Review - Gippsland Lakes Ocean access long-term monitoring and management plan

Prepared by
Gippsland Environment Group
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Overview

Gippsland Ports invited comment to the Gippsland Lakes Ocean Access Long-Term Monitoring and Management Plan which Gippsland Environment Group (GEG) has reviewed. We found the plan was incomplete on references and vital information, including the 2022 CSIRO report. The information provided was difficult to access and/or verify. Similarly, the uploading of documents to the Love Our Lakes website was confusing as dates in the URL did not match the date of review/study as some were decades old. GEG have referenced these studies to highlight concerns.

For decades GEG have lobbied for more active monitoring of biodiversity, in particular monitoring of salinity in the Gippsland Lakes. This would lead to authorities recognising that the current trajectory of increasing salinity must stop and provide for fully informed management decisions. Increasing salinity is also a Ramsar concern, with Australia's Ramsar Implementation Plan 2016-2018 stating, in relation to Gippsland Lakes, that "[i]n August 2017, the Victorian Government advised the Administrative Authority of a potential change in ecological character due to increasing salinity. A formal assessment is currently being prepared".

Gippsland Environment Group (GEG) has reviewed the *Long-Term Monitoring and Management Plan* (LTMMP) and is concerned self-assessment is not adequate in the absence of adequate monitoring.

Response summary

- GEG are concerned that incomplete monitoring of the downward trajectory of the Gippsland Lakes prevents evidence-based management.
- There are no measures of salinity or condition reports of smaller wetlands in the 40 years since listing and many may have changed unrecorded, from fresh or brackish to saline.
- Extending dredging permits to include other areas is a high risk to the ecology of the Gippsland Lakes.
- There is lack of planning for climate change in managing sea level rise and seawater ingression into the lake.
- The scour hole could be expensive for the government and the environment, especially that of the all-important outer barrier. The scour hole is potentially exacerbated by a deeper entrance.
- We question the necessity for the entrance to be deeper and the benefits of a potentially 'safer' navigation for vessels is at a cost of cumulative and continued decline in the condition of the Gippsland Lakes and loss of Ramsar sites.
- CMA and Ports authorities claimed at the TACC meeting that there is insufficient funding for a full EES in relation to the new dredging permit. It was claimed that it is not needed.

Authorities need first to acknowledge and identify the need for funding and go through the pathways to secure funding. The impacts of entrance and inner channels dredging to increased depths remain insufficiently monitored and under reported.

- As supporting material for an application for consent under the *Environment Protection (Sea Dumping) Act 1981 (Cth),* "the LTMMP needs to demonstrate how the environment at the port and surrounds will be protected over the longer term and should identify responsible parties and include mechanisms for the regular review of compliance with permit conditions, as well as a process for continuous improvement of environmental management and performance" (see Long Term Monitoring and Management Plan Requirements, Commonwealth Government Guidance 2011[1]) In our view, the LTMMP does not demonstrate protection and maintenance of environmental values as required by the Commonwealth guidance material.
- To the extent that the LTMMP is intended to be supporting material for an application for consent under the *Marine and Coastal Act 2018 (Vic)* ('MAC Act') there is a lack of detailed responsiveness to section 69 (Matters to which Minister must have regard in determining applications for consents) and Part 2 (Objectives and guiding principles for the planning and management of the marine and coastal environment). The LTMMP is not designed on its face as an assessment or response to MAC Act requirements set out in s 69 or its objectives and guiding principles. To the extent the LTMMP is intended to inform an application for consent under the MAC Act, we note that the Minister must ensure a consent is consistent with matters set out in the MAC Act, including:
    - The Marine and Coastal Policy (section 69(a)), which applies to the Gippsland Lakes and includes a policy that "the design and location of marine-based structures and access points… should minimise the need for capital and maintenance dredging" (section 10.6(c)) and a policy to "protect and seek to enhance the values and characteristics that contribute to natural features and landscapes (including seascapes) in the marine and coastal environment, including by managing cumulative effects" (section 3.1);
    - The Marine and Coastal Strategy (section 69(b)) which includes actions to "support sustainable use and development of the marine and coastal environment" (Action 4) and notes the need to review and update the Victorian Guidelines for Dredging to include risk-based environmental, human health and cultural protection practice and support their implementation (Action 4.10);
    - The objectives set out in Part 2 of the MAC Act (section 69(c)), notably:
        - To protect and enhance the marine and coastal environment (section 7(a));
        - To promote the resilience of marine and coastal ecosystems, communities and assets to climate change (section 7(b);
        - To respect natural processes in planning for and managing current and future risks to people and assets from coastal hazards and climate change (section 7(c));
        - To acknowledge traditional owner groups' knowledge, rights and aspirations for land and sea country (section 7(d));
        - To promote a diversity of experiences in the marine and coastal environment (section 7(e));
        - To promote the ecologically sustainable use and development of the marine and coastal environment and its resources in appropriate areas (section 7(f));

- To improve community, user group and industry stewardship and understanding of the marine and coastal environment (section 7(g));
- To engage with specified Aboriginal parties, the community, user groups and industry in marine and coastal planning, management and protection (section 7(h); and
- To build scientific understanding of the marine and coastal environment (section 7(i)).

The guiding principles set out in Part 2 (section 69(d)), including the principles of: Integrated coastal zone management (section 8); Ecosystem-based management (section 9); Ecologically sustainable development (section 10); Evidence-based decision-making (section 11); Precautionary principle (section 12); Proportionate and risk-based principle (section 13); and Adaptive management (section 14).

Current management of the Gippsland Lakes arguably fails to implement principles of ecologically sustainable development.[2]

Dredging risks

The GLOA LTMMP states the following,

This EPBC self-assessment has determined that the Gippsland Ports' GLOA program will not have a significant impact on any EPBC listed species, vegetation community or wetland of international importance based on the significant impact criteria provided by the 'Matters of National Environmental Significance: Significant Impact Guidelines 1.1' (DoE, 2013)

The DELWP response to the LTMMP notes that "it could be argued this document does not achieve Objective 4 [(Maintain local environmental, social and cultural values)] with respect to environment values. The structure of the document does not allow a ready understanding of how information generated by the current monitoring and management program is designed to ensure that there are no significant adverse impacts on the range of MNES and biodiversity values protected under State legislation in the Gippsland Lakes."[3]

The LTMMP does not meaningfully identify or address the potential impacts on matters of national environmental significance relevant to the dredging, particularly listed threatened species and ecological communities (section 18 and 18A EPBC Act), listed migratory species (section 20 and 20A EPBC Act), and as an action in a declared Ramsar wetland (section 16 and 17B EPBC Act).

The long-term marine influence from the opening of Lakes Entrance is identified as a threat to the ecological character of the Ramsar sites by the steering committee.[4] The LTMMP, p68 provides evidence of risk from dredging clearly identifying that dredging could cause long term hydrological changes within the lakes as noted in Table 21 below from their report.

Table 21: GLOA identified risk activities and stressors

		Activity							
		1	2	3	4	5	6	7	8
	Stressor	Dredging GLOA channel footprint	Introduction of a new vessel	TSHD dredge operation	CSD dredge operation	At-sea material placement	Onshore material placement	Vessel manage-ment	Sand Transfer Station
1	Hydrodynamic processes causing scour and erosion	●							
2	Hydrodynamic processes causing changes in salinity in the Lakes	●							

Salinity has also been identified as a risk by Ports, but the appropriate monitoring has not been implemented. The rise in water salinity is causing a major change in the functioning of a whole ecosystem, with significant impact to wetlands. (Described in the EPBC act as significant impact guidelines for Ramsar listing)

Base line studies

There is a lack of baseline studies and re-setting of the baselines. A particular concern relates to limits of acceptable change (LAC) defined for salinity of Lake Wellington which have been exceeded. Resetting the baseline (LAC) would exclude the possibility of rehabilitation of Lake Wellington and its Ramsar wetlands. Under the Ramsar Convention 1982, there is an obligation to maintain the ecological character of the site and the values they support.

