Inverloch Coastal Resilience Project:
Preliminary Economic Assessment

Report prepared for the South Gippsland Conservation Society

by David Cotterill, July 2019

South Gippsland Conservation Society
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ACKNOWLEDGEMENTS

This study is based on a review of a range of relevant literature. The sources used are referenced in a separate section at the end of this report and individually throughout the document when first cited.

The study used:

- Data sourced from Bass Coast Shire including Census and other data provided by Id Consulting available on relevant Bass Coast web sites
- Bass Coast Tourism visitor data collected by Bass Coast Shire and provided courtesy of Theresa Mahood, Bass Coast Tourism.

1 Introduction

Bass Coast is renowned for its natural, unspoilt coastline. Inverloch is a key part of this coastline which features an extensive, vegetated dune system that stretches from Eagles Nest to Point Smyth. The surf beach is highly valued by residents and visitors and is a major attraction for swimmers, surfers, nippers and beach walkers. The beach and its vegetated dune system also has ecological and habitat values, providing one of the largest stands of remnant vegetation in Inverloch and forming an important function as a biolink. The critically endangered Hooded Plover and other shorebirds nest in the dunes directly behind the beach.

This section of coast has long been recognised as being vulnerable to rising sea levels and storm surges associated with the effects of climate change. Significant recession of the beach has occurred over the past 7 years (in excess of 40 metres). If this rate of recession were to be sustained over the next 10 years, and without management, the dune system would be lost and infrastructure would be needed to protect housing along Surf Parade.

1.1 Objectives of this Economic Study

This study is part of a suite of ecological, cultural heritage, economic and geomorphological studies. The objective of this study is to compile information about the use of the coastal area and the views of local residents and visitors on the value they derive from living in or visiting the Inverloch area. Previous relevant studies are reviewed.

The findings of this study will be added to those of the other studies in the current suite of studies noted above. The combined information is available as input to the work undertaken under the proposed Local Coastal Hazard Assessment that is intended to ensure that the full suite of ecological, social, economic and aesthetic factors are considered in the development of a climate change management strategy for this section of the Bass Coast, including the consequences of any “retreat’’ strategy option that may be considered.

In recognition of the threat posed by climate change along the Victorian coast, the Victorian Government has committed to helping coastal communities manage the risks from coastal hazards through the undertaking of Local Coastal Hazard Assessments. A number of these assessments have been completed along the Victorian coast and the Gippsland Regional Coastal Plan 2015-2020 identifies the need for detailed coastal hazard assessment and adaptation planning around Anderson Inlet and Venus Bay. While the timing of the initiation of this investigation is currently unclear, the timeline provided in the Regional Coastal Plan indicates that work should commence within the next two years.

This information will be able to be drawn on, and considered, by Government during the preparation of the Anderson Inlet and Venus Bay Coastal Hazard Assessment.

2 Importance of beaches, surf and dune systems in Australia

The “beach” is a major element of Australian culture. As a large Island, Australia has a substantial number and area of attractive beaches. According to Short (2006), Australia has 10,685 beach systems incorporating approximately 15,000 kilometres or about half the Australian coastline (BASTRA, Raybould et al., 2013).

The term ‘beach’ is typically applied to a shore with a cover of unconsolidated sand or shingle (Shepard, 1937). Most recreation users would relate to the description of a beach as ‘... a stretch of sand longer than 20 metres and remaining dry at high tide’ (Australian Government, 2007), however this is inadequate as a framework for beach management. The geomorphology literature describes the beach as a system that extends ‘... from the landward limit of the swash to the depth at which wave action ceases to be a component to transport non-cohesive seabed sediment’ (Hardisty, 1990). Similarly, Section 4 of the NSW Coastal Protection Act 1979 describes a beach as ‘... the area of unconsolidated or other readily eroded material between the highest level reached by wave action and the place where tidal or lake waters reach a depth of 10 meters below Australian Height Datum’ (Coastal Protection Act, 1979).

The BASTRA research focusses on beaches as recreation environments and the potential impacts of climate change on recreational activities and values and thus argues that beaches are part of a dynamic system reliant on both the surf zone, which may extend many metres out to sea and on the landward coastal dunes for transport and storage of sand (Dugan et al., 2008).

The distribution of sand within this dynamic system is almost certain to be affected by changes in sea level and storm activity associated with climate change. Furthermore, as a leisure environment, it is also almost impossible to separate the surf zone from the tidal part of the beach and from the dunes at the back of the beach, because people move freely between these zones while engaging in a broad range of passive and active recreation activities. The (BASTRA) paper therefore adopts a definition of the beach as ‘a system that extends seaward to the depth at which wave action ceases to impact on seabed sediments and landward to the practical limit of the beach/dune system formed by a vegetation line or built structure such as a wall’. As such, the beach system incorporates a range of environments that supports both active and passive forms of recreation stretching from the near-shore surf zone and swimming areas to the beach and back beach.

2.1 Use of beach and surf resources for recreation

Defining the difference between residents and tourists is related closely to the difference between recreation and tourism. Recreation activities are those activities undertaken during leisure time (Lynch & Veal, 2006) and the beach system provides a wide variety of active (walking, running and swimming) and passive (sunbathing and relaxing) recreation services. These services are consumed by both local residents and short-term visitors to a coastal region, and are frequently a major motivator of long-term migration into a region and the attraction of short-term visitation. Thus, recreation services associated with beaches create substantial economic value and economists look to market and non-market approaches to provide indicators of the economic value of those recreation services.

