km^2	EOO of 12 333 km^2 was estimated based on minimum convex polygon. The minimum plausible value 9 660 km^2 is calculated from data obtained between the period of 2003 to 2021.
Trend	contracting			Lack of strong genetic differentiation between northern and southern populations suggest that western saw-shelled turtles were once more continuously and widely distributed, and may have suffered range contraction in the past (Fielder et al. 2012; Chessman 2015).
Area of Occupancy	192 km^2	140 km^2	192 km^2	AOO of 192 km^2 was estimated based on the 2x2 km grid. The minimum plausible value 140 km^2 is calculated from data obtained between the period of 2003 to 2021.
Trend	contracting			It has been inferred that the range expansion of the Macquarie River turtle has led to a range contraction in sympatric populations of western saw-shelled turtles (Chessman 2015).
Number of subpopulations	6	3	6	In New South Wales, western saw-shelled turtles are found in the upper Namoi River and tributaries, upper Gwydir River and tributaries, upper Severn River and tributaries, the Deepwater River and Copes Creek (Chessman 2015; Chessman 2021, pers comm, 2 December 2021). In Queensland the species is found in Bald Rock Creek (Chessman 2015).
Trend	stable			
Basis of assessment of subpopulation number	Comprehensive surveys of western saw-shelled turtle in NSW by Chessman (2015) from 2012-2015 showed four separate populations in the Namoi, Gwydir, Severn and Deepwater River systems. The Copes Creek population may be isolated from the population in the rest of the upper Gwydir River system by a weir near the downstream end of Copes Creek and possibly by Lake Copeton (Chessman 2021, pers comm, 2 December 2021). Alongside the known Queensland population of Bald Rock Creek, this brings the total number of populations to six.			
No. locations	3	1	3	The western saw-shelled turtle occupies three catchments and is exposed to a number of widespread threats which impact some drainages differently.
Trend	stable			

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Basis of assessment of location number	The Namoi, Gwydir and Border Rivers systems are not connected aquatically. While Copes Creek may also be isolated from the rest of the Gwydir River system, primary threats to the western saw-shelled turtle such as climate change and water extraction are likely to affect the Gwydir River Basin, including Copes Creek. For this assessment Copes Creek and the upper Gwydir subpopulations are considered to be one location. The western saw-shelled turtle in the Severn and Deepwater Rivers and Bald Rock Creek subpopulations are also likely to be similarly affected by threats such as drought events due to their locality, and as such have been classified as one location. The Namoi River system and its tributaries have been classified as the third location. Furthermore, in 2015 the Bellinger River sawshell turtle, this congeneric sister species (in the same genus as the western saw-shelled turtle) suffered mass mortality owing to a novel nidovirus (Zhang et al. 2018). Although the likelihood of such event occurring in the Namoi, Gwydir or Border Rivers systems is unknown, the close affinity between these species and current contraction of the western saw-shelled turtle due to fox predation and the associated male-skewed adult sex ratio may means that a single similar event could rapidly affect all individuals within a single catchment.			
Fragmentation	Not severely fragmented. Chessman (2015) suggests the subpopulations are unlikely to exchange individuals across drainages due to the remote chance of western saw-shelled turtles traversing over land, except when coming up onto stream banks for nesting. However, there are limited data available to support the species being severely fragmented.			
Fluctuations	Owing to the extreme longevity and overlapping generations, freshwater turtles are not subject to major fluctuations in abundance. Similarly, the number of mature individuals is not typically subject to extreme fluctuations.			

Criterion 1 Population size reduction

Reduction in total numbers (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered **Very severe reduction**	**Endangered** **Severe reduction**	**Vulnerable** **Substantial reduction**
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%

A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.

A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(*a) cannot be used for A3*]

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

Based on any of the following

(a) direct observation [except A3]
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Criterion 1 evidence

Eligible under Criterion 1 A2bce + A3bce + A4bce for listing as Endangered.

Survey data indicate a severe lack of recruitment, suggesting that many of the western saw-shelled turtle subpopulations are in decline. Lack of strong genetic differentiation between northern and southern subpopulations suggest that western saw-shelled turtle was once more continuously and widely distributed and has suffered range contraction in the past (Fielder et al. 2012; Chessman 2015).