After listing major changes in the depth of dredging of the entrance and inner channels have occurred, in effect raising the volume of the ocean outlet allowing more opportunity for the denser sea water to enter the lakes system. Failure to fully acknowledge that the primary source of salinity is from the dredged Entrance has led to avoidance of the obvious problem that the deepened entrance from 2008 has contributed to that increase. The salinity figures in all the lakes and Lake Wellington reflect that increase from 2008. Whilst East Gippsland Catchment Management Authority (EGCMA) constantly reference increasing salinity for Lake Wellington, the resolve to effectively assess and manage the threat has been inadequate.

- EGCMA (Ramsar 2016) rated the data on salinity in Lake Wellington as *Fair* but states limited evidence and expert opinion-based assessments
- EGCMA (GLTR 2022) again states that salinity is impacting on Ramsar sites

The following comments from the 2022 report are in the absence of proposed full monitoring for the trajectory of decline, what is causing the decline and what could lead to management pathways toward salinity reduction.

The lesson learnt from over two decades of investigations into shifts across stable states is that the strong feedback loops inherent in any change makes it almost impossible to reverse, no matter what the scale of management intervention
... There is evidence that salinity in Lake Wellington is increasing and the impact of this on the ecological character of the Ramsar site is currently being investigated. In addition, the Ramsar Site Management Plan (DELWP 2015) has a commitment to setting realistic rehabilitation goals for Lake Wellington.[5]

Resetting the baseline salinity would appear to facilitate continuation of the deeper entrance.

Hydrodynamic modelling and salinity

Gippsland Lakes (CSIRO, 1998) PDF p4 of 39 environmental audit recommended,

A three-dimensional hydrodynamic model of the Lakes needs to be constructed to examine in more detail the precise interactions of freshwater and marine inflows, tidal mixing and Entrance dynamics, and saltwater/freshwater balances.

There is no evidence these studies have been done, instead, a 2022 GLOA LTMMP review uses a previous 2013 review which does not show the most recent measurements of tidal constituents since 2013. The 2013 review does not address broader sets of questions beyond

adverse impacts, such as the effects of dredging on climate resilience or on opportunities for ecosystem recovery, restoration or enhancement. If no new data has been provided and assessed, the 2022 review conclusions about the degree of sensitivity the dredging had on the lakes system is unsupported. The pattern and regime of salinity in the lakes is consistent with the premise that the bulk of the salt comes from sea water invading at Lakes Entrance. Bird (1978) PDF p9/11

Key findings on p10 of the LTMMP, section 3.3.2 Hydrodynamic modelling review concludes that the shallowing of Reeves Channel gives a secondary control, and yet it is dredged to 4 meters.

Table 3: GLOA navigational area dimensions

Navigational area	Dimensions of navigation reliability (metres)		Maximum design target (metres)	
	Width	Depth	Width	Depth
Bar	80 to 450	3.5	80 (min)	4.5-5.5
Entrance channel	50	3.5	50	4.5
Swing basin	100 (dia.)	3.5	100 (dia.)	4.5
Cunninghame Arm	50	3.5	50	4.5
Reeves Channel to The Narrows	50	3.0	50	4.0
Hopetoun Channel	50	3.0	50	4.0
North Arm	50	3.0	50	4.0

A 1981 Tidal Scouring Report[6] found,

…significant tidal scour deepening due to erosion averages of 3 meters in Reeves channel reaching up to 9 meters in the narrowest section at Metung. Detectable scour has occurred as far West as Point Turner in Lake Victoria.

Additionally, an unsupported claim is made that this area towards Metung is unaffected by Ports dredging works. The LTMMP report states,

Changes in the tidal prism have little influence on the mixing and salinity regime.

But does not detail the hydrodynamic studies that it has used to come to this conclusion. A report on reducing salt intrusion into Lake Wellington (SKM, 2011) does not support Ports conclusion that the tide has little influence on the mixing and salinity regime.

2. THE SALINITY REGIME OF LAKE WELLINGTON
Salinity levels in the Gippsland Lakes system vary depending on relative influence of freshwater inflows from the catchment and marine water inflows through Lakes Entrance. Typically, salinity is close to seawater near the Lakes Entrance and in the eastern area of Lake King. However, during periods of low freshwater flow the salinity can be high throughout the Lakes. A wedge of highly saline water can also move many kilometres upstream into the inflowing rivers. Pdf p2 of 8

This is also supported over 40 years ago (Bird, 1978) that the entrance is the primary cause of salinity.

The tidal influence on the transfer of saline water affects a significant portion of the Gippsland Lakes region. While the tidal influence decreases further inland the influence is still measurable as far upstream is the lower Latrobe River. PDF p3 of 8

Likewise, the EGCMA (GLTR, 2022) notes salinity and tidal influences on p12.

3.1.3 Results

Summary

Indicator	Status and trends (Unknown / Poor / Fair / Good)	Summary
Salinity	 Lake Wellington  Lakes Victoria & King **Data quality:** Fair **Data custodian:** EPA Victoria	Salinity in the Gippsland Lakes is influenced by rainfall, river flow and tidal exchange. During periods of drought, when freshwater inflows are low, salinity rises across the system. Conversely during flood periods, salinity across all surface waters drops to near fresh. Salinity in Lakes King and Victoria was assessed as good, while salinity in Lake Wellington was assessed as poor (see Appendix 2). The EWMA plotted over time illustrates that while there have been patterns of variability in response to rainfall events, there has been no sustained change in salinity in Lakes King and Victoria. The salinity in Lake Wellington, however, has continued to increase over time, largely in response to reductions in freshwater inflows, but also influenced by rising sea levels (EPA Victoria 2013, 2015).

Data monitoring, hydrodynamic modelling, assessments -who is responsible and why there is still little data decades on?

It appears salinity monitoring stopped at McLennan Strait during the 2008 entrance deepening trial, or not publicly available, at a time when salinity was showing a sharp rise. This trial was the opportune time to increase, not to stop monitoring to assess the impact of a deeper entrance. The trial in 2008 by Ports may have taken navigation into account but there was no EES to assess environmental impacts. The dredging plan was then continued without critical qualitive assessments conducted.

Five ongoing salinity monitoring points over the 354 square kilometres of the Gippsland lakes are inadequate. Modernised, cross sectional water quality across many more sites within the lakes and fringing wetlands is needed. Water quality measurements once a month is not enough and should also include monitoring on high flow events to capture what is being suspended in the water column. Modern water quality stations can provide a nearly continuous record of water quality and it can be published or distributed by telemetry to the internet. This could be used to refine water quality procedures. [7]

Bird (1978) recognised the significance of the McLennan Strait noting,

Salinity at depth was generally greater than salinity in the surface water (see table), indicating that denser sea water had been spreading into the lakes at depth, and gradually mixing with the less saline surface water.