Although there is no single tourism industry, tourism as an economic activity that:

'... comprises all of the inter-related activities that are required to produce goods and services for consumption by tourists. This includes transport, accommodation, education, retailing, cultural and recreational services' (Commonwealth of Australia, 2010).

As tourism services are defined according to who consumes the outputs, a clear definition of what constitutes a tourist is essential for making measurements and comparisons. Most countries have adopted the United Nations World Tourism Organization (UNWTO) standard definition of a tourist as a person who travels outside their 'usual environment' for less than a year for reasons other than employment (United Nations World Tourism Organization, 1994, p. 7). Thus, tourism involves travel for leisure and also for business, employment and education.

To remove the ambiguity of the term 'usual environment', the Australian Bureau of Statistics and Tourism Research Australia (TRA) identify individuals that qualify as tourists by distinguishing between overnight and daytrip visitors. Overnight visitors must travel more than 40 kilometres away from home to be called a 'tourist', and daytrip visitors must take a round trip of more than 50 kilometres from their home to qualify (Australian Bureau of Statistics, 2010; Tourism Research Australia, 2011). Both these categories of tourist, and their associated expenditures, are relevant to beach communities.

2.2 Importance of beach and surf resources to residents

The services provided by beach systems act as a strong attraction for local residents. Small and Nicholls (2003) estimated that in 1990, 23% of the global population lived within 100 kilometres of the shore and this zone had three times the global average population density. They also demonstrated that densities are highest close to the shoreline and at low elevation (Small & Nicholls, 2003). This was despite the extensive availability of unpopulated, low-elevation land at high latitudes (polar regions) that reduced the weighted densities (population divided by available area at that elevation or proximity) for both low-elevation and coastal lands. Notwithstanding this statistical anomaly, more than 100 million people are thought to reside within one metre of mean sea level (Zhang, Douglas, & Leatherman, 2004).

This effect is even more pronounced in Australia. Australians have a strong geographical affinity for the coast, with approximately 85% of the Australian population living within 50 kilometres of the coast (Australian Bureau of Statistics, 2004). Around 50% of residential addresses are located within seven kilometres of the coastline, and around 6% in the zone that is less than five metres above mean sea level and within three kilometres of the coast (Chen & McAneney, 2006). Net migration to the coast is expected to increase the proportion even more in the future (National Sea Change Taskforce, 2006). Population growth in the coastal zone has also rapidly outstripped that in other areas (Greve, Cowell, & Thom, 2000). This has resulted in rapid coastal development which brings management challenges and also restricts the available climate change adaptation options. To a large extent, the settlement pattern is driven by the recreational opportunities and perceived quality of life benefits associated with coastal areas (Gurran, Hamin, & Norman, 2008). Australia's coastline is arguably our most important recreation resource.

2.3 Values associated with the coast

Despite the obvious attraction of the coast for Australians both as a place to live and visit, the significance of coastal dunes and vegetation is often challenged. Coastal dunes and vegetation have traditionally not been considered worthy of protection, and along much of Australia's urbanised coastline, they were cleared to make way for development. Back dunes were also mined for sand in some locations, disturbing the sediment balance and ecology of these areas and creating degraded landscapes (Brewer and Whelan, 2003). These are examples of exploitation of the economic potential of the coast without careful consideration of the significance of the dunes and vegetation for the maintenance of other coastal values important to the community.

With increasing recognition of their significance, in recent times much effort has been directed towards restoring coastal dunes and vegetation in areas where they have been lost or degraded. One of the primary reasons for doing so is that coastal dunes and vegetation provide a protective buffer for coastal assets and infrastructure against the risks from coastal processes and hazards. These risks are expected to increase with climate change and rising sea levels in the future, and, where appropriate, restoring coastal dunes and vegetation is seen as a more desirable way of providing protection than through using hard engineering options (Arkema et al., 2013). The NSW Government has supported many dune restoration projects along the state's coastline, and has prepared a manual to assist shoreline for ongoing work in this area (NSW Department of Land and Water Conservation, 2001). Dune restoration projects also feature prominently amongst the grants awarded by the NSW Government through its Estuary and Coastal Management Program.

2.4 Importance of beach and surf resources to tourists

Tourists have long been drawn to the beach and the commercial activities that service tourists needs have become the primary source of regional income and jobs in many coastal locations. The attractive nature of beaches generates substantial tourism earnings, which are concentrated in coastal regions (Klein, Osleeb, & Viola, 2004). These income streams are potentially threatened by changes in the quality and extent of the beach systems on which they depend (Jones & Phillips, 2007).

The coastline is a major drawcard for domestic and international tourists in Australia. Approximately 22% of all domestic overnight trips (including trips taken primarily for business reasons) involved a visit to the beach or coast (Tourism Research Australia, 2013) and 62% of international visitors to Australia report beach visits/recreation as one of their most important holiday activities (Department of Foreign Affairs and Trade, 2008).

Coastal recreation resources are in the front line of events forecast to occur as a result of climate change. Beaches made from dynamic and easily transported sediments (e.g. sand, silt) are especially vulnerable to sea-level rise, changes in storm intensity and frequency. All of these contribute to erosion. In addition, forecast changes in average temperatures and precipitation will also affect recreation use of coastal assets.