Survey data from Redleaf Environmental (2021), Spark (2020) and Chessman (2021) show subpopulations across the range being skewed toward older individuals, with few juveniles captured. The skew towards older individuals suggests a lack of recruitment owing to low embryo, hatchling or juvenile survival likely caused by red fox nest predation (Chessman 2021; Redleaf Environmental 2021). Red foxes raid nests to prey on the eggs of western saw-shelled turtles (Spark 2020; Streeting 2021, pers comm, 30 November 2021). Between 2017 and 2021, 499 western saw-shelled turtle nests were found to have been raided by foxes, an estimated nest predation rate of 97.8 per cent (Streeting 2021, pers comm, 30 November 2021). The extent of these impacts is wide, and an estimate of decline as a result of red fox predation is likely to be severe, and unlikely to subside without management.

Habitat modification causing sedimentation, riparian degradation and water extraction, as well as increased droughts and reduced flooding due to climate change have a moderate to severe impact on western saw-shelled turtles, further contributing to the decline in recruitment.

Given the Beardy Waters and Severn River subpopulations of western saw-shelled turtles are approximately a quarter of the size of their historical abundance (Redleaf Environmental 2021) and red fox predation is limiting recruitment throughout western saw-shelled turtle's range (Spark 2020; Chessman 2021; Redleaf Environmental 2021) the overall subpopulation is inferred to have declined and continues to decline over three generations (75 years), by at least 50 per cent, qualifying the species for listing under Criterion A2b. Habitat modification, riparian degradation and climate change along with red fox predation further qualifies the species for listing under Criterion A2ce. Further, the causes of species decline have not ceased, qualifying the species for listing under Criteria A3bce and A4bce,

The Committee considers that western saw-shelled turtles have undergone a very severe reduction in numbers over three generations (75 years for this assessment), which is equivalent to at least 50 percent and the reduction and cause of the decline has not ceased. Therefore, the western saw-shelled turtle has met the relevant elements of Criterion 1 to make it eligible for listing as Endangered.

Criterion 2 Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy

	Critically Endangered Very restricted	**Endangered Restricted**	**Vulnerable Limited**
B1. Extent of occurrence (EOO)	**< 100 km²**	**< 5,000 km²**	**< 20,000 km²**
B2. Area of occupancy (AOO)	**< 10 km²**	**< 500 km²**	**< 2,000 km²**
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	**= 1**	**≤ 5**	**≤ 10**
(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			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Criterion 2 evidence

Eligible under Criterion 2 B2ab(ii,iii,v) for listing as Endangered.

The Extent of Occurrence (EOO) of 12,333 km² meets the threshold for Vulnerable under Criterion B1, and the Area of Occupancy (AOO) of 192 km² meets the threshold for Endangered under Criterion B2. Lack of strong genetic differentiation between northern and southern subpopulations suggest that the western saw-shelled turtle was once more continuously and widely distributed and has suffered range contraction in the past (Fielder et al. 2012; Chessman 2015). Chessman (2015) suggests the subpopulations are unlikely to exchange individuals across drainages; however, there is insufficient data available to classify the species as severely fragmented.

The western saw-shelled turtle occupies three locations corresponding to the three catchments it is known from (Table 3), and so meets subcriterion a) for Endangered.

Continued decline in AOO, habitat quality—due to construction of impoundments, water extraction and habitat modification by humans, and climate change, as detailed above—and an expected decline in the number of mature individuals due to lack of recruitment also qualifies this species as Endangered under subcriterion b(ii,iii,v).

The Committee considers that the western saw-shelled turtle's Area of Occupancy (AOO) is restricted, the number of locations is less than five and continuing decline is inferred in AOO, the quality of habitat and number of mature individuals. Therefore, the western saw-shelled has met the relevant elements of Criterion 2 to make it eligible for listing as Endangered.

Criterion 3 Population size and decline

	Critically Endangered **Very low**	**Endangered** **Low**	**Vulnerable** **Limited**
Estimated number of mature individuals	**< 250**	**< 2,500**	**< 10,000**
AND either (C1) or (C2) is true			
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	**Very high rate** **25% in 3 years or 1 generation** **(whichever is longer)**	**High rate** **20% in 5 years or 2 generation** **(whichever is longer)**	**Substantial rate** **10% in 10 years or 3 generations** **(whichever is longer)**
C2. An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each subpopulation	**≤ 50**	**≤ 250**	**≤ 1,000**
(a) (ii) % of mature individuals in one subpopulation =	**90 – 100%**	**95 – 100%**	**100%**
(b) Extreme fluctuations in the number of mature individuals			

Criterion 3 evidence

Not Eligible

The population size of the western saw-shelled turtle is estimated at >20,000 mature individuals Although there is some uncertainty surrounding this estimate, it is highly unlikely that the number of mature individuals is less than <10,000 (Table 3). Based on this population size, the subspecies is not eligible for listing under Criterion 3.

Therefore, the Committee considers that the western saw-shelled turtle has more than 10,000 mature individuals and is not eligible for listing under Criterion 3.