	Salinity (°/oo)	
	Surface	Near Floor
Off the Latrobe River Mouth	4.8	9.0
Centre of Lake Wellington	5.1	5.6
East Lake Wellington	4.9	4.9
West end McLennan Strait	4.9	8.0
East end McLennan Strait	6.2	17.3
West Lake Victoria	17.8	20.8

(Source: State Rivers & Water Supply Commission records for samples taken on 1st March 1959)

In 1959 salinity was distinctly increasing from east to west across the Lakes system and also in the Strait.

SKM (2011) also includes a focus on McLennan Strait.

These investigations demonstrated that salt water can be transferred from Lake Victoria to Lake Wellington even when there is a net outflow of water through McLennan Strait from Lake Wellington. Focusing on Lake Wellington in particular, there are a number of factors that determine its salinity:

- *Magnitude of river inflows*
- *Salinity of river inflows*
- *Salinity of Lake Victoria*
- *Important and export of salt to/from Lake Wellington via McLennan Strait.*
- *Rainfall*
- *Evaporation*
- *Groundwater interactions*
- *Tides*
- *Wind*
- *Ocean levels which are influenced by atmospheric pressure, wind and tides.*

This report cites seven previous publications that demonstrated that salt water can be transferred from Lake Victoria to Lake Wellington even when there is a net outflow of water through McLennan Strait from Lake Wellington.

Outflows must be larger than 130 GL/month before salt import reduces to zero. This is because dense saline water can be driven through the Strait and into Lake Wellington by tidal or wind induced currents even when fresher Lake Wellington water is flowing out near the surface of McLennan Strait.

The report also says the tidal influence is measurable as far upstream as the lower Latrobe River. In very dry times there is a net inflow from Lake Victoria to Lake Wellington. This concept is noted in SKM, 2010 technical report.

Therefore, how can this be refuted in Ports LTTMP on p25 claiming that tidal prism has little influence on the mixing and salinity regime? This claim ignores evidence of the salinity gradient from east to west and hydrodynamic studies. EGCMA (Ramsar 2016) Page 24 state there is a 2 CM tidal rise and fall in Lake Wellington. Anecdotally, it appears that tidal rise has increased. This is from observing the shore erosion at Marlay Point.

Hydrodynamic modelling

Instead of the three-dimensional hydrodynamic model that the CSIRO audit recommended, LTTMP (2022) is using a previous 2011 review (*Hydrodynamic and Salinity Effects Associated with TSHD on the Gippsland Lakes*)[8] which does not show the most recent measurements of

tidal constituents since 2011. If no new data has been provided and assessed, the 2022 review is unsupported. The Review done by Ports for Ports admits,

The inflow of saline water through the permanent entrance therefore provides the baseline salinity coming into Lake Wellington through McLennan Strait;

That 2011 report details some data from modelling the thousands of megalitres of water involved with 5cm tidal exchange from a 2001 study.

For a tidal range of 5 cm the volume of water exchanged from the ocean with Lake Victoria and Lake King is 9,000 ML. This is much less than the 45,000 ML volume of Reeve Channel (Bek and Bruton, 1979) which connects the Entrance to the main body of Lake King. Thus, water flowing through the Entrance penetrates only a fraction of the length of Reeve Channel on the flooding tide before the tide changes" (Webster et al, 2001). [9]

Without new measurements of tidal exchange since 2008 changes to the entrance profile, this modelling is now outdated. It needs new data and new modelling by independent experts.

The LTMMP also notes the absence of detailed tidal velocity through the entrance to calculate tidal prism rather their modelling suggests a 16% increase in tidal range from 2008.

Why hasn't tidal velocity been measured when it is critical to understand the implication of the deepened entrance?

Both ends of the Strait could be subject to modern hydrodynamic studies to understand the increasing salinity in Lake Wellington. Failure to fully acknowledge that the primary source of salinity is from the dredged Entrance has led to avoidance of the obvious problem that the deepened entrance from 2008 has contributed to that increase. The salinity figures in all the lakes and Lake Wellington reflect that increase from 2008. Resetting the baseline salinity would appear to facilitate continuation of the deeper entrance. The significant flow on-impacts of raised salinity in Lake Wellington on ecological character is inadequately monitored. There is a lack of baseline data which has been repeatedly noted in many documents since the time of listing.

The recent EGCMA (GLTR, 2022) report references the marine influence but still do not clearly acknowledge that the artificial entrance is the primary source of salinity.
Additionally, the report also states *there is limited evidence and expert opinion on which to base assessment.*

To use only surface water data and not include at depth is misleading. It is this point that EGCMA need to further explain why there is limited evidence. Is there a lack of resources? Salinity is a key threatening process and water quality monitoring should be more extensive.

Table 26 from EGCMA (Ramsar 2016) highlights some deficits in monitoring program for Ramsar sites show that are still not in place or scant. P92 and 93

Table 26: Monitoring program for the Gippsland Lakes Ramsar Site.

Recommended monitoring				Linkages to existing programs / activities
Program	**Indicators and method**	**Frequency**	**Responsibility**	
Seagrass	Extent (mapping consistent with Roob and Ball 1997) and condition (consistent with recent programs e.g. Warry and Hindell 2012).	Mapping every five years. Condition every two years.	DELWP	Proposed mapping to be undertaken in 2015 by Monash University, DELWP (Arthur Rylah Institute).
Water quality monitoring in priority lakes and wetlands	Salinity, dissolved oxygen, water clarity, nutrients (dissolved and total) and chlorophyll-a Algal species and enumeration	Monthly and event based (i.e. more frequent sampling during, algal blooms)	EPA Victoria, DELWP, West Gippsland CMA	Current water quality monitoring by EPA Victoria covers Deep and Shallow Lakes. Suggest expand to include: Sale Common, Macleod Morass, Lake Reeve and priority estuarine reaches.
Sediment quality monitoring in lakes and wetlands	Nutrients, toxicants	Every five years	EPA Victoria, DELWP	Not currently included in any routine monitoring programs.
Mapping of wetland (including saltmarsh) vegetation communities in the Ramsar site.	Mapping of wetland EVCs, consistent with that of Boon (2011) and current WGCMA mapping.	Every ten years	DELWP, Parks Victoria, East and West Gippsland CMAs	Boon et al (2011) mapped saltmarsh communities. Current mapping of wetland Ecological Vegetation Classes in West Gippsland CMA region (lower Latrobe wetlands only). Needs to be expanded to East Gippsland CMA Region.
Condition assessments of priority vegetation communities: Freshwater marshes Swamp paperbark Common reed emergent beds Saltmarsh River Red Gum grassy woodland Riparian vegetation	A purpose built condition assessment that measures: Species composition and abundance (cover); Invasive species Structure Recruitment	Every ten years	DELWP, Parks Victoria, East and West Gippsland CMAs	No current programs in place.
Monitoring of threatened plant species: dwarf kerrawang (*Commersonia prostrate*); swamp everlasting (*Xerochrysum palustre*); and metallic sun-orchid (*Thelymitra epipactoides*), River swamp wallaby grass (*Amphibromus fluitans*).	Extent and condition	Annual	DELWP, Parks Victoria	Existing monitoring and protection programs for a selected group of threatened plants are in place by DELWP and Parks Victoria.

Recommended monitoring				Linkages to existing programs / activities
Program	**Indicators and method**	**Frequency**	**Responsibility**	
Waterbird counts and breeding records (including for cryptic species such as the Australasian bittern).	Abundance of each species, and evidence of breeding. Build on existing programs, but with a preference for a total wetland / site count at priority locations (can use a combination of aerial survey, with ground / boat surveys).	Annual	DELWP, Parks Victoria	Current: Shorebirds 2020; Waterfowl annual counts (game species); nesting tern monitoring; and DELWP Hotspot program. Needs to be expanded to include an annual count at all priority locations in the site and targeted to specific species.
Frog monitoring: adults and tadpoles / juveniles	Audio monitoring of calls Fyke net trapping of tadpoles	Annual	DELWP, Parks Victoria	DELWP Hotspot currently monitors adults through calls.
Native fish: abundance and species	Purpose built monitoring program will need to be developed. Different methods will be required for wetland vs open water habitats. At a minimum surveys should measure abundance and community composition. Consideration given to population age structure, perhaps via the use of otolith samples for a subsample of common species.	Annual	DELWP	Current (historic) sampling in the Deep and Shallow Lakes only. Needs to be expanded to include sampling in the freshwater wetlands and estuarine reaches.
Abundance and population structure of Burrunan dolphins	Using the methods developed by Kate Charlton-Robb, for visual surveillance	Annual	DELWP	Current program funded by Gippsland Lakes Environment Fund, but is not on-going.

It has taken 37 years to suggest, again, measuring the water quality and salinity in the Ramsar wetlands (Sale common, McLeod Morass, Lake Reeve and priority estuarine reaches). These recommendations have already been suggested in the EGCMA (Ramsar 2010) report and gives the following suggestions, but they are far from fully implemented 12 years after the report and 40 years after Ramsar listing.

Current water quality monitoring by EPA Victoria covers Deep and Shallow Lakes. Suggest expand to include: Sale Common, Macleod Morass, Lake Reeve and priority estuarine reaches. Sediment quality monitoring in Nutrients, toxicants Every five years lakes and wetlands. [10]

Recent EPA Report Card 2020–21[11] highlights the few monitoring sites.

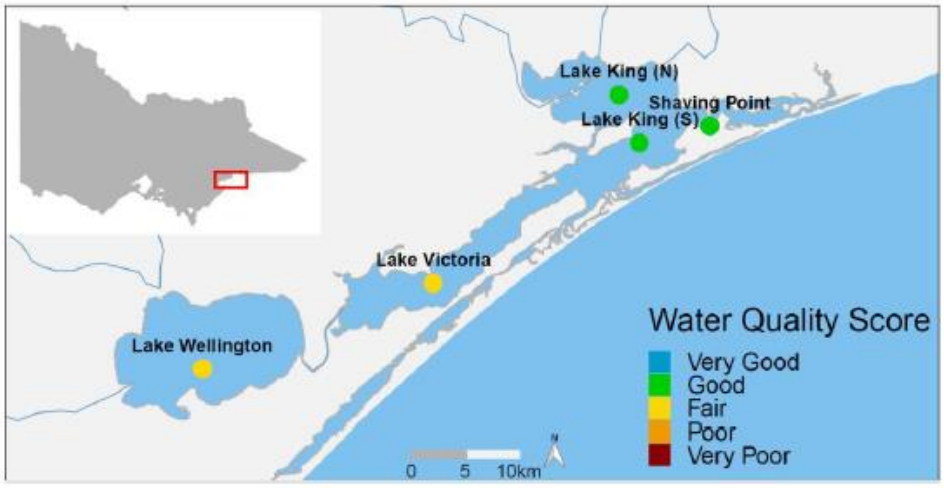

Figure 17: WQI scores of EPA monitoring sites in the Gippsland Lakes.

Low freshwater flows from rivers upstream are a compounding problem. Low flow allows the saltwater wedge[12] from the lakes to push up the rivers to a point in the river where it rises above sea level. Salt water can enter the river that far. The salt intrusion length is determined by the intersection of the sea level with the riverbed.

Easterly weather conditions push water up into the rivers. Prior to the elevated salinity level of the lakes, over-bank spills into wetlands where replenishing. Now this causes damage by salt scald. This interconnectivity between the lake and wetlands, once replenishing can now be catastrophic.

West Gippsland CMA Lake Wellington Land and Water Management Plan (WGCMA, 2018) identify the lower reaches of the Latrobe River is in 'very poor' condition related to high salinity and resultant river health. The Central and Gippsland Sustainable Water Strategy (CGSWS) cannot identify a way to secure water to re-establish environmental flows for the Latrobe River.

This is further exacerbated by both a loss in pumped groundwater becoming a surface return flows to the Latrobe River as the three coal mines close. The current emergency flood diversion of high-water flows from the Morwell River (major tributary of Latrobe River) is spilling over into the Hazelwood mine pit instead of flowing through to the Latrobe River and Gippsland Lakes. The flood diversion was to be short-term, but ENGIE Hazelwood want the Morwell River Flood Diversion to stay in place to support mine fill for rehabilitation subject to relevant approvals.

These replenishing freshwater high flows should be going towards rejuvenation of the lower Latrobe and Ramsar wetland in this high rainfall year. Worse, the unregulated Morwell River will eventually enter the Latrobe River as a spillway post closure from the Yallourn mine pit as the built Morwell River Diversion levee will eventually erode and collapse as clarified by Yallourn Mine Manager where the Yallourn open cut coal mine is rehabilitation rehabilitated to an interconnected lake.

In subsequent dry years the loss of the Morwell River flow into the Latrobe, could be ecologically catastrophic.

In response to low flows and saline conditions the vegetation dies back. Loss of vegetation and bank integrity allows salty water to spill into the wetlands.
This photo is the lower Latrobe looking south toward Dowd Morass in March 2019.

Many wetlands such as Dowd Morass on the Latrobe River are lower than the river.

It would be constructive for authorities charged with the management of the Gippsland Lakes ecological health to lobby to regain and maintain Morwell River flows into the Latrobe and lakes system.

Damming the upper catchments of Latrobe River has created a barrier denying essential sediment flows from healthy environments to provide food downstream, impacting biodiversity and ecosystem health. Temperatures increases on low flows & reduced flows alter aquatic habitats.

Shoreline erosion

Influencing factors, EGCMA (GLTR, 2022) P64

Boon et al. (2015b) concluded that the known or inferred causes of shoreline change in the Gippsland Lakes were threefold:

1. *changes in absolute water level;*
2. *changes in wave energy and accompanying currents; and*
3. *changes to fringing vegetation (especially to beds of common reed, Phragmites australis) in response to increased salinity following opening of the artificial entrance in 1889.*

GEG believe the increased shoreline erosion is mostly caused by the increase of salinity. Lake Wellington for example changed from a macrophyte-dominated to a phytoplankton-dominated system dating from around 1965. The underwater plants damped wave action like a forest moderates wind. This loss of macrophytes has allowed wind driven wave action in the shallow like Wellington. During an easterly wind, waves smash the shore with spray spreading far over the normal water line. The water level also rises up along the west shore of the lake in an easterly wind. This has caused decline in Phragmites Australis especially on the shores that face due east. In more sheltered areas phragmites has endured despite salinity rises, showing remarkable salt tolerance.

There are remnants of ancient redgums far out in the water showing the extent of erosion. An old log here shows how wave mitigation can protect the shore with a little spit of land maintained.

Photo of Marlay Point high water line here after an easterly storm.

Salt laden water high above the usual water line is very damaging to vegetation.
At Marlay point waves went over the concrete wall and eroded the infrastructure.

Below at Clydebank Morass the land used to join with the far bank but now has eroded away and a new shallow lake has formed off to the left of the photo. This inundated a large area of Ramsar wetlands. This was probably unrecorded by authorities but early satellite images could have identified the pending breach. This 2004 satellite image shows the remnants of a track.

The same image but in 2018 of Lake Wellington west shore shows significant wave action.