3 Impact of climate change on beach and surf recreation and tourism

Climate change is likely to exacerbate existing coastal management challenges and this understanding was a major motivator for this study. Table 1 outlines a range of potential climate change impacts on the coast. The key impact for Inverloch relates to coastal erosion. The sea front along the surf beach has been significantly eroded over the recent past with considerable physical and visual damage to the beach and dune areas. Access to the Surf Lifesaving Club has been changed and repaired more than once over the recent past. The dunes have been damaged and reduced in area threatening the Inverloch to Cape Paterson road. This road provides the most direct access to the RACV Resort a major tourism and recreation asset on the outskirts of Inverloch.

Recent publicity related to the Great Ocean Road recognized a similar story to the impacts at Inverloch. (https://www.theage.com.au/national/victoria/oceans-rising-can-we-save-our-collapsing-coastline-20190111-p50qvy.html.)

Table 1: Direct and indirect climate change impacts on beaches

Climate change (driver)	Principal direct physical and ecosystem effects	Potential secondary and indirect impacts)
Sea-level rise	• Increased inundation of coastal zone • Increased coastal erosion • Increased risk of flooding and storm damage • Saline intrusion into surface and groundwater.	• Disruption of coastal economy, tourism impacts • Displacement of residents in impacted areas • Damage to coastal Infrastructure • Health impacts associated with water quality changes.
Altered wave climate	• Increased wave run-up • Altered erosion and accretion balance	• Enhanced erosion
Storm frequency and intensity changes	• Increased wave heights, run up and storm surge • Southward Shift in cyclone zones	• Increased storm damage
Ocean acidification	• Impacts on reef-building corals	• Reduced storm protection function, less resilient and functional reefs.

Adapted from Aboudha & Woodroffe, (2006)

3.1 Sea Level Rise

In 2007, the Intergovernmental Panel on Climate Change (IPCC) released the Fourth Assessment Report (AR4). It predicted that global sea levels will rise between 18 and 59 centimetres by 2090–2099 compared with 1999 levels (IPCC, 2007). As is widely reported, this does not include the inputs due to melting of terrestrial ice sheets, because the climate science community could not agree on the magnitude or timing of this contribution. The IPCC estimates this will add approximately 10–20 centimetres to global sea levels (IPCC, 2007).

Over the period 1900-2010 global SLR has risen by 0.19metres. The average rate in Australia was 1.4mm per annum between 1966 and 2010 (Climate Change in Australia website). Between 1993 and 2010 mean global SLR rose by 3.2, per annum (IPCC, 2014).

By 2030, the projected range of SLR for the Southern Australian coastline is .07 to 0.19 metres above the 1985-2005 level (Climate Change in Australia website).

By 2090, the intermediate emissions case (RCP4.5) is associated with a rise of 0.27 to 0.66 metres and the high emissions case (RCP8.5) a rise of 0.39 to 0.89 metres (Climate Change in Australia website). Coastal Risk Australia estimates that global mean SLR could increase by 2.7 metres when the Greenland and Antarctic ice melt and ice sheet instability are taken into account.

Work by prominent author Stefan Rahmstorf on the most recent IPCC report has suggested that SLR may be significantly underestimated by current climate models. The results of his semi-empirical analysis suggest a global eustatic SLR of between 0.5 and 1.4 metres by the year 2100.

This was further updated by Grinsted et al. (2009), who extended a semi-empirical approach to the past 200 years, and also estimated future SLR by 2100. Their estimation (see Table 2, p. 469 in Grinsted et al., 2010) is that IPCC estimates of SLR may be only one-third of the possible rate by 2090–2099, (Grinsted, Moore, & Jevrejeva, 2010). This rate of SLR can only be explained by the rapid decay of large ice shelves posited for Greenland based on paleoclimatic records (Overpeck et al., 2006). Another recent study estimated the physical constraints on glacial supply of water to the ocean based on the cross-sectional area of the glacier and potential flow rates, and found bounds that are consistent with these higher rates of SLR (Pfeffer, Harper, & O'Neel, 2008).

This range appears to be supported by observations of sea level which indicate that the rate of rise is accelerating (Church & White, 2006; Rahmstorf et al., 2007). The observed SLR indicates that sea levels are already tracking towards the upper end of the range of projections from the Third Assessment Report (TAR) (Rahmstorf, et al., 2007). This is cause for some concern, as the thermal inertia of the oceans means that SLR will begin slowly and then accelerate (Walsh et al., 2004). Thus, we may experience greater rates of SLR than we are currently anticipating, even under the most pessimistic emission scenarios. Despite uncertainty about the exact magnitude of SLR, the direction of change is clear and the precautionary principle requires action even in the absence of scientific certainty (Brundtland, 1987). This principle is a critical component of ecologically sustainable development (ESD), which is a key objective of much environmental legislation pertaining to coastal management in Australia, and hence there is a legislative requirement to respond to SLR.

Superimposed on global eustatic sea-level rise[1] (SLR) is regional variability, but although it is important in determining local impacts, projections are subject to greater uncertainty (Christensen et al., 2007). In the case of south-eastern Australia, strengthening of the East Australian Current is likely to lead to a contribution of around 12 centimetres of additional global SLR, relative to the global average (McInnes et al., 2007). These additional amounts bring the upper end of the global SLR projection envelope for the New South Wales (NSW) coast to around 91 centimetres. McInnes also notes projections for Victoria include:

- Higher temperatures and more hot spells
- Less rainfall but more rainfall intensity
- Less run off in almost all areas
- More frequent and longer lasting drought
- Greater risk of bush fires
- Rise in sea levels of 18-59 centimetres by 2100. The SLR off the east coast of Australia is expected to be above the global average.

Given the recent weather conditions in Victoria these projections seem very real. The paper also notes a slight increase in rainfall intensity with the potential for a one in 130 year storm to become a one in 100 year event. The largest increase in rainfall intensity are projected along the coastline of southern Victoria and west of Melbourne.

On the east coast of Australia, this may be coupled with an increased frequency and intensity of large storm systems (Australian Government, 2009). These are expected to have a range of impacts, including shoreline recession and more frequent coastal flooding. This is likely to be enhanced by an increased variability and overall reduction in rainfall, which will reduce the extent of coastal systems such as saltmarsh, and their capacity to mitigate flood impacts (AGO, 2006). These projections are concerning for Inverloch and Bass Coast.

3.2 Implications for coastal resources

The most likely and immediate climate change impacts include:

- The impact of more frequent and larger storm events. These are occurring at Inverloch among other places and have led to:
  - Some 40% of dune vegetation lost since 2014
  - Reduced area of the surf beach
  - The need to repair/replace coastal infrastructure and construct new access paths from the road and adjacent houses to service structures such as the Surf Lifesaving Club, car parking areas and to the beach and the sea
- An increase in sea level, which has the potential to critically impact the state and function of coastal systems (Australian Government, 2009; CSIRO & NSW Government, 2007).

[1] Eustatic sea-level rise is the change in global average sea-level attributed to changes in the volume of the world's oceans

Although there are current investigations and reports on a number of aspects of marine tourism (e.g. diving, fishing and whale watching), there is no national study on the tourism and recreation values of beaches, arguably the most valuable and threatened coastal tourism asset.

Previous work in Sydney and on the Gold Coast has highlighted the social and economic importance of beaches for tourism and recreation in Australian coastal cities (Anning, 2012; Lazarow, 2009, 2010; Lazarow, Miller, & Blackwell, 2008; Lazarow, Raybould, & Anning, 2013; Raybould, 2006; Raybould & Lazarow, 2009; Raybould, Lazarow, Anning, Ware, & Blackwell, 2011; Raybould & Mules, 1999), but the recreation and tourism values are related to the condition of these assets.

3.3 Implications for Inverloch

As noted in a recent article in the Melbourne Age https://www.theage.com.au/national/victoria/oceans-rising-can-we-save-our-co, there is considerable concern about beach erosion at Inverloch. The article notes that the foreshore at the surf lifesaving club has receded 33 metres since 2012. The club moved its observation tower inland twice to escape creeping inundation and recently has resorted to a lookout on skids so that it can be moved back to avoid the encroaching surf.

Continuation of the recent patterns of coastal erosion would threaten the low-lying Inverloch to Cape Patterson Road and the Bunurong Coastal Drive. This level of impact would disrupt access to the RACV Inverloch Resort and mean visitors would need to change their route to and from the Resort and potentially reduce visitation to Inverloch township. These types of disruption will not be unique to Inverloch but will occur across the Bass Coast Shire, the region and Victoria's Coast from Portland to Mallacoota.

The Victorian Government Department of Environment Land Water and Planning (DELWP). DELWP brings together Victoria's planning, local government, environment, energy, suburban development, forests, emergency management, climate change and water functions into a single department to strengthen connections between the environment, community, industry and economy. The Department's challenge is to maintain Victoria's liveability with a population that is expected to almost double by 2050, while responding to climate change and protecting the State's natural environment, infrastructure and heritage for future generations.

In addressing the task at the local level DELWP commissioned GHD to undertake a review of options to manage coastal erosion at Inverloch Main Beach. Coastal erosion has led to a landward movement of the beach by approximately 40 metres. This erosion put the Surf Lifesaving Club (SLSC) and a stretch of the Cape Patterson-Inverloch Road at risk. The distance of these assets from the active dune escarpment was estimated at 16m to the SLSC and 6m to the road.

During an inter-agency meeting to address the issues it was decided to:

- Undertake immediate emergency works to protect the road- Vicroads
- Short term works to protect assets and/or reduce erosion risk before the Winter 2019
- Longer term management of the relevant coastal area over the next 10 years or more.

After a site inspection GHD were commissioned by DELWP to undertake a review of options available for the management of coastal erosion at Inverloch Main Beach. The review focused on short term measures that could be implemented before the winter of 2019 to protect the SLSC and CP-I Road.

3.4 GHD Analysis

GHD's analysis of air photographs from 2006 to 2017 indicated that the beach was relatively stable from 2006 to 2012, but from 2012 onwards there has been rapid erosion, with retreat (shoreline moving landward) at up to 10m/yr. At the same time there has been a large build-up of sand in Andersons Inlet on the other side of Point Norman, where the coast has moved landward over 200m and created the Ayr Creek Lagoon.

GHD noted that it seemed clear that the erosion at Main Beach has a major cyclical component, with periods of erosion lasting several years corresponding to periods of increased storminess, and periods of recovery during more settled years (Water Technology, 2014). On top of this cycle there may also be a trend of long term recession due to sea level rise and sediment loss which means that the dune does not fully recover after each erosion cycle. The current situation is at the extreme end of the erosion cycle by historical standards, but it is possible more erosion will occur before the recovery begins.

Further, the analysis showed that in the middle part of the beach near the SLSC, the coastline has retreated by 43m over 7 years, with an average rate of 6m/yr. and a maximum rate of approximately 10m/yr. At the western end of the beach near CP-I Rd the coastline has retreated 36m over 7 years, with an average rate of 5m/year and a maximum rate of approximately 10m/year.

3.5 Risks to Key Assets

3.5.1 Inverloch SLSC

If the current erosion trend continues then the erosion escarpment is expected to reach the surf club building in 2 to 6 years. GHD noted that the building is not currently at risk from movement of sand under the foundations but if the current erosion trend continues it could be at risk in one to two years.

3.5.2 Cape Paterson-Inverloch Road

If the current erosion trend continues then the erosion escarpment is expected to reach the road within the next one to two years. The road may also be at risk from soil failure due to its proximity to the erosion escarpment. The width of the zone of reduced foundation capacity from the erosion escarpment at this location is approximately 10m. The road is already within this zone and GHD noted that its foundation stability should be checked by a geotechnical engineer.

If there is any further erosion of the dune then the road may also be at risk of inundation by wave runup during storms.

3.6 Protection Options

The GHD report discusses a range of coastal protection options including:

- Do nothing/ retreat. This may be a feasible option for some of the area and assets including the SLSC in the short term, one and possibly two years subject to careful monitoring and active management of beach access paths. Do nothing is an unacceptable risk for the road
- Beach nourishment- Even in the best-case scenario nourishment is only a temporary solution and typically needs to be repeated within 1 to 10 years
- Dune Reconstruction and Management. A very large volume of sand is potentially available at Point Norman that could be used for nourishment and dune reconstruction for protection of the road and SLSC in the short-term. The effectiveness of dune management is limited if the erosion trend continues. It provides a buffer against erosion but does not stop the erosion from occurring
- Sand Trap Fencing. If the fences are sturdy enough they may trap wave-transported sand and provided a degree of wave protection to the toe of the dune by slowing the velocity of swash (broken waves running up and down the beach) and reducing wave run-up. This technique has been used at Port Fairy in combination with dune reconstruction and management, which in combination have been effective at stabilising the retreating dune. Advantages of the approach is it is cheap, easy to install and remove if necessary and has a smaller footprint on the beach compared with rock protection
- Rock or Geobag Revetment. A formal rock revetment can provide reliable long-term protection. Advantages include its robustness. Disadvantages include a revetment can reflect waves and increase scour of the beach, slowing the recovery after storms and reducing beach amenity. Termination of the revetment in an area susceptible to erosion can cause rapid end scour. This needs to be managed and repaired or the structure will be damaged. The revetment can interrupt access to the beach and significantly alter the landscape character. Revetments can be expensive but may be able to be justified for high value assets such as the Road and the SLSC
- Large rock groynes in combination with sand nourishment could be a feasible long-term management option but are not feasible in the short term because of the need to undertake coastal process studies to develop an appropriate design. This is important as poor design can create erosion problems due to limitations in sediment supply
- Small geobag groynes could be cost effective, easy to construct and to remove if necessary
- Vertical Seawall. An effective seawall is likely to be large and expensive and would take at least 12 months to plan and build and is not a feasible short-term option. VicRoads proposed a buried sheet pile wall along the Cape Patterson to Inverloch Road. This could be a possible solution given VicRoads' relevant experience.

3.7 Feasible Proposed Options

3.7.1 Feasible short-term options

GHD proposed the following feasible options for short-term management of erosion risk, i.e., options that can be implemented before winter 2019 to protect the Cape Patterson-Inverloch Rd and the Surf Life Saving Club:

- Do nothing – this is a reasonable approach for the SLSC which is not considered to be at risk in the next 12 months. Some works will still be required to manage the beach access, monitor the erosion and plan protection measures that can be implemented quickly when needed
- Revetments – rock or geobag revetments could be used to provide short or long-term protection to the road and SLSC. Ongoing monitoring and repair of end-scour and erosion of the beach in front of the revetment may be required. This is a relatively expensive option
- Nourishment to rebuild dune profile, with dune management and sand trap fencing to protect the toe - this relatively cheap option could be used to provide temporary protection to CP-I Rd and/or the SLSC.

3.7.2 Feasible long-term options

The combination of large groynes and beach nourishment warrants further investigation as a long-term option. A detailed coastal process study is required to assess the feasibility of this approach and develop an effective design that minimised negative impacts to the surrounding shoreline.

3.8 Inverloch Coastal Protection Plan

As noted above, the coastline at Inverloch has been experiencing significant erosion in recent years, impacting on public access, amenity and major assets. DELWP, Bass Coast Shire Council, Parks Victoria, Regional Roads Victoria and the West Gippsland Catchment Management Authority have formed a working group to address erosion at Inverloch. The working group has developed a short-term erosion control plan for key areas along the Inverloch Surf Beach.

Trial works to construct two rows of Beachmaster wet-sand fencing in combination with sand nourishment and dune reconstruction, are planned to occur in early 2019. This work has been jointly funded by the Victorian Government's Protection of Victoria's Iconic Beaches and Coastline project and Bass Coast Shire Council. The progress and outcomes of this project are being monitored by a partnership of DELWP, Deakin University, the University of Melbourne and community volunteers. The monitoring program will involve flying drones to create a 3D model of the beach profile. Community volunteers will be trained to operate the drones conducting monitoring flights every four to six weeks for two years. The data collected will provide input to assess the success of the current project and in developing future protection works at Inverloch.

3.8.1 Areas of concern

There are two main areas of concern, the foreshore in front of the Inverloch SLSC and the foreshore in front of Bunurong Road where erosion threatens to impact public assets.

The foreshore adjacent to the SLSC has retreated 33.5 metres since 2012. Currently, the building is located 16 metres from the face of the dune with this distance being relatively stable since the end of the winter.

The foreshore adjacent to Bunurong Road, particularly near the Surf Parade intersection, has experienced 35.6 metres of coastline retreat since 2012 with the road currently within 6 metres of the eroding edge.

4 Implications for coastal tourists and recreation users

In order to understand the impact of climate change on beach users and tourists to coastal locations, it is important to understand the factors that are critical in their decisions about when, where and how often to use these resources. Climate change projections suggest a number of potential outcomes for beach users, as summarised in Table 2.

Table 2: Climate change impacts on coastal tourism and recreation

Climate Change Projection	Hazards	Consequences	Implication for Recreation
Precipitation	• Drought • Potential reduced numbers but increased intensity of storm activity	• Water scarcity • Temporary inundation	• Increased costs for asset managers may result in reduced service quality and availability
CO2	• Ocean acidification	• Loss of biodiversity	• Reductions in fish stocks accessible to recreational fishers • Reductions in marine flora and fauna encounters for scuba divers
Sea surface Temperature	• Algal blooms	• Coral bleaching • Eutrophication	• Reduced water quality limiting direct water contact activities • Reductions in marine flora and fauna encounters for scuba divers
Sea-level rises	• Erosion • Inundation	• Coastal Recession • Infrastructure damage	• Coastal Changes to beach width and profile • Changes to sediment availability for bar formation impacting on surf quality
Wind and Wave	• Erosion	• Beach rotation • Coastal recession • Infrastructure damage	• Nuisance of increased wind and sand to beach users • Changes to wave quality for users •
Storm intensity	• Unprecedented erosion. • Infrastructure damage		

The effects of these impacts on tourism will depend on their severity. At worst they could deter visitors from visiting a particular location.

Residents are also expected to be affected with more residential damage and potential personal injury. In these situations, at best, residents can expect higher insurance costs and potentially properties may be uninsurable.

4.1 Policy definition of climate change impacts and adaptation responses

Regardless of the level of certainty and accuracy about climate change projections, coastal managers and decision-makers must respond to the policy context in which they operate. This typically occurs at the state government level, where policy definitions of planning zones and management processes that must be adhered to in order to obtain funding typically dictate the response to climate change projections at the local level. In response to these challenges, some difficult decisions must be made about the use and management of coastal resources. In terms of the response to SLR and associated shoreline recession and increased impacts of storm-induced erosion, these decisions are typically framed as a choice between the options of protection, adaption or relocation (IPCC, 1990; Klein et al., 2001).

Each choice brings with it costs and benefits, hence there must be a clear consideration of both before a good decision can be made (Walsh, et al., 2004), and thus information about these costs and benefits is required.

For a number of reasons, ranging from the political to the practical, some form of coastal protection is likely for urban coastlines in Australia (Lipman & Stokes, 2003). Given the large investments required, in many cases this will involve the use of formal decision support tools, with the most prevalent in Australia being cost–benefit analysis (NSW Government, 2007). This method requires quantification of all the costs and benefits in monetary terms such that the process adequately addresses environmental and social issues (Hanley, Shogren, & White, 2001). Valuing environmental resources such as beaches is a potentially controversial issue, particularly given the strong cultural association of Australians with the beach (Australian Government, 2007). Nevertheless, all decisions require trade-offs, and where these decisions involve environmental resources, logic would dictate that it is best practice to ensure that these trade-offs are made with a sound understanding of the benefits and costs of each potential course of action.

4.2 Assessing the adaptation options – need for economic information

In Australia there is very little data on how people use the coast for recreation, and the extent to which they value this asset, and even less data on how these values might be threatened by climate change. Projections by the IPCC (IPCC, 2007) and CSIRO (CSIRO & NSW Government, 2007) indicate that coastal communities will be forced to adapt to changing climatic conditions this century. In Australia, adaptation decisions relating to the coast and beaches are frequently made at the local community level by local governments which have primary responsibility for shoreline management. Currently there are gaps in recreation value information and few case studies of adaptive responses that can guide local communities in coastal planning and management decisions. In order to adequately consider the importance of

recreation and tourism in coastal policy decisions, estimates of the economic value of beach recreation are required. However, few empirical studies of beach recreation in Australia exist, and hence values are typically transferred from previous studies conducted elsewhere. This is known as the benefit transfer (BT) process.

4.3 Community attitudes and behaviour

The Victorian Coastal Council (VCC) (now Marine and Coastal Council) is the peak advisory body to government on coastal and marine issues in Victoria. Its role is to provide strategic direction for planning, management and protection the Victorian coast for current and future generations. A key part of this role is developing, monitoring and updating the Victorian Coastal Strategy (VCS). The Strategy identifies the following three significant issues facing the State's coast that require specific attention:

- Climate change which will result in impacts on the coast, including:
  - Increase in storm activity and intensity
  - Sea level rise
  - Inundation
- Rapid population growth in coastal areas; and
- The health of our unique and valued marine environment.

As part of the monitoring and updating process the VCC has commissioned a series of community attitudes and behavior surveys. There have been four waves of research in 1996, 2000, 2007 and 2012. These were carried out by the Ipsos-Eureka Social Research Institute with the findings published in publicly available reports (Ipsos – Eureka, 2012).

The fourth wave of research was designed to provide insight into public attitudes towards the coast and the value it delivers. The research also aimed to assess levels of usage of coastal areas, as well as track how attitudes and behaviours have developed over time compared with previous waves of research.

4.3.1 Use of the Victorian coast

The key findings and conclusions of the Ipsos- Eureka Wave Four report follow:

- The coast is an important part of the lives of most Victorians. Victorians make a substantial number of trips to the coast on a yearly basis, over four-in-five (84%) reported having made at least one day-trip to the coast in the last twelve months with the average number of day trips in the last twelve months being 23.4 trips.
- Over half (57%) of Victorians had made an overnight trip to the Victorian coast in the last twelve months. The average number of overnight trips within the last twelve months was 5.6 trips.
- The most frequently visited locations along the Victorian coast were Phillip Island (7%); Sorrento (6%); Lorne (5%); Torquay (5%); and Apollo Bay (5%).
- Those living within five kilometres of the coast reported visiting their local foreshore frequently, over a quarter (26%) said that they visited daily, and 86% report visiting their local foreshore at least once a month.

- Overall, Victorians appeared to be satisfied with their coastal experience: 87% gave a rating of either Excellent or Very good.
- All of those who visited the coast were asked what the most enjoyable aspect of the trip was. The most popular answer, given by just under a fifth of respondent (19%) was enjoying the atmosphere / scenery / just being there followed by spending time with friends / family and walking / hiking (11% for both).
- According to Victorians, the top three things that contribute to a good coastal or marine experience all relate to a clean and unspoilt environment. These contributors included clean / clear water (37%); a lack of litter / rubbish / debris (37%); and a pristine / unspoilt / undeveloped / natural environment (22%).
- Among those who made visits to the coast, the most commonly mentioned activity was walking or hiking, (by almost two thirds, 63%). Swimming was the next most common activity (52%), then nature-based activities / appreciation (31%).

4.3.2 Planning for sea level rise

- Overall, Victorians considered climate change and sea level rise to pose a (current or future) threat to the Victorian coast. Over two thirds (67%) of Victorians reported they agree with the statement climate change is causing sea levels to rise leading to coastal erosion and flooding in vulnerable, low lying areas of Victoria's coast.
- However, the qualitative research revealed that despite agreement that the Victorian coast was likely to be (or currently is) affected by sea level rise, the implications of a one metre sea level rise were not well understood, particularly in terms of magnitude. Participants found it very challenging to visualise the implications of this scenario. One metre was considered by most to be quite negligible in terms of impact since it would most likely occur via a 'slow creep' that would mean people would be able to adapt to that change. A minority of participants perceived one metre sea level rise to be significant and mentioned implications for things such as land, stormwater and flora and fauna. There were many questions raised relating to flood and storm events and what was or wasn't 'natural cycles'.
- The responsibility for responding to the impacts of climate change and sea level rise in Victoria was thought by 29% of respondents to rest with the Victorian State Government. The second most common response was Federal Government (24%), and third was local government (15%). The perceived role of State Government was reflected in the agreement with the statement I believe planning laws for the coast should limit development in areas likely to be affected by sea level rise, the mean agreement rating being 7.4 (on a zero to ten scale).
- Both the quantitative and qualitative research show that Victorians were unsure over the role individuals should play in terms of taking responsibility for risk posed to them by sea level rise. Respondents had mixed feelings about the statement 'Individuals who live in coastal areas likely to be affected by sea level rise should be responsible for managing their own risk', with a mean agreement rating of 5.0 (on a zero to ten scale). Although participants in the discussion groups felt strongly that if people chose to live in property that had clearly been identified as at risk of flooding

they should manage their own risk, they also acknowledged the confusion and lack of knowledge that was likely to exist regarding risk.

- Communication from those who possess knowledge about anticipated sea level rise (most likely assumed to be State and Federal Governments) was identified as critical in helping people to manage their own risk.

4.3.3 Population growth and coastal development

- From both the qualitative and quantitative research it is apparent that the character of coastal settlements is highly valued. The majority (63%) of Victorians agreed with the statement "I am concerned that our Victorian coastal towns are increasingly looking more like ordinary Australian suburbs or parts of the city". Participants from the focus group discussions were able to describe easily a 'typical' Victorian town: small, laid-back places with friendly locals and little traffic. Typical coastal towns were usually framed as opposite to Melbourne. The Gold Coast and Surfers Paradise were mentioned frequently as examples of inappropriate development on the coast.
- Victorians had some concern that coastal towns look too much like Melbourne suburbia, and the discussion groups revealed that people have very definite ideas about how coastal towns should not look. Victorians were keen for coastal towns to retain their (often longstanding) sense of character and not develop into sprawling or high-rise metropolises with too many people.
- The consideration of moving to the Victorian coast appeared quite low with seven percent (7%) of those living further than five kilometres from the coast reporting that they were considering this within five years, however, this equates to a large number of Victorians (an estimated 300,000 persons).
- Seventeen percent (17%) of respondents reported that they have access to a Victorian beach house owned by themselves or family. Qualitative research indicated that many have access to beach houses owned by friends.
- In the discussion groups, there were obvious concerns about the development of some areas of the Victorian coast and this was reflected quantitatively, just over half (52%) said they were not confident in Government planning and building guidelines capacity to protect Victorian coastal towns' character and feel.
- Victorians appeared to have mixed feelings regarding how to best accommodate increased demand for housing along Victoria's coastline. In the quantitative research, when asked to choose between two simplified options, just over half (52%) reported a preference for allowing towns to expand outwards, and 39% preferred increasing the density of housing. In existing town boundaries (9% were unable to choose). The qualitative research demonstrated that the dilemma of expansion out or increasing the density was more complex. The majority of the qualitative research participants felt that coastal towns should probably increase in density rather than sprawl outwards. The community felt that there were firm caveats with both scenarios; expansion was tolerated as long as there were parameters on that sprawl and increased density was tolerated as long as buildings remained relatively low-rise. For any growth to be deemed appropriate, the character of the coastal town has to be retained. Where expansion was thought to need to occur, there was

strong support for developing inland rather than creating a continuous stretch of development along the coastline.

4.3.4 Natural coastal and marine environment

- The natural features of the Victorian coastal and marine environment were extremely important to Victorians. There was strong agreement with the statement the flora and fauna that live in marine environments are important to all Victorians (with a mean rating of 8.4 on a zero to ten scale). However, there was a more varied response to agreement with the statement “I feel I know a fair bit about Victoria’s coastal and marine environments” (with an overall mean rating of 5.3).
- There was relatively strong disagreement with the negatively framed statement "The coastal and marine environments are unimportant to my lifestyle" with a mean rating of 2.8 overall (on a zero to ten scale). The sentiment of feeling that coastal and marine environments are important to Victorians’ lifestyles was also reflected in the qualitative research. Participants spoke of visiting the coast quite frequently, or if they did not currently visit the coast often it was almost always a significant part of growing up and family holidays.
- From the qualitative research, it is evident that amongst those living in coastal areas there is a clear sense of pride in the local coastal and marine environment.
- Top-of-mind associations with the Victorian coast are usually focused on the iconic features of the coastline including the Great Ocean Road, the Twelve Apostles, Phillip Island and the penguins. Sandy beaches were the classic association with anything coastal; however, there were sometimes mentions of the less obvious features of the coastal and marine environment including fish, birds, marine mammals, invertebrates, estuaries, mangroves, and wetlands.
- Just under half of Victorians (48%) reported concerns or annoyances with Victorian coastal or marine environments (consistent with Wave Three). The biggest cause of concern was rubbish / litter / cigarette butts (mentioned by just over a third), followed by overcommercialised coast / inappropriate development (11%) and antisocial behaviour / drunks / hoons (8%).
- Although a few participants were concerned that the Victorian coast was currently under threat, the general consensus was that it was healthy.
- When asked what threatened the coast, participants in discussion groups were most likely to cite quite broad threats initially, and then litter and pollution. When pressed, participants named a range of other threats such as erosion, population pressure, pressure of recreational use, and dredging. Threats to the coast were either considered to be due to people’s proximity to the coast or more indirectly via climate change.
- The majority (83%) of Victorians reported that they have heard of Victoria’s Marine National Parks and Marine Sanctuaries. Awareness was higher than in Wave Three (72%). Support for Marine National Parks and Marine Sanctuaries remains high in Wave Four, (93%), with no notable difference to Wave Three.

4.3.5 Coastal management

- The majority of Victorians agreed that the Victorian coast is well managed (67% agreed); however, this measure has declined since the previous wave of research in 2007 (when 74% agreed).

- Despite this agreement that the Victorian coast is well managed overall, Victorians appeared to be unsure about whether specifically the government is doing a good job of managing the coastal and marine environment. The majority of respondents (58%) rated their agreement with the statement The government is doing a good job of managing the Victorian coastal and marine environment as around midway on the zero to ten scale (on average, the agreement rating was 5.2).
- From the qualitative research it is clear that coastal and marine management is generally not 'visible' to the community (other than development on the water's edge), leaving most unsure as to what is involved in actively managing these environments.
- Victorians generally did not feel well informed about coastal planning and management. This may be why there has been a decrease since Wave Three on agreement that the coast is well managed. Group discussions also implied this link. When people were unsure about who managed the coast, there was a greater tendency to assume that it was not being well managed.
- There was scepticism over the ability of communities to influence the development of their local areas. Just over a third (35%) of Victorians agreed that local communities have enough say in government planning decisions affecting their local area.
- The top four mentions when asked what, if any, are the issues affecting the Victorian coastal and marine environment that the government should respond to were overfishing / illegal fishing (29%); pollution (21%); development (14%); and pollution from stormwater (12%).
- Interest expressed in volunteering to help improve and protect the coast was similar to previous waves, with almost one-in-three Victorians in agreement with the statement "I would be interested in joining a volunteer group to improve and protect the coast."
- Seventeen percent (17%) of respondents said they had definitely heard of the VCC (similar proportion in Wave Three in 2007); the majority, 73%, said they had not (76% in 2007). A majority (80%) of Victorians have not heard of the VCS, 11% said they had definitely heard of the VCS, 9% thought they probably had.

5 Economic valuation and valuation methods

Environmental assets provide a number of services and benefits – not all of which can be captured by a market price. For example, in the case of sand dune systems, they provide tourism benefits which can be clearly represented by a market or commercial value (by tourists direct and indirect payments to visit them), but may also provide non-market, unpriced benefits such as recreation (assuming that access to the sand dune is free), amenity, and ecosystem services. In addition to the benefits experienced from using the environmental asset, there are also nonuse values which need to be considered. For example, those who do not use an environmental system may still value its conservation for altruistic reasons or purely for the knowledge that it exists. In addition, natural coastal systems including beaches, dunes and miscellaneous coastal vegetation can provide protection from a range of environmental events, including storms and sea level rises.

The full classification of natural resource values is provided in Figure 1 (see section 5.1). This diagram is based on the information provided in the Queensland Government's Introductory Guide to Environmental Economic Valuation (2003).

The valuation of climate change options based on a Total Economic Value (TEV) framework should be based on a cost benefit analysis (CBA) approach. The CBA framework takes into account the estimated costs of protecting, maintaining and operating the coastal area, the incremental income and the incremental social and environmental benefits generated by their continued availability. The benefