Assessment of Congestion and Conflicting Use Management for the Gold Coast Waterways

Volume 2: Discussion Paper

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Executive Summary

This study was commissioned by the Gold Coast Waterways Authority (GCWA) to help develop a better understanding of the current and emerging users and uses of the Gold Coast waterways (GC waterways). With a growing population, the study will provide a baseline for the current status of the GC waterways and helped identify current and emerging conflicts. The GCWA will use this information to aid in the future management of the GC waterways.

On this basis, the GCWA engaged Envirosphere Consulting to undertake a comprehensive desktop assessment/literature review of the current users and uses (social, environmental and economic) of the GC waterways and current industry practices for managing congestion and conflicting waterway uses. This information was used to develop recommendations to help better manage the GC waterways for current and future users, uses and conflicts.

The following section summarises the key points from this Discussion Paper, and outlines the key recommendations from the study.

Genesis

This study was commissioned by the Gold Coast Waterways Authority (GCWA) to assemble and interpret relevant local and international literature on waterway conflict and congestion, and source as many relevant datasets as possible to permit preliminary spatial analyses of these issues within the Gold Coast waterways (GC waterways). A key outcome was a gap analysis to highlight further data needs. The details of literature findings, datasets, spatio-temporal analyses, and the Strengths, Weaknesses, Opportunities and Threats (SWOT) analyses of individual sections of the waterway, are found in the Technical Report. This document (the Discussion Paper), sets out the most important common themes elucidated in the Technical Report, and uses them to frame recommendations for acquiring further information, planning processes and tools.

Status

The study examined over 120 literature sources and assembled and analysed over 40 spatially based datasets relevant to the study areas, and reviewed data on trends in tourism visitation and satisfaction.

In brief, this information presents a very detailed picture of patterns of use by diverse user types in different parts of the GC waterways. It represents a valuable resource for the managers of the waterways. However, it also identifies substantial gaps in knowledge of use patterns; critically, this includes information about smaller recreational craft, which represent by far the largest class of users.

The study considers socio-cultural aspects of conflict, perceptions of crowding and the range of responses to these issues. Conflict in this context can range from vessel densities so high that there is risk of collision and injury, to quiet mangrove-lined estuaries disturbed by the passage of a jet-ski.

Apart from the most extreme end where public safety may be compromised, conflict is defined by what users expect to encounter in their day on or by the water. Conflict occurs when the actuality is less satisfying than the original expectation. Of course, these perceptions can change over time, and vary widely between individuals. Residents of an area, for instance, may have a more ‘realistic’ expectation of the number of vessels likely to be encountered per day, by virtue of local knowledge, than an international visitor with expectations formed by advertising imagery.

Users are also more likely to perceive conflict if they feel that the values they place on an area are being threatened; that is, it is being damaged. A key concept here is ‘naturalness’. Most users place a very high value on locations perceived as natural or unspoilt, although these may not necessarily correspond to sites of highest biodiversity. Once valued, residents or regular visitors often feel a sense of stewardship for such areas, expressed as a responsibility to care for and maintain its values. These are powerful agents for co-operative management approaches.

Recommendations

All of the above can be expressed spatially, and the values and expectations of different user types overlaid with known patterns of use, to determine where uses that are not compatible are most likely to occur. This can then be used to frame management responses. However, in order to do this, information on all those variables must be held at a sufficiently fine spatial scale to permit the analyses. Section 3.2 of this document sets out the critical information gaps that should be filled to permit analyses of this type for the GC waterways. Section 3.3 provides recommendations for information needs (based on the critical information gaps); and preferred planning processes and tools suited to this type of management scenario.

1 Introduction

This study was commissioned by the Gold Coast Waterways Authority (GCWA) to help develop a better understanding of the current and emerging users and uses of the Gold Coast waterways (GC waterways). With a growing population, the study will provide a baseline for the current status of the GC waterways and helped identify current and emerging conflicts. The GCWA will use this information to aid in the future management of the GC waterways.

On this basis, the GCWA engaged Envirosphere Consulting to undertake a comprehensive desktop assessment/literature review of the current users and uses (social, environmental and economic) of the GC waterways and current industry practices for managing congestion and conflicting waterway uses. This information was used to develop recommendations to help better manage the GC waterways for current and future users, uses and conflicts.

The project was undertaken in two distinct parts:

Volume 1: Technical Report

Volume 2: Discussion Paper (i.e. this document).

In summary, the main purpose of the Technical Report was: (i) to review the available literature on congestion and conflicting use management; (ii) to capture all known and readily accessible information and data currently available on the social, environmental and economic users and uses of the GC waterways; and (iii) based on the knowledge developed during (i) and (ii), to identify critical gaps in data and understanding. Please see 'Volume 1: Technical Report' for further details and understanding.

The purpose of this Discussion Paper is to develop recommendations to suitably address the critical gaps in data and understanding that were identified in the Technical Report (see gap analysis tables reproduced in Appendix B).

Please note that, in the interests of readability, in-text references have not been included in this Discussion Paper. For complete details and further information, please refer to the Technical Report.

2 Summary of Key Findings

This section summarises the key information from the Technical Report and discusses its importance in the context of the identified critical gaps in data and understanding.

2.1 Emerging themes from literature and local datasets

The detailed literature review and data searches completed for the Technical Report identified six major themes around the issue of conflict and congestion management in the use of waterways and more than 40 relevant spatially-based datasets.

The six major themes identified were:

1. Conflict and congestion
2. Social carrying capacity and perceived crowding (waterways)
3. Users – social values and behaviour
4. Personal risks to users
5. Adapting to regional cultural and industrial change
6. Management tools and planning

2.1.1 Theme 1: Conflict and congestion

Key findings of this theme related to intra-user conflict (e.g. between surfers and other surfers), user-user conflict (e.g. between anglers and personal watercraft (PWC) users), users-managers conflict (e.g. management/aquaculture), and general conflict (e.g. understanding conflict in recreational settings). The technical report found that conflict is more easily avoided than managed when it appears, so timely planning to anticipate possible conflicts, and to put prudent policy measures in place before these become acute, is desirable.

The Technical Report highlighted the fact that most conflict between users is asymmetric (i.e. one party is annoyed more than the other) and that small, noisy, high-speed craft are generally regarded as the source of most ill-will from other use types. It also identified that small, high-speed recreational vessels represented the numerically dominant user group of the GC waterways and that the number of smaller vessels (particularly those in the 3.0 m – 4.5 m size range) were growing most quickly with larger vessel numbers being almost static.

Four main management options were identified to manage asymmetric conflict: relocation of activities (e.g. zoning, or relocating shore facilities such as docks or refuelling stations); managing numbers by setting use limits; controlling categories (e.g. zoning to allow sailing boats or speedboats, but not both), regulation of activity (e.g. speed limits).

If regulations are put in place, effective enforcement is a priority for conflict resolution. As detailed in the technical report, when users perceive (rightly or wrongly) that other users' transgressions are not being adequately addressed, this quickly results in escalating antagonism and calls for additional, and more visible, enforcement action. Frequently cited examples are PWC and motorboat users' disregard for speed limits or approach distances and anglers breaking catch limits. One important exception in the GC waterways context is the surfing community – novice surfers' lack of etiquette is a primary factor in surfer conflict, but most surfers would not like to see on-water policing or regulations put in place.

The technical report also describes non-regulatory approaches that can and do work, and there are

many possibilities for intervention opportunities, such as informative cards and brochures in gear hire enterprises or hotels in coastal tourism areas. One such approach involves encouraging users to become familiar with the activities that they are objecting to, so that they are familiar with the limitations and logistics of that use. To put it simply, a boat owner who is also a PWC user is likely to be accepting of other PWCs; similarly, shoreside residents are more likely to support boaters if they are boaters themselves.

The project found that there was a distinct lack of data/information available (both qualitative and quantitative) on recreational vessel use within the GC waterways (especially those within the 'small, noisy, high-speed' category mentioned above). It was therefore not possible to perform a spatio-temporal analysis of patterns of use by this type of use/user group. While an approximate indication of patterns of use can be gained by extrapolation from similar organised commercial operations, these would most certainly not be accurate nor representative of the overall use patterns in general.

It is recommended that targeted multi-modal surveys of the patterns of use of recreational vessels within the GC waterways (particularly those < 8 m in length) be undertaken at a scale fine enough to permit mapping of areas of potential conflict.

Congestion (and the subsequent user conflicts) was found to be clearly a function of density of users. As well as data pertaining to the use of the waterway itself, it is necessary for any planning process to consider trends in adjacent land use, and the management of shorelines bordering the waterway. A topical example is the predicted rise in vessel use in the Northern GC waterways section, as a consequence of rapid residential development (refer to Volume 1: Technical Report, Section 3.4). This is based on recent (2018) population forecasts showing that the resident population in areas adjacent to the northern Broadwater will rise far more rapidly than the rest of the GC waterways regions. Preliminary analyses suggested that a consequential rise in the frequency of waterway use, particularly in the Northern Section of the GC waterways, could be expected over the next decade, and beyond.

The population data also showed that the coastal postcodes adjacent to the northern parts of the Broadwater (e.g. Pimpama, Coomera, *etc*.) have experienced very rapid population growth over the past 10 years, and that populations in these areas are predicted to more than triple over the next 25 years. A concomitant increase in the boating traffic experienced in these northern Broadwater areas could also be realistically expected. While further study is required to model this more accurately, based on the available information it can be assumed that such a scenario may lead to localised overcrowding (described further in Section 2.1.2 below), due to limited access points and a level of use that would potentially be incompatible with the high environmental values of the area.

It is recommended that a comprehensive analysis of these forecast shifts in population density and distribution be carried out to support the most accurate predictions of future vessel use patterns within the GC waterways.

2.1.2 Theme 2: Social carrying capacity and perceived crowding

The concept of carrying capacity is key to understanding the perception of crowding as a conflict issue. In plain language, how crowded users feel, compared to what they expected, affects how satisfied they are with their experience.

Carrying capacity can vary with a range of demographic parameters (age, income, ethnicity), and the type of use involved, and may change over time. The number of other users that an individual will tolerate before they feel crowded varies for different areas, different activities, or even different types of the same activity (e.g. fly-fishing compared to bait fishing). Residents of an area are usually more used to encountering numbers of people, and are therefore less sensitive to crowding, than tourists or visitors to the same area. Of course, expectations change, and so the perception of crowding may vary through

time, and with familiarity or frequency of use. However, it is clear that continual increases in user numbers are not accepted by most users, especially where the benefit of these increases (e.g. economic activity) is uneven. In addition, the ecological carrying capacity of a location may be exhausted before the social carrying capacity is exceeded.

Feeling crowded is the single most common negative factor for visitors and tourists, so it can affect both tourism demand and visitor numbers. The most common response to perceived overcrowding is displacement – that is, avoiding the crowded situation. Older, well-educated visitors with higher incomes are more likely to feel crowded, and so are more likely to be displaced. Visitors, tourists or residents who can afford to go elsewhere will do so, taking their tourist dollars with them, resulting in a large economic cost. More commonly, users will stay in the area but will move their activities to another time or space; for example, surfers, anglers and boat users will move to other areas or avoid peak times to escape perceived crowding. As visitor numbers increase, displacement effects should be carefully monitored, as additional impacts will become evident on 'spillover' locations that were previously subject to low levels of use. Spatial and temporal zoning approaches are possible strategies to manage this, but may also incur additional costs in increased monitoring and/or enforcement relating to these altered patterns of use.

Perceived crowding also makes users feel less safe. This is particularly the case with large numbers of craft such as PWCs and cabin cruisers, as may occur on summer weekends or holiday periods. In order to identify and minimise conflict, we need to understand how users perceive other users of their own or different use types. When compliant behaviour, good ecological conditions, and respect for the environment and each other are seen as social norms then individual users are more likely to conform to higher standards and hold others to account. In order to manage it, the carrying capacity of a location needs to be established. To do that, it is necessary to understand what visitors expect in their experiences on GC waterways. Surveys assessing users' satisfaction are relatively common, but few include questions about what users expect to see or experience.

Within the GC waterways, the study found no direct data about user expectations or perceived crowding at a scale that would permit spatial analyses. The Technical Report documents some assumptions about the expectations of particular user groups, from published descriptions of tour types, or activities of clubs or competitive users. Without spatially explicit information on user expectations, it has not been possible to predict locations in the GC waterways that may be perceived as crowded by different user groups or demographic segments. Therefore, **the study recommends** targeted surveys of user expectations within the GC waterways, to be combined with other layers of use frequency, to enable predictive modelling of perceived overcrowding.

2.1.3 Theme 3: User values and behaviour

As detailed in the Technical Report, even in urban settings user enjoyment is closely tied to the availability of natural spaces. The perception of naturalness correlates with ecological value, and is an important part of user satisfaction within the GC waterways, especially in the Northern and Southern Sections, where intact vegetated shorelines have been retained. However, how users value a place is not necessarily (or only) related to its ecological values. So high biodiversity spaces, which are therefore given high levels of protection (marine national park zones, shore side national parks), are not always the locations most highly valued by users. Nevertheless, this well-documented preference for areas with high naturalness suggests that this be accorded some priority in planning for future use of the GC waterways. Even if not the areas of highest documented biodiversity, areas with high naturalness values will generally be more sensitive to overuse than (for example) modified shorelines. While the numerous recreational PWC and small boat users contribute greatly to the local economy through their activities (fuel, bait, tackle, vessel and trailer registrations), the environmental impacts from these (boat wash, extractive fishing) may be high compared to other users.

Places that are highly valued are most commonly those with high recreational opportunities, high water quality, opportunities to see wildlife, and with aesthetic appeal. Users also place high value on continuity of place, that is, maintaining the valued 'character' of a location not readily replaced or duplicated elsewhere. Because of this, uses that are incompatible with that 'character' (e.g. frequent noisy high-speed PWCs in a quiet protected bay where families swim) will cause conflict, even if the area is not perceived as crowded, or only very occasionally so. This corresponds with a strong sense of stewardship for valued places, a sense of ownership and responsibility to maintain its quality.

A common factor for negative perceptions is poor water quality, with clean-ups and pollution prevention as chief concerns. In South East Queensland (SEQ), pollution is the primary concern, and residents are far less likely to visit their waterways if they perceive that the water is even slightly polluted (or even 'muddy').

Tourists seek different qualities to residents in their waterway visits. Non-physical attractions for tourists (easy access, social experience, infrastructure and facilities) may balance out declines in the physical or environmental conditions, but only up to a point. High noise levels and a perceived low level of 'authenticity' are strongly negative for tourists. Those visitors classed as 'unfocused users' (who simply value being on the water) are highly sensitive to noise and intrusive activities such as jet-skiing, water-skiing and speed-boating. These users, and others who appreciate waterways for their aesthetic values, are often overlooked in planning and management of waterways.

If they are accurately known, it is straightforward to incorporate user values for particular places into decision support tools. The study found no quantitative or qualitative data about the values that users place on different parts of the GCWA area, except by extrapolation from commercial operations, which are unlikely to be an accurate representation. User values are based on people's perceptions and experiences, and typically vary from place to place, and so are easier to map (and manage for) than more fundamental differences in individual or cultural ideologies. The emerging tool of Public Participation GIS, where interested individuals use on-line mapping tools to provide spatially accurate information about activities, knowledge or values, is already being used in SEQ. This tool can be used to map user values in the GC waterways in order to find areas where there is a higher risk of conflict, because different users value the area for potentially conflicting values. With this information, these areas can then be prioritised for planning approaches to separate conflicting uses in time or space, as well as for an enhanced management presence. There is also extensive information on the natural values of the GC waterways, which will help to prioritise spatial management actions.

Therefore, **the study recommends** targeted, spatially explicit surveys of the values that users place on parts of the GC waterways, and their linkage to known ecological values. A public participation mapping survey of user knowledge and values for all of Moreton Bay is underway at the time of writing; similar but more targeted techniques will assist in providing a key data layer so that places where incompatible uses are likely to co-occur can be predicted with confidence. Such information is a critical element to the success of any future planning and management activities for the GC waterways.

2.1.4 Theme 4: Personal risks to users

The use of motorised vessels worldwide always presents risks both to the vessel operators and passengers, and to other users. In the GC waterways context, the analyses in the Technical Report show that while PWCs are no more inherently dangerous to other users than other motorised vessels, the combination of speed, power and the exposed position of operators places them (the PWC operators themselves) at increased risk.

While PWCs are viewed as more risky than other vessels at a global level, in Australia more fatalities involved dinghies than any other vessel type. Typically, these were overloaded, capsized, and the passengers were not wearing Personal Floatation Devices (PFDs). The involvement of alcohol in such accidents was common. Existing laws require that all boat operators carry or use PFDs, and prohibit

operating a vessel with a blood alcohol concentration of 0.05% or greater. PFDs, of course, function simply to keep a person afloat – they don't protect against the causes of most injuries (collision), provide no protection to the most commonly affected body parts (head and neck), and little defence against the most common injuries (laceration / fracture).

The analyses in the Technical Report show that on the GC waterways PWC incident rates are not climbing. Nevertheless, small vessels (PWCs and vessels < 8 m) are responsible for accidents, injuries and deaths within the GC waterways area, and there are clear spatial hotspots where these occur most frequently (see Volume 1: Technical Report, Section 4.6). Such incidents are, unsurprisingly, more likely during long weekends and public holidays than either weekends or weekdays (Volume 1: Technical Report, Section 4.6.2, Figure 49). However, they are not limited to these times, and can also occur when a combination of factors (e.g. good weather, favourable water temperatures, fish spawning aggregations) occurs to prompt intense periods of activity where some of the uses in the location are clearly incompatible. A good example is the occurrence of relatively high numbers of small high speed vessels crossing the mouths of the Southern Section creeks which are also popular surfing, windsurfing and stand-up paddle board (SUP) locations.

Risks associated with emergent technologies, such as high-speed electrically powered small water craft, drones, hydrofoil equipped vessels, or the latest generation PWC variants do not yet appear in published analyses or available datasets. Our knowledge of the patterns of use of these craft, and any additional risk they may pose, is poor.

Within the GC waterways, incident rates are relatively stable, although the number of vessels is increasing, and there are caveats about the completeness of the most recent data (Volume 1: Technical Report, Section 4.6.2, Figure 49). Most studies are some years old. Given that there are already known hotspots of elevated risk, and the rising rates of PWC and other small powered vessel ownership against a background of strong population growth, it is likely that incident rates will rise over the next several years. There is therefore no room for complacency in carrying out the studies required to predict areas of possible higher risk, and managing to ameliorate this.

Given that demographic predictions show that the number of users/vessels within the GC waterways will grow substantially in future years, **the study recommends** that predictive modelling techniques should be used to match current areas of high injury rates with patterns of different (especially incompatible) use types. These relationships can then be used to predict future locations where injury rates may be high, based on forecast vessel numbers, types and changing distribution patterns.