Criterion 4 Number of mature individuals

	Critically Endangered Extremely low	**Endangered Very Low**	**Vulnerable Low**
D. Number of mature individuals	< 50	< 250	< 1,000
D2.[1] *Only applies to the Vulnerable category* Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to Critically Endangered or Extinct in a very short time			D2. Typically: area of occupancy < 20 km^2 or number of locations ≤ 5

[1] The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments may include information relevant to D2. This information will not be considered by the Committee in making its recommendation of the species' eligibility for listing under the EPBC Act, but may assist other jurisdictions to adopt the assessment outcome under the *common assessment method*.

Criterion 4 evidence

Not Eligible

The total number of mature individuals of the western saw-shelled turtle is estimated at <20,000 (Table 3). Therefore, the western saw-shelled turtle has not met the required elements of criterion D to be listed.

The western saw-shelled turtle inhabits three catchments which each having the potential to be separately impacted by water extraction, climate change and/or disease. A disease event similar to that which impacted the Bellinger River sawshell turtle has the potential to affect the entire subpopulation within one catchment, but not affect the other two. Furthermore, the impact of these threats is likely to be exacerbated given that the western saw-shelled turtle's population has little recruitment.

The Committee considers that the number of locations is three, and there are potential future threats that could drive the western saw-shelled turtle to Critically Endangered or Extinct in a very short time. Therefore, the western saw-shelled turtle has met the relevant elements of Criterion 4 to make it eligible for listing as D2 Vulnerable. However, as noted above, species cannot be listed under criterion D2 under the EPBC Act.

Criterion 5 Quantitative analysis

	Critically Endangered **Immediate future**	**Endangered** **Near future**	**Vulnerable** **Medium-term future**
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

Criterion 5 evidence

Insufficient data to determine eligibility

Adequacy of survey

The survey effort has been considered adequate and there is sufficient scientific evidence to support the assessment.

Public consultation

Notice of the proposed amendment and a consultation document was made available for public comment for 33 business days between 11 July 2022 and 24 August 2022. Any comments received that were relevant to the survival of the species were considered by the Committee as part of the assessment process and provided to the Minister for the Environment with the Committee's advice.

Listing and Recovery Plan Recommendations

The Threatened Species Scientific Committee recommends:

i) that the list referred to in section 178 of the EPBC Act be amended by transferring *Myuchelys belli* from the Vulnerable category to the Endangered category.

ii) that there not be a Recovery Plan for this species in accordance with the provisions of the EPBC Act and the Committee's conservation planning principles as follows:

- An approved Conservation Advice is an effective, efficient and responsive document to guide the implementation of priority management actions, mitigate key threats and support the recovery for this EPBC Act listed Endangered species.
- An approved Conservation Advice would support the species recovery by identifying priority actions, stakeholders for engagement, and the survey and research priorities to facilitate a better understanding of key threats as well as biological and ecological knowledge gaps.
- The threats facing the entity, and the recovery actions needed can most effectively be guided via an approved Conservation Advice.
- The species is known from six subpopulations in north-eastern New South Wales (NSW) and south-eastern Queensland (QLD). In the upper Namoi River and tributaries, upper Gwydir River and tributaries, upper Severn River and

tributaries, the Deepwater River, Copes Creek (all in NSW) and in Bald Rock Creek (QLD). The key stakeholders are NSW State agencies, private landholders, local communities and Traditional Owners.

- The species is affected by the potential for populations to be impacted by disease, continuing decline in habitat quality, and ongoing high nest predation rates by foxes. However, these major threats are well-known and can be managed at local and state scales without the need for a Recovery Plan.

Having regard to the above factors, a Recovery Plan is not required as it would not provide a significant conservation planning benefit above existing mechanisms.

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Climate Change, Energy, the Environment and Water 2022, Conservation Advice for *Myuchelys belli* (western saw-shelled turtle), Canberra.

This publication is available at the SPRAT profile for *Myuchelys belli* (western saw-shelled turtle).

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Gmail [redacted]

Phil Spark's contact details

1 message

Marty Dillon <martin.dillon@lls.nsw.gov.au> 11 April 2024 at 16:04
To: [redacted]
Cc: [redacted]

Hi [redacted]

As I mentioned yesterday, [redacted] is a professional ecological consultant with direct experience in surveying for Bell’s turtles in Carlisles gully, and in approaching the owners of Pine Creek dam to request permission (unsuccessfully) to access the dam. Phil has also conducted extensive surveys of the very large population of Bell’s turtles in Kentucky reservoir on Kentucky creek near Uralla.

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Cheers,

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