Vehicle access has been identified by authorities as a threatening process. The Landcare planting was fenced to try to prevent vehicles from driving right up to the waterline.

Vehicles drive very close to the waterline making erosion worse.

To view short video of wave action on the banks of Lake Wellington at Marlay Point, south of Marlay Point foreshore reserve, open the following link then click small photo to open video.
https://share.icloud.com/photos/0c86t00iDa53ABH96ytlwkPaw

Below, phragmites in Lake Wellington at Marlay Point. Its May 2020 and they are going into winter dormancy. This shows their salt tolerance and ability to protect the shoreline where wave action is not strong in sheltered positions.

Cultural Values

On the Boole Poole Peninsula, Aboriginal graves are being exposed by erosion from wave action. Salinity has rendered the lakes devoid of epiphytes which mitigate wave action. These processes of wind and waves and salinity have impacted on the reed beds which stabilised the shores. Traditional Custodians from the Brataualung, Brayakaulung, Brabralung, Krauatungalung and Tatungalung family clans, are attempting to manage the active erosion at the highly important site at Round Head, in the Gippsland Lakes.

Here, representatives from GLAWAC check a scar tree which is eroding and almost falling into the water at Marlay Point Reserve.

Locals have asserted to GEG members that they are Traditional Custodians not Traditional Owners, ***You can't "own" your mother.*** Cultural sensitivity could lead to better management of the Gippsland Lakes. The Lakes thrived for many thousands of years under their custody yet suffer catastrophic decline since colonisation.

Freshwater Wetlands

With little data available, achievable flows and actions to protect fringing wetlands are impossible for authorities to design. In the Heart Morass, citizens took matters into their own hands and implemented flows over the wetlands much to the displeasure of the authorities. The Heart Morass and Sale Common had been subject to salty water inundation during an easterly weather event. The illegal watering actions stimulated some monitoring of this Ramsar wetlands.[13]

Little information and data have been systematically collected on the values of individual wetlands making it difficult to detect change of the ecological character of the Ramsar site since listing in 1982.

EGCMA (GLTR, 2022) p40 and 41 state there is no information to draw conclusions about condition trends of the two large freshwater complexes, Sale Common and parts of Macleod Morass. Macleod Morass condition has not been assessed. This report mentions the unmapped and unreported losses or change to saline conditions of many other smaller once freshwater wetlands. It does not link the significance of these changes to our Ramsar obligations. There is only quantitative data of Sale Common from 2015 and 2020 and satellite imagery from 2020.

Dowd Morass

There is data available for wetland habitat extent in Dowd Morass from two points in time, 2015 (derived from intense ground surveys) and 2021 (mapped by remote sensing from satellite imagery).

Dowd Morass received scores for various EVC components in different mapping units ranging from 19 for a patch of coastal saltmarsh aggregate (EVC9) to a low of 8 for a patch of Brackish Wetland (EVC 565). The overall score was 16, indicating vegetation was in Good condition. This ranking, however, must be set against the large number of earlier research reports on Dowd Morass, which indicate that the Swamp Paperbark component of this wetland is in poor condition, stressed by high salinity and prolonged flooding (e.g. Raulings et al. 2010, 2011; Salter et al. 2007, 2010a, b). EGCMA (GLTR 2022) P44

But on p45 there is no information available to allow trends in the composition or structure, or the total area, of the variably saline wetlands of the Gippsland Lakes to be determined.

Trend
There is no information available to allow trends in the composition or structure, or the total area, of the variably saline wetlands of the Gippsland Lakes to be determined. Boon et al. (2008) indicated that there had been a steady loss of Common Reed (Phragmites australis) and encroachment into former reed-vegetated areas of Dowd Morass by Swamp Paperbark (Melaleuca ericifolia) since the 1950s, but whether similar patterns have taken place in other variably saline wetlands is unknown. The mapped extent of broad vegetation communities in 2021… will provide a benchmark against which future changes in extent can be assessed.

This is an example of a shifting baseline due to lack of historic monitoring. Standards should have been set at the time of Ramsar listing and all old information should be used as a reference even though new methods are being used for assessment. There should be mapping available from the time of Ramsar listing.

Mapping of wetland vegetation at Sale Common is available for three points in time 2015…This equates to two wet phase mapped products and one during a dry phase. P40
The condition of the other large freshwater wetland associated with the Gippsland Lakes, MacLeod Morass, has not been recently assessed and is not known. P41 EGCMA (GLTR 2022)

A new baseline is set 40 years after listing. There is no mapping or condition report on smaller freshwater wetland. They may mostly have changed to saline. This process has not been recorded.

The brackish marshes next to the river channels mentioned on page 42, shows how much of the salinity is coming from the saltwater wedge in the river and the importance of keeping Lake Wellington as fresh as possible. The dynamics of loss of freshwater flows and the salt from the lakes is primarily the cause. These marshes would have once been fresh but the progression to brackish next to the salt wedge in the river has not been monitored.

Wetlands of the Gippsland Lakes that experience variably saline regimes include Dowd Morass, the Heart Morass, Lake Coleman and Clydebank Morass. Data on vegetation composition, however, is limited to only two of these wetlands: Heart Morass and Dowd Morass. There are many unmonitored smaller variably saline wetlands as well. Some were once fresh and have transitioned to variably saline then saltmarsh. The wetlands south of McLennan Strait may have made this transition. It was once a stronghold of Growling Grass Frogs.

4.4.3 Results

Summary

Indicator	Status and trends (Unknown / Poor / Fair / Good)	Summary
Variably saline vegetation extent	 **Data quality:** Good **Data custodian:** DELWP	Vegetation in wetlands of the Gippsland Lakes that experience variably saline regimes are often dominated by swamp paperbark Melaleuca ericifolia, but beds of reeds and sedges are also common and important. Quantitative information on vegetation condition is available only for two of the major variably saline wetlands, Heart Morass and Dowd Morass. The condition of other large, variably saline wetlands associated with the Gippsland Lakes is not known. The quantitative information available indicates that the status should be given as Good. There is no information available to discern any trend in condition or in area. Substantial changes in vegetation types, condition and extent are, however, likely to be related as much to long-term patterns in climate as they are to direct human activities over time frames relevant to this assessment.
Variably saline vegetation condition	 **Data quality:** Fair **Data custodian:** DELWP	

For Dowd Morass and the Heart Morass:

The annual median salinity will be less than four grams per litre in five successive years.

- Are both Morass going to be regularly monitored?
- Is this to be assessed now with regular salinity monitoring of both the Morass'? Water Quality measurements once a month is not enough.
- Sediment quality monitoring in nutrients and toxicants every five years for both the lakes and wetlands.
- Have these suggested expansions been implemented?
- This also needs to be extended to include any proposed new dredging sites.

Saltmarsh

EGCMA (GLTR 2022) indicates that data quality for saltmarsh is fair, so they are unable to assess a trend in condition of saltmarsh. It has only been measured in 2011 and 2021.

- 14 were in poor condition. There are incomplete records since listing, so a new benchmark is set.
- This area could have been a freshwater wetland before the Latrobe River lower reaches became contaminated with sea water.
- There are breaches in the bank between the river and the wetlands and some look manmade. Possibly they were once made to drain the Dowd Morass.
- Intrusions of saline water are affecting vegetation condition.

Current mapping of wetland Ecological Vegetation Classes in West Gippsland CMA region (lower Latrobe wetlands only). Needs to be expanded to East Gippsland CMA Region.