2.1.5 Theme 5: Adapting to cultural and industrial change

Change in the types, volume and distribution of uses of the GC waterways is inevitable. This study has collated a wide range of data types and relevant literature to document as fully as possible the current state of knowledge, as well as pointing out gaps in the data needed to predict and manage their future use. To implement successful management strategies, it is necessary to understand how users individually and collectively react and adapt to change.

In SEQ, and more widely, the general effects of increased use of waterways have included damage or loss of culturally and environmentally significant sites. Such tensions between recreational and traditional use are common issues as regions develop and change. Similar tensions exist between long-term low-intensity users, and recent increases of more intrusive use types.

Social change takes place continuously, but where residents are engaged and involved in industries which compliment tourism, local opportunity and economy and visitor experiences can benefit. Initially, residents are likely to support increased visitor numbers which bring additional income to the area. Typically, though, as visitor numbers continue to increase, resident perceptions of these benefits decline, in part due to increased prices and living expenses for residents, and partly through increased

environmental disturbance. The loss of social and cultural identity also contributes to declining support when the benefits are not equally shared (e.g. when increased tourism benefits foreign owners or developers at the expense of residents or long-term visitors).

Minimising conflict in the face of change or development is dependent on the core values that existing users attribute to their waterways, as described above. Support for change relies on an equitable distribution of benefit to existing users.

When managing change, it is useful to understand how users receive and evaluate information about 'the new'. People are more likely to access trusted networks (friends, peers, the media), rather than seek the reports for themselves. When taking these 'cognitive shortcuts' they will, in general, seek information that supports their own preformed opinions. Understanding this dynamic is important for organisations such as GCWA in framing engagement and consultation strategies.

To this end, **the study recommends** a planning process that includes an open and inclusive process which will engage user groups in both gathering new information (or validating existing data), as well as in planning for future management.

2.1.6 Theme 6: Management tools and planning

Marine Spatial Planning (MSP) is a promising model for the management of coastal waterways and tourism across the land-sea interface. MSP builds analysis, public participation, and adaptive measures into a planning framework, and in addition uses the most accurate data available to provide spatial outcomes appropriate for planning. In Australia, it has been used in a specialised form for Marine Park planning since the advent of the Great Barrier Reef Marine Park, and more recently the Moreton Bay Marine Park, which covers part of the GC waterways. Planning must also consider current and planned management, and planning processes currently underway in neighbouring or overlapping jurisdictions. These include the upcoming Moreton Bay Marine Park Zoning Plan review, Redlands Shire strategic planning and the Southport Spit Master Plan. MSP has cross-jurisdictional capabilities as a planning, rather than regulatory tool, allowing different jurisdictions to collaborate in implementing an agreed management model. MSP can also be used specifically to anticipate and resolve conflict, by finding and mapping incompatible use. MSP is also adaptive, in that it monitors progress towards defined goals, and adapts implementation of management measures in response to the progress being made.

The study recommends that a MSP approach is an appropriate model for developing and implementing future management of the GC waterways.

The current study has provided a wide variety of data layers from more than 40 sources that will support detailed, spatially explicit planning approaches. A key feature of planning for the future use of the GC waterways will be the ability to predict future use patterns. Any prediction, or model, is only as good as the data upon which it is based. In order to do this, it is critical to address the data gaps identified as part of this project, so that current patterns of all known user groups (including all major vessel types) can be determined, and that users' values and expectations are known.

As discussed in Section 2.1.3, open and accessible tools such as PPGIS can assist not only with providing spatially detailed information, but potentially in promoting greater engagement with the planning process. **The study recommends** the use of these and related technologies in the planning and community engagement process.

2.2 Summary of spatial analyses and identified potential conflicts

The following is based on the SWOT analysis in the Technical Report; a summary graphic is reproduced in Appendix C. The SWOT analysis summarised the key information and provided a snapshot of the Strengths, Weaknesses, Opportunities and Threats for the three main sections of the GC waterways as used for this project.

For complete details and further information, please refer to the Technical Report.

2.2.1 Status of GC waterway sections

The Northern Section is the largest, with the greatest diversity of habitat types, protected natural and artificial waterways, unconstrained access to offshore waters, and a wide spectrum of recreational and commercial uses. It is the GC's most valuable natural asset, in scenic, economic, and ecological terms. However, most parts of the waterway are shallow, so use for larger vessels is constrained to narrow channels. Although unquantified (see Volume 1: Technical Report, Section 5), anecdotally the use levels by small recreational craft can be very high at peak times of the year, with significant crowding occurring at popular anchorages, and increased risk of incidents, as evidenced by the marine incident data presented in Volume 1: Technical Report (see also Sections 2.1.3 and 2.1.4 above). Many recreational activities are already spatially or temporally separated (e.g. by weather or vessel draft), but with increasing population density, it is likely that without proper planning and management the risk of conflicting uses in identified hotspots, and potentially in other locations with changing demography, will increase in future.

The Mid-Section is largely comprised of sheltered and modified or artificial waterways, and access for larger craft is limited because of height restrictions imposed by road and pedestrian bridges. As a consequence, these waterways, including artificial lakes not connected to the river, are popular for competitive long-distance unpowered water sports (kayaking, rowing) as well as recreational and fitness-based activities. This could be a significant future drawcard for these types of sporting events. However, in places the waterways are narrow, and the modified bank structures reflect wave energy, creating potential conflict between users of powered (especially high-speed or larger vessels) and unpowered craft (which are often unstable and sit low to the water). Speed limits are in place in many parts of these waterways, but infringements are common. An additional factor is the emergence of new and/or low-cost technologies (e.g. DIY electrically driven surfboards or hydrofoil craft). Little data exists about the risks associated with the use of such craft.

The Southern Section includes the estuaries and mouths of Tallebudgera and Currumbin Creeks. These provide very high scenic amenity for family-oriented recreation and scenic exploration in small, shallow draft vessels, especially kayaks and SUPs. Their popularity for this type of use is evident from fitness tracking data (Volume 1: Technical Report, Sections 4.3.5 and 4.3.6). However, the footprint of the creeks is small (only 322 ha) and there is potential for conflict between this low intensity use and noisy, high powered small vessels, especially PWCs and dinghies. In addition, the creek mouths are the only easy access point for small vessels to the reefs immediately offshore. At peak times, and in favourable weather, MSQ data shows a high incidence of vessel-based incidents and accidents, highlighting the conflicting use between these vessels and unpowered uses (board riders, kayakers, SUPs and swimmers).