The report says,

Condition assessments of priority vegetation communities:

- *Freshwater marshes*
- *Swamp paperbark*
- *Common reed emergent beds Saltmarsh*
- *River Red Gum grassy woodland Riparian vegetation,*

Suggests monitoring with a purpose-built method but then admits there is no program in place. It's hard to tell what is being done from this. The report also raises concerns about the baseline data that was collected at the time of Ramsar listing. Little information and data have been systematically collected on the values of individual wetlands since listing.[14]

Gippsland Lakes (CSIRO, 1998) noted,

Much of the original freshwater marsh system is slowly being replaced by saline scalds and salt marshes, as part of the long-term response to marine incursions.

GEG argue that reducing the entrance depth and volume to minimum navigable level should be the most direct, inexpensive and effective way to help mitigate these incursions.

New dredging areas

There is no detail available on the proposed 10-year permit Ports seek for dredging McLennan Strait, areas of Lake Wellington and further into the rivers. EPA released a report card of Gippsland Lakes in 2020 noting,

Lake Wellington is a sink for sediments, nutrients and contaminants. Wind and waves within the shallow waters of the lake can resuspend sediments and nutrients. Algal blooms often develop because of the high availability of nutrients.[15]

There needs to be significant scrutiny and transparency of this proposed dredging permit given the history of toxic contaminants in Lake Wellington including mercury. Additionally, dredging will affect hydrological flows by removing the sediment or silt barrier to deepen the navigation channel also removing that secondary natural salinity control, by a shallowing affect like mentioned behind Flanagan in mitigating the tidal incursion. (LTMMP Section 3 on p25)

Flow studies and salinity testing around dredged areas could supply data that may show the extent that salty water can extend up the river because of dredging. The ecology of predominantly fresh water and brackish fringing wetlands for the shallow lakes, such as Jones Bay and the estuarine reaches of the rivers are critically affected by hydrological flows. EGCMA (Ramsar 2016)

Sediment details and studies are needed for contaminants that may be released during dredging. Examples may include heavy metals, microplastics, agricultural chemicals, pharmaceuticals, endocrine disruptors, PFAS and nutrients such as phosphates and nitrogen that feed algal blooms. Activating acid sulphate soils may also be triggered.

The primary source of nutrients that drive algal blooms in the Gippsland Lakes is nutrient contamination from the catchment. However, a large amount of the phosphorus from the catchment has been stored in the sediment over time and can be released to the water column under certain biogeochemical conditions.

Phosphorus released from sediments, rather than catchment load, supplies most of the phosphorus supporting the development of recent Nodularin blooms (WGCMA 2018) p26. Dredging sediments would certainly release more nutrients.

- Is there mapping for the extent of phragmites and other vegetation that could be affected by dredging?
- What sediment testing is in place and what is being measured?

The LTMMP states that current dredging operations is unlikely to have an adverse impact on the migratory behaviour of Australian Grayling. Have ports investigated the likely consequences of dredging further into the lakes system? The sediment plume will be very different from the clean ocean sands near the Entrance.

Dolphins

Monitoring in 2021 indicated that many of the dolphins had skin lesions and up to 10 individuals were confirmed or presumed dead, with a further 26 absent from surveys. Researchers are investigating the cause of the event, but suspect that the freshwater conditions that persist throughout the summer of 2021 may be contributing factor. In 2007, similar freshwater condition in the lakes led to the deaths of several dolphins and similar skin disease. EGCMA (GLTR 2022) P 56

5.3.3 Results

Summary

Indicator	Status and trends (Unknown / Poor / Fair / Good)	Summary
Burrunan dolphin abundance	Data quality: Fair Data custodian: Australian Marine Mammal Foundation	In 2011 a new species of dolphin, the Burrunan dolphin was described from south-eastern Australia. There are only two known resident populations of this species, one from Port Phillip Bay and one from the Gippsland Lakes. The Gippsland Lakes resident population was estimated at around 94. In winter, males move into the Gippsland Lakes increasing numbers and breeding commences. Recent freshwater conditions in the Lakes are thought to have contributed to a decline in the health of the resident dolphins, with 10 confirmed or presumed deaths and a further 26 individuals not sighted during surveys. There is some evidence that this impact of fresher conditions on dolphin health and population has occurred in the past, but we do not know if and when populations will recover.

This is confusion between the cause (fresh water) and association with fresh water.

The skin lesions may have been associated with freshwater condition in the lakes, but it is unlikely that the fresh water caused the lesions and more likely that it was contamination with toxicants within the fresh water. Flood waters pick up many toxicants that result from human activities and there is often associated toxic algae blooms. P13 of EGCMA (GLTR 2022) indicated the implication of toxicants on the health of fish and dolphins. These dolphins evolved spending time in the fresh or brackish Gippsland Lakes.

Toxicants – for their importance in maintaining the health of aquatic biota (fish and dolphins) and human health through consumption of fish.

During floods, contaminants in the catchment are flushed into the lakes. Recent prolonged wet conditions caused overflow of dairy effluent dams and East Gippsland Water sewerage treatment system to name a few. The bushfires degraded many of the catchments with associated runoff of ash and topsoil. Using the term “freshwater disease” to describe or explain the lesions is not acceptable.

Bird Usage

The sole environmental consideration given to the dredging trial in 2008 was to mention the preservation of the nesting sites of the hooded plover and little tern within a 3 km radius of the entrance. The Little Terns are now listed as endangered under the EPBC act.

In 2018 Gippsland Ports got a Victorian Coastal award. The booklet noted,

Over the past decade, erosion, destabilisation and flooding have diminished these habitats considerably, impacting breeding activity and survival.[16]

This was the 10 years since the entrance was deepened. Rigby Island nesting sites all washed away and much of the vegetation. The swamp paperbarks died. The irony of this, ports dredging contributed to the problem, gets a grant to fix it, then receives an award!

Rigby island has successfully been replanted by Landcare groups and Greening Australia since. Ports claim that their audit shows that the Rigby Island buffer zone has not been breached by GLOA actions during the breading season so no impact on EPBC listed shorebird species island during breeding season.

3.1.2 Wetland and Shorebirds
Wetland species (including migratory species) are considered unlikely to be affected as there is no important habitat located adjacent to GLOA activities. GLOA dredging activities are unlikely to have a significant effect on the hydrodynamic or salinity regime (refer Section 3.3.1), suggesting little to no impact on wetland species or their habitat throughout the Gippsland Lakes system. Therefore, these species are not likely to be at risk of significant impact. LTMMP p16

This statement contradicts Ports risk management and is unsubstantiated.

Risk is identified that dredging could cause long term hydrological changes within the lakes. P21

It is unsubstantiated that the dredging is unlikely to have a significant effect on hydrodynamic salinity regime.

Conversely this is at odds with all the background information. EGCMA make this comment about the wetlands;

Many of the fringing wetlands around the Lakes would have been, in pre-European times, fresh or at least only episodically brackish (Bird 1961b, 1966; Boon et al. 2016). The creation of the artificial opening to the ocean at Lakes Entrance in 1889, combined with construction of large dams to allow the extraction of water from inflowing rivers for human consumption in the 20th century, has led to a decrease in the area of freshwater wetlands such that Sale Common and MacLeod Morass are now the only remaining large freshwater systems; small patches of freshwater wetland persist in the brackish marshes next to the river channels. EGCMA 2018 p42

It remains a fact that the marine influence on the whole of the Gippsland lakes is due to the dredged entrance. The marine influence is having a widespread ecological impact on the Gippsland Lakes. The dredged entrance is driving hydrodynamic change. This is accentuated since 2008 deepened entrance. Ports actively resist proper monitoring or EES of the lakes which would reveal there is a problem.

Frogs

Presence of the endangered Green and Gold Bell Frogs and Growling Grass Frogs are a good indicator of wetland health so should be mapped and recorded across the system. Springtime recording of their uniquely recognisable call is an inexpensive way and doesn't take extensive technical equipment. Greening Australia should have long term funding to continue their work.

Scour Hole

The deeper entrance and increase total speed have continued to undermine the training walls particularly adjacent to the deep scour hole. In an effort to save the ageing structure Ports have continued to place rock on the training walls in the hope they can address the undermining of the structure. This is costing millions of dollars and is a progression of the impacts on the lakes following the drive to maintain a deeper entrance.

Permit approval in the absence of monitoring

After listing, major changes in the depth of dredging of the entrance and inner channels have occurred, in effect, raising the volume of the ocean outlet allowing more opportunity for the denser sea water to enter the lakes system.

GEG maintain that the proper pathways were not followed in the 2008 trial of deeper dredging to 5.5 meters. Historically the entrance had a depth range from 1.2 m to 3.6m from the time of construction in 1889 up till the 1970s. At the time of the dredging trial the State Planning Minister Madden waived the need for an environmental effects statement saying the process will enable suitable monitoring and assessment of the residual environmental risks. There was no extra monitoring undertaken, but the Victorian EPA water quality results clearly demonstrated doubling of salinity since 2008.

The Pelican hopper dredge arrived in time to commence work under the new permit and being a more efficient dredger could clear the channels on its yearly visit an extra 2 meters deeper to allow for slump in addition to the 3.5 meters (total dredged depth 5.5 meters). This was to back up the less efficient dredger. The new permit in 2011 allowed the entrance to be deepened an extra 3 meters.

Since 2017 the new hopper dredge Tommy Norton has been able to keep the channels at full depth and the extra allowance for accretion are not needed.

There is a need to assess historical perspective of the extra allowance for sand accretion in relation to legislative obligation for ports to maintain environmental values.

The salinity gradient from the entrance to the west reinforces that the entrance is the primary source of salinity. The LTMMP conceptual model of salinity within the Gippsland Lakes shows salinity levels from over 20 years ago.

The salinity concentrations are much higher now and exceeding the LAC in Lake Wellington.

Monitoring and suggestions for managing salinity

There is a need to secure more resources.

- More extensive, modernised salinity and water monitoring around the lakes system.
- Measurement of salinity with the larger wetlands has only recently started and should be done across the Ramsar sites. There are no salinity measures of salinity or condition reports of smaller wetlands in the 40 years since listing and many may have changed unrecorded, from fresh or brackish to salty.
- Hydrodynamic studies, flow velocity studies around the entrance, the inner channels and other more distant points such as McLennan Strait including velocity and salinity at different levels as recommended by Gippsland Lakes (CSIRO, 1998) environmental audit.
- Important monitoring is not started or has just begun now 40 years after Ramsar listing.
- Modern techniques using drones and satellite imagery are underutilised.
- Resetting the limits of acceptable change for salinity in Lake Wellington fails to acknowledge that the primary source of salinity is from the dredged Entrance.
- Measures need to be taken to prevent gaps in the monitoring as has occurred in the past.

Interactions with other threats: climate change

The Gippsland Lakes have confronted two step changes (non-linear changes in ecological character) since colonisation in late 19th century and late 1960s/early 1970s. It is likely another step change in degradation is underway or likely without management intervention. The recent CSIRO report into Vulnerability of the Gippsland Lakes Ramsar Site and its

catchment to bushfire and climate change,[17] notes the interactions of dredging with threats caused by climate change:

*"For the Gippsland Lakes system, including the Ramsar site, freshwater riverine inputs remain significant but have declined and become more variable, and there has been an increase in marine saline inflows. Upstream wetlands, not affected by sea-level rise, have experienced reduced hydrological and biological connectivity. Wetlands with marine influence have experienced increases in connectivity and water level, with shoreline inundation and erosion, and altered sand dynamics, silt jetties and mudflats. There is a general increase in salinity throughout the system. There are regular pulses of increased sediment and nutrient load from bushfire and bushfire management activity. These climate impacts combine, sometime synergistically, with other threats. Demand for dredging the channel opening has increased due to increased sand transport into the Gippsland Lakes from higher sea levels, greater tidal prism and deceased river flows out of the Gippsland Lakes. Some areas of acid sulfate soils (ASS) are permanently inundated, leading to a reduction in oxidation."*To the extent that the LTMMP is a supporting document for an application for consent under the MAC Act, it should promote the resilience of marine and coastal ecosystems, communities and assets to climate change (section 7(b)); and respect natural processes in planning for and managing current and future risks to people and assets from coastal hazards and climate change (section 7(c)).

Conclusion

GEG are concerned that incomplete monitoring of the downward trajectory of the Gippsland Lakes prevents evidence-based management. There is lack of planning for climate change in managing sea level rise and seawater ingression into the lake. We have EPPC concerns and Ramsar concerns.

We believe that a full EES is needed before the dredging permit is issued to satisfy the requirements of the *Marine and Coastal Act 2018*

We question the necessity for the entrance to be deeper and the benefits of a potentially 'safer' navigation for vessels is at a cost of cumulative and continued decline in the condition of the Gippsland Lakes and loss of Ramsar sites. The port area is limited for larger vessels.

Ports are very focused on their navigation responsibilities, to the detriment of their environmental obligations. Unless monitoring and research can be supplied which show the current entrance depth is not impinging on the salinity of the Gippsland Lakes, then for the sake of caution the entrance could be kept at the minimal navigable depth.

References

Bird (1978) SHORELINE EROSION AND SALINITY INCREASE excerpt from E.C.F. Bird revised and updated publication, *A Geomophological Study of the Gippsland Lakes* (Australian National University Press,1965) https://vro.agriculture.vic.gov.au/dpi/vro/egregn.nsf/pages/eg_geomorphology_gipps_lakes_pdf/$FILE/geomorphology%20gipps%20lakes%20shoreline%20erosion.pdf

(CGSWS) Central and Gippsland Sustainable Water Strategy

Gippsland Lakes (CSIRO, 1998) - Gippsland Lakes Environmental Audit Review of Water Quality and Status of the Aquatic Ecosystems of the Gippsland Lakes https://www.loveourlakes.net.au/wp-content/uploads/2015/05/CSIRO-Gippsland-Lakes-Environmental-Audit-101998.pdf

DEWLP - The Department of Environment, Land, Water and Planning

EGCMA (Ramsar 2016) Gippsland Lakes Ramsar Site Management Plan -East Gippsland CMA, Bairnsdale https://egcma.com.au/wp-content/uploads/2019/06/Gippsland-Lakes-Ramsar-Site-Management-Plan-Full.pdf

EGCMA (2016) Gippsland Lakes Priorities Plan, East Gippsland CMA, http://www.loveourlakes.net.au/wp-content/uploads/2017/02/Gippsland-Lakes-Priorities-Plan-Final.pdf

EGCMA (GLTR, 2022) Environmental Technical Report - East Gippsland CMA https://www.loveourlakes.net.au/wp-content/uploads/2022/01/EGCMA_GL_EnvironmentReport2022_TechnicalReport_digital_FINAL.pdf

EJA governance of the Gippsland lakes https://www.envirojustice.org.au/wp-content/uploads/2020/12/2020-09-01-Discussion-Paper-for-Workshop-1_Final.pdf

Gippsland Lakes priority plan - Gippsland Lakes Coordinating Committee 2016 http://www.loveourlakes.net.au/wp-content/uploads/2017/02/Gippsland-Lakes-Priorities-Plan-Final.pdf#page21

GLOA Environmental Management Plan https://www.gippslandports.vic.gov.au/wp-content/uploads/2017/05/2019-gloa-emp-version-4.3-final-oct2019.pdf

GLOA (LTMMP 2022) GIPPSLAND LAKES OCEAN ACCESS Long-term monitoring and management plan https://www.gippslandports.vic.gov.au/wp-content/uploads/2022/06/2022-gloa-ltmmp-22-32-rev-v.7_-review-draft-opt.pdf

Grayson, R. (2006). Prioritising nutrient reduction for the Gippsland Lakes and catchments - Part 1 - Loads and Sources. Catchment to Sea Pty Ltd

HISTORY OF DREDGING THE ENTRANCE TO GIPPSLAND LAKES https://www.gippslandports.vic.gov.au/wp-content/uploads/2017/06/Dredging-Facts-Sheet_24Apr2017.pdf

Hydrodynamics of the Gippsland Lakes Fryer Easton 1980 https://people.eng.unimelb.edu.au/imarusic/proceedings/7/FryerEaston.pdf

Kirono, D., Hopkins, M., Melbourne-Thomas, J., Biswas, T., Dunlop, M., Round, V., Sheppard, M., Joehnk, K., Briggs, P. (2022) Vulnerability of the Gippsland Lakes Ramsar Site and its catchment to bushfire and climate change. Final Report submitted to the Department of Agriculture, Water and the Environment, DAWE. CSIRO, Australia.

Lindsay B. and Silbert N., *Unsustainable Water Management in the Gippsland Lakes: A Legal Analysis* (Environmental Justice Australia, 2021).

MACA (2018) Marine and Coastal Act 2018 https://www.marineandcoasts.vic.gov.au/marine-and-coastal-act

National Framework and Guidance For describing the ecological character of Australian Ramsar Wetlands 2008
https://www.agriculture.gov.au/sites/default/files/documents/module-2-framework.pdf

Long Term Monitoring and Management Plan Requirements for 10 year Permits to Dump Maintenance Dredge Material at Sea (Commonwealth Government Guidance, 2011)

News articles –
Shoreline erosion
https://www.gippslandtimes.com.au/news/2021/11/22/council-to-write-to-state-govt-on-loch-sport-erosion/
Watering wetlands by field and game https://www.duck.org.au/field-game-australia-water-theft/

Ramsar Gippsland Lakes BMT WBM. (2010). Ecological Character Description of the Gippsland Lakes Ramsar Site. Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra. https://rsis.ramsar.org/RISapp/files/533/documents/AU269ECD.pdf

Salt wedge estuaries http://www.coastalwiki.org/wiki/Salt_wedge_estuaries

SKM (2010). Lake Wellington Salinity – Preliminary Investigation of Management Options, Report prepared for Gippsland Lakes Taskforce
http://www.loveourlakes.net.au/wp-content/uploads/2015/05/lake-wellington-salinity.pdf

SKM (2011) Lake Wellington Salinity: Investigation of Management Options
https://www.loveourlakes.net.au/wp-content/uploads/2015/05/Lake-Wellington-Salintiy-Investigation-of-Managment-Options.pdf

Review of Hydrodynamic and Salinity Effects Associated with TSHD on the Gippsland Lakes Aug 2011
http://www.loveourlakes.net.au/wp-content/uploads/2015/05/review-of-hydrodynamic-and-salinity-effects-associated-with-tshd-on-the-gl.pdf#page21

Tidal Scouring in the Gippsland Lakes- KING (1981) http://geg.org.au/wp-content/uploads/2012/03/TIDAL-SCOURING-IN-THE-GIPPSLAND-LAKES-1981-1.pdf

Tilleard, J. W. and Ladson A. R. (2010). Understanding the environmental water requirements of the Gippsland Lakes system: Stage 2: Input to the Gippsland Region Sustainable Water Strategy, report by Moroka Pty Ltd for the East and West Gippsland Catchment.

WGCMA (2018) Lake Wellington Land and Water Management Plan Technical Appendices -West Gippsland CMA 2018
https://www.wgcma.vic.gov.au/wp-content/uploads/2017/10/Lake-Wellington-LWMP-technical-appendix-final-draft-23082018-2.pdf

Endnotes

[1] Long Term Monitoring and Management Plan Requirements for 10 year Permits to Dump Maintenance Dredge Material at Sea (Commonwealth Government Guidance, 2011)

[2] Bruce Lindsay and Nicola Silbert, *Unsustainable Water Management in the Gippsland Lakes: A Legal Analysis* (Environmental Justice Australia, 2021).

[3] Comment – Final Draft Gippsland Lakes Ocean Access, Long Term Monitoring and Management Plan (DEWLP, 14 July 2022)

[4] (p127) Ramsar Gippsland Lakes BMT WBM. (2010). Ecological Character Description of the Gippsland Lakes Ramsar Site. Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra. https://rsis.ramsar.org/RISapp/files/533/documents/AU269ECD.pdf

[5] Case Study - Lake Wellington Changing Conditions https://www.loveourlakes.net.au/wp-content/uploads/2022/01/EGCMA_GL_EnvironmentReport2022_TechnicalReport_digital_FINAL.pdf

[6] KING (1981) *Tidal Scour in The Gippsland Lakes*, KING, G.1981 ROYAL SOCIETY OF VICTORIA PROCEEDINGS http://geg.org.au/wp-content/uploads/2012/03/TIDAL-SCOURING-IN-THE-GIPPSLAND-LAKES-1981-1.pdf

[7] https://pubs.usgs.gov/tm/2006/tm1D3/pdf/TM1D3.pdf

[8] P21 http://www.loveourlakes.net.au/wp-content/uploads/2015/05/review-of-hydrodynamic-and-salinity-effects-associated-with-tshd-on-the-gl.pdf#page21

[9] (Webster et al, 2001). Webster, I.T. Parslow, J.S. Grayson, R.B. Molloy, R.P. Andrewartha, J. Sakov, P. Tan, K.S. Walker, S.J. and Wallace, B. (2001). Gippsland Lakes Environmental Study – Assessing Options for Improving Water Quality and Ecological Function, Final Report prepared for the Gippsland Coastal Board by CSIRO

[10] Ramsar Gippsland Lakes BMT WBM. (2010) https://rsis.ramsar.org/RISapp/files/533/documents/AU269ECD.pdf

[11] https://www.epa.vic.gov.au/-/media/epa/files/publications/2037---report-card-2020-21.pdf?la=en&hash=8F84A5A90089ECB93FD1DE028D3257F3

[12] http://www.coastalwiki.org/wiki/Salt_wedge_estuaries

[13] https://www.duck.org.au/field-game-australia-water-theft/

[14] 4.3 Characterising Baseline Information p119-124 https://rsis.ramsar.org/RISapp/files/533/documents/AU269ECD.pdf

[15] https://www.epa.vic.gov.au/about-epa/publications/1857

[16]https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0024/405717/Victorian_Coastal_Awards_2018_WebBooklet_2.pdf

[17] Kirono, D., Hopkins, M., Melbourne-Thomas, J., Biswas, T., Dunlop, M., Round, V., Sheppard, M., Joehnk, K., Briggs, P. (2022) Vulnerability of the Gippsland Lakes Ramsar Site and its catchment to bushfire and climate change. Final Report submitted to the Department of Agriculture, Water and the Environment, DAWE. CSIRO, Australia.