The graphic at Appendix C summarises the strengths, weaknesses, opportunities and threats relating to the waterways in each section.

3 Discussion and Recommendations

3.1 Conclusions – what do we know?

The study examined over 120 literature sources and assembled and analysed over 40 spatially based datasets relevant to the study areas, as well as examining available data on trends in tourism visitation and satisfaction.

The components of the study now provide a comprehensive overview of patterns of use, trends in tourism and local demographics of the GC waterways, set within the context of international studies on managing potentially conflicting use on waterways. This is a detailed and valuable resource for managers. All the data layers have been provided in GIS-ready form to support planning and management initiatives.

However, not all the data needed to identify actual or potential conflict areas exists at the scale necessary for a spatial planning process. Therefore, the study has also identified further information that will be important to support those planning processes.

The main themes around conflict identification and management that apply to waterways both locally and elsewhere have been described in detail in Section 2, as have the most important findings of the spatial analyses. One of the biggest drivers, giving some urgency to management planning, is the forecast increase in local population, and associated changes in distribution.

Given that the vessel and visitor numbers within the GC waterways are forecast to continue to increase strongly over the coming decades, it is clear that management interventions in some form will be required in the future. The study acknowledges that there is already considerable spatial management in place, such as the Moreton Bay Marine Park Zoning Plan (scheduled to be reviewed commencing 2020) and the anchoring and mooring restrictions of the *Transport Infrastructure (Waterways Management) Regulation 2012*. The timing of this GCWA-driven planning initiative is opportune, since it will interface readily with the Marine Park Zoning Plan review process.

The pattern of use data for commercial and non-powered recreational and sporting craft identified locations where conflict may lead to incidents, accidents or injuries (as evidenced by incident and enforcement statistics), however, it was also highlighted that there are likely to be additional conflict hotspots yet to be identified (e.g. user/user conflicts based on differing values associated with the waterway, or because the conflicts are between users and environmental values).

At present, accident and injury rates are not climbing as fast as vessel registrations – but the international experience shows that they will rise as vessel densities rise, and the extent of overlapping and incompatible uses grows. Therefore, there is an opportunity at this time to plan for management of future use patterns before they occur. Information that can help predict the spatial and temporal patterns of use across diverse types of uses and users is critical to allow conflicting uses to be mapped and identified. These are a powerful tool to support adaptive MSP approaches, used successfully in other parts of the world, and elsewhere in Australia.

A broad mix of uses takes place within the GC waterways. While there are known conflict hotspots, in terms of incidents, accidents and injuries, these are in absolute terms relatively rare. Set against the backdrop of increasing population, and concurrent rises in registrations of small vessels, this should be seen as a significant opportunity. There is a window in time over the next several years, given stable and invested governance, to set in place outward looking and inclusive management practises, adaptive monitoring and data gathering, to identify and ameliorate potential conflicts in order to avoid the mistakes of other jurisdictions.

3.2 Critical information gaps – what else do we need to know?

The Technical Report provided a detailed breakdown of gaps in the available information (Appendix B) that will need to filled to enable appropriate planning and management processes to address the issues outlined above. It highlights further work required to enable spatial analyses of potential future conflict hotspots. More urgently, there were other critical gaps, as identified in Section 2.1, for which there is no data or information beyond anecdotal observations. These include the patterns of use of small recreational vessels, which make up the greatest number of users and vessels within the GC waterways. Similarly, there is only extremely limited quantitative data available about the values that users place on particular waterways, areas, or adjacent shorelines.

The information gaps identified here are therefore not an exhaustive list; however, they are considered the highest priority actions to support future planning and management for the use of the GC waterways.

Table 1: Critical information gaps identified from spatial and literature analyses

Critical information gap 1:	There is no quantitative data on the patterns of use of recreational vessels, especially small (< 8 m) trailerable craft, within GC waterways available at the scale required for effective management decisions. Such information is critical for effective decision making. Approaches such as targeted multi-modal surveys of where and when these vessels are distributed, and how they are used, are proven ways to address critical information gaps such as this.
Critical information gap 2:	Maps of predicted use of the GC waterways, at a spatial scale suitable for management planning, do not currently exist. However, they could be derived from spatially detailed analyses of forecast demographic shifts on lands adjacent to the GC waterways, especially in the forecast high population growth areas adjacent to the Northern Broadwater. This will allow the surveyed current use patterns to be used to predict the intensity and distribution of future use, and is critical to future management of the GC waterways, especially in the Northern Broadwater, where initial analyses suggest substantial increases in the levels and distribution of use.
Critical information gap 3:	Information about the expectations of users of the GC waterways in different locations, and at different times, is not currently available at spatial scales useful for management planning. Understanding, this is key to predicting where users are most likely to feel crowded, and therefore at most risk of displacement. A spatially explicit user survey of user experiences and expectations within the GC waterways is a proven method of filling these data gaps.
Critical information gap 4:	Spatially explicit information to understand the values that users place on different parts of the GC waterways, and their linkages to ecological values, is not currently available. Such information is critical to identifying uses incompatible with those values, and thereby to place priorities on particular use types. This will enable prediction of conflicts between user values, ecological values and patterns of user behaviour. A spatially explicit user survey of user knowledge and values within the GC waterways is an established practice for addressing these data gaps.
Critical information gap 5:	Databases to permit predictive mapping to identify areas of potentially higher risk of incidents, accidents or injuries in the future do not currently exist. However, they could be developed, based on existing patterns of use (Critical information gap 1), underpinned by predicted population trends (Critical information gap 2), and are necessary for future planning of the GC waterways, in that such mapping will enable planning for strategies required to manage these risks. While there are known sites of

higher risk of incidents, accidents and injuries, it is likely that other high-risk areas will emerge as patterns of use change over time.

3.3 Key recommendations – how do we get there?

The recommendations from the study have been separated into those related to information needs based on the identified critical information gaps and possible other studies in the Gap Analysis (see Appendix B); and planning processes and tools identified in the summary of major themes (see Section 2.1) that are consistent with contemporary approaches elsewhere, both nationally and overseas. Where possible, related studies have been grouped together. It is acknowledged that a wide range of potential planning approaches could be applied, however, those recommended below are in wide contemporary use in marine environments, and provide the necessary spatial resolution for this setting.

3.3.1 Information needs

Recommendation 1
It is recommended that a targeted study aimed at mapping the patterns of use of small trailerable vessels be undertaken in order to permit spatial analyses of this numerically dominant vessel type (Critical information gap 1).

Recommendation 2
It is recommended that a comprehensive analysis of forecast demographic shifts on lands adjacent to the GC waterways be undertaken to enable prediction of the intensity and distribution of future use (Critical information gap 2).

Recommendation 3
It is recommended that a coordinated program of public participation mapping to provide spatially explicit information about the user expectations for, and values of, the GC waterways be undertaken, in order to predict and thereby ameliorate future conflict using targeted management strategies (Critical information gaps 3 and 4).

Recommendation 4
It is recommended that a predictive mapping study is undertaken to identify areas of potentially higher risk of incidents, accidents or injuries, based on the relationship between existing patterns of use and incident statistics, and extrapolated to fit predicted use patterns (Recommendation 2). This will enable planning for strategies required to manage future risks (Critical information gap 4).

Recommendation 5
It is recommended that additional studies to fill other data gaps identified in the Gap Analysis (Appendix B) be undertaken to support planning processes. Highest priority gaps NOT covered in the recommendations above relate to information about use by snorkelers and swimmers; recreational fishing (as distinct from boating); and patterns of PWC use specifically (as a subset of small vessel use).

3.3.2 Planning processes and tools

Recommendation 6
It is recommended that coordinated cross-disciplinary planning using Marine Spatial Planning

approaches, be undertaken based on robust modelling of potentially conflicting uses, and areas of risk (of incident, accident or injury) under a range of future use scenarios.

Recommendation 7
It is recommended that planning tools used should include open and accessible resources (e.g. PPGIS) that enable users, groups, industry and regulators to transparently contribute to, and access, relevant information layers. This will assist in wider understanding and ownership of agreed management interventions, which may not all be regulatory.

Recommendation 8
It is recommended that the planning approach should be combined with a comprehensive strategy to engage user groups in the information gathering and management planning phases. Any MSP process will need to complement existing or planned processes in neighbouring or overlapping waterway jurisdictions, such as the Moreton Bay Marine Park Zoning Plan review.

4 Appendices

Appendix A: Description of GC waterway subdivisions as used in the Technical Report and Discussion Paper.

Based on catchment properties, the GC waterways were subdivided into three main sections as listed below. For analyses of tourism and demographic data, the Mid-Section was further divided by Australian Bureau of Statistic (ABS) level 2 boundaries (below).

Table 2: Subdivisions of GC waterways used in the reports and as illustrated in Figure 1, with description of catchments and area totals.

Section	Tourism Region	Catchment Properties	Area
Northern Section	1: Broadwater North waterways (north of the Seaway)	Smaller rivers (Albert, Coomera and Pimpama) and several creeks (Pimpama and Broadwater creeks) draining via extended lowlands mostly modified by man-made drainage channels into a shallow sandy estuarine system.	7474 ha
Mid-Section	2a: Broadwater South waterways 2b: Nerang and Central waterways, associated canal estates and lakes	A small river with a heavily regulated flow regime (Hinze Dam, Little Nerang Dam) draining through a heavily urbanised area with an extensive network of man-made canals and lakes into a narrow estuarine section also modified by a number of artificial structures, including a heavily modified and stabilised entrance system.	1995 ha
Southern Section	3: Tallebudgera and Currumbin Creeks and associated canal estates	A combined catchment of two major creeks carrying runoff from the hinterland plateau and slopes along a comparatively steep altitude gradient (in relation to the Northern Broadwater and Nerang River sections) via short and partly modified estuaries with narrow openings stabilised by rock formations and man-made breakwaters at the creek entrances.	322 ha

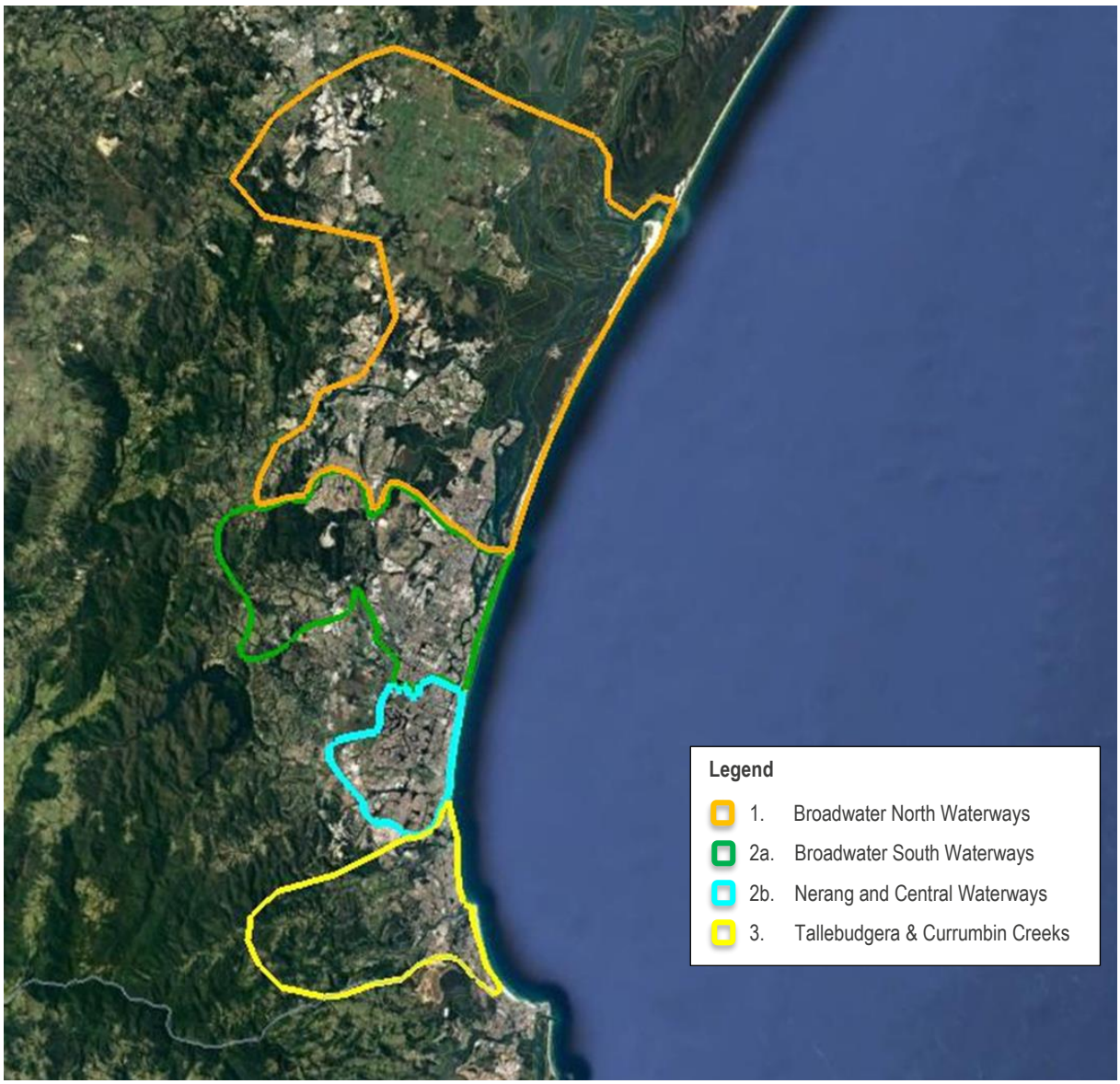

Figure 1: Map of GC waterways used in the reports, as described in Table 2 (from Earthcheck 2018).

Appendix B: Gap Analysis Tables

The following tables (3 to 5(a) and (b)) have been reproduced from the Technical Report. For complete details and further information, please refer to the Technical Report.

Table 3. Availability of quantitative data about use and user types within the GC waterways.

	Spatial distribution			Temporal distribution				Priority
	General use areas	Hot spots	Densities	Day	Week	Season	Trends	
Recreational fishing (from vessel)	YES (DAF*)	SOME (club competitions)	NO	NO	NO	NO	SOME (DAF)	1
Sailing (trailerable and non-trailerable)	YES (Regatta courses, anchorages)	SOME (Leon & Warnken 2008)	SOME (Leon & Warnken 2008)	NO	SOME (Leon & Warnken 2008)	SOME(Leon & Warnken 2008)	SOME (Qld recr. vessel register)	3
Power boating	SOME (large vessels only)	NO	SOME (Leon & Warnken 2008)	SOME (GCCC boat ramp surveys)	SOME (Leon & Warnken 2008)	SOME (Leon & Warnken 2008)	SOME (Qld recr. vessel register)	1
PWC use	SOME (tour operators only)	NO	NO	NO	NO	NO	NO	1
Water skiing, wake boarding	YES (club activities, GCWA restricitions)	SOME (STRAVA)	NO	NO	NO	NO	NO	2
Rowing	YES (school & club activities)	YES (STRAVA)	NO	SOME (school & club activity logs)	SOME (school & club activity logs)	SOME (school & club activity logs)	SOME (school & club activity logs)	3
Kayaking, outrigger canoeing	SOME (STRAVA, tour operators)	SOME (STRAVA)	NO	FEW (AIS activity logs)	FEW (AIS activity logs)	FEW (AIS activity logs)	FEW (AIS activity logs)	2
SUP boarding	SOME (STRAVA, tour operators)	SOME (STRAVA)	NO	NO	NO	NO	NO	2
Wind surfing, kite surfing	SOME (STRAVA, tour operators)	SOME (STRAVA)	NO	NO	NO	NO	NO	2
Diving	YES (clubs & tour operators logs)	YES (clubs & tour operators logs)	SOME (clubs & tour operators logs)	SOME (clubs & tour operators logs)	SOME (clubs & tour operators logs)	SOME (clubs & tour operators logs)	SOME (clubs & tour operators logs)	2
Snorkeling, swimming	NO	NO	NO	NO	NO	NO	NO	1
User values for (e.g.): Visual amenity Cultural significance Peace and quiet, etc	NO	NO	NO	NO	NO	NO	SOME (Healthy Land and Water)	1

* DAF = Queensland Department of Agriculture and Fisheries

Table 4. Availability of quantitative and anecdotal data about use and user types within the GC waterways

	Spatial distribution			Temporal distribution				Priority
	General use areas	Hot spots	Densities	Time of day	Part of week	Season	Trends	
Recreational fishing (from watercraft)	YES (most of Northern Broadwater)	Some (north wall of Seaway)	NO	Some (mostly morning and afternoon)	NO	YES	NO	1
Sailing (trailerable and non-trailerable)	YES (most deeper parts of Northern Broadwater)	YES (Hollywell, main channel Southport Yacht Club to Seaway)	Some (regatta registrations)	YES (Wednesday afternoons, weekends late morning to afternoon)	YES (Wednesdays & weekends)	Some (regattas)	NO	3
Power boating	Some (Coomera & Nerang Rivers, Broadwater)	NO	NO	Some	Some	NO	NO	1
PWC use	Some (everywhere unless banned)	NO	NO	NO	Some	NO	NO	1
Water skiing, wake boarding	YES	YES	NO	Some	YES	Some	NO	3
Rowing	YES (see spatial analyses)	YES	YES	YES	YES	YES	Some	3
Kayaking, outrigger canoeing	Some (see spatial analyses)	Some	Some	Some	Some	Some	Some	2
SUP boarding	Some (Southern Creeks, protected canals & areas around Broadwater islands)	Some	NO	Yes	Some	NO	NO	2
Wind surfing, kite surfing	YES (Southern Broadwater)	YES	NO	Some	Some	YES	Some	2
Snorkelling, diving, swimming	YES (Seaway & Wavebreak Island rock walls)	YES	NO	YES	Some	Some	Some	2
User values for (e.g.): Visual amenity Cultural significance Peace and quiet	NO	NO	NO	NO	NO	NO	Some	1

Table 5. Candidate data sets and associated projects for filling identified information gaps within the GC waterways from existing datasets (a) and data from new studies (b).

a)

Existing data set type	Extractable information	Custodian of data set	R&D requirements
Location of mobile phones (IDs) on waterways	Movement, hotspots, launch places, spatio-temporal trends for any watercraft (based on speed and area of use)	TELSTRA	Algorithms to discriminate between types of users (watercraft)
Tracks of sports activity monitoring mobile devices	Movement, hotspots, launch places, spatio-temporal trends for non-powered watercraft (based on user-defined type of activity)	STRAVA	Automated GIS module to extract and analyse incoming vector data
Location and type of injuries from watersport activities from GC hospital admissions to emergency departments	Conflict hotspots and identification of actual high risk activities and areas, spatio-temporal trends	Qld Health	Method for extracting relevant information from relevant Qld Health databases
Forecast GC population demographics based on housing development trends	Forecast increases/trends in housing type at best available resolution	Qld Treasury	Validate assumptions relating to vessel ownership and household type
Multi-year AIS position data and IDs	Mooring, transition and anchoring hotspots of larger (mostly > 8 m) commercial operators, spatio-temporal trends in relation to marine incident reports	AMSA, Vesselfinder.com	Automated (GIS) module to extract and analyse incoming point data
Multi-year location information on issue of infringement notices	Non-compliance types and hotspots, spatio-temporal trends (effectiveness of risk aversion measures)	Qld Police	Method for extracting location information and mapping of incident records
Imagery from waterways surveillance cameras	Ground truthing for AIS and mobile phone data, characterisation of behavioural patterns (= usage of watercraft)	GCCC, TMR	Method for automated screening of video footage
Navionics waypoints database	Recreational fishers waypoints uploaded to Navionics website	Garmin Ltd	GIS spatial analysis process to condense several years of vector and point data (can build on STRAVA analyses)

b)

New data set type	Information type	Eventual custodian	R&D requirements
Spatial distribution of small (< 8 m) recreational vessels	Densities, i.e. vessels.ha^{-1}.day^{-1} over identified temporal units (weekdays, weekends, holidays)	GCWA/Researchers	Targeted surveys using multiple methods (e.g. aerial snapshot surveys, boat ramp surveys, on-water census)
Spatial distribution of activities from small (< 8 m) recreational vessels	Densities (as above) by activity types (e.g. fishing, water sports, sightseeing, transit)	GCWA/Researchers	Targeted surveys using multiple methods (e.g. aerial snapshot surveys, boat ramp surveys, on-water census)
Place-based user values	Polygons with value scores for value types (e.g. visual amenity, cultural heritage, peace and quiet)	GCWA/Researchers	PPGIS, questionnaires, boat ramp surveys
User attitudes to other use types	Conflict scores for use type pairs (e.g. water skiers' attitudes to large >8 m vessels; fishers' attitudes to PWC users)	GCWA/Researchers	PPGIS, questionnaires, boat ramp surveys

Appendix C: SWOT Analysis

The following figure has been adapted from figures contained within the Technical Report (i.e. Figures 58, 62 and 66). For complete details and further information, please refer to the Technical Report.

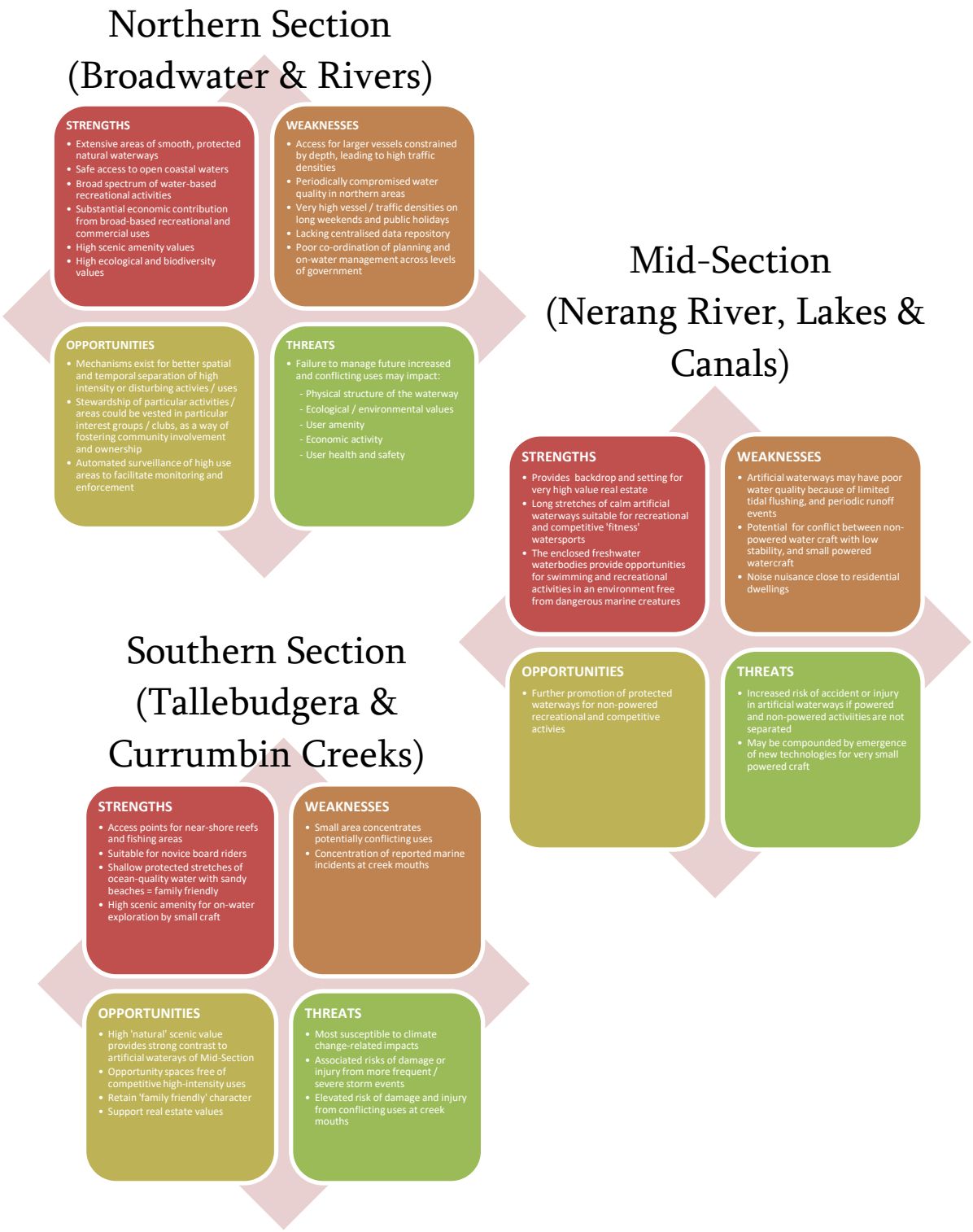

Figure 2: SWOT analyses for the Northern, Mid and Southern Sections of the GC waterways.

GOLD COAST WATERWAYS AUTHORITY

Queensland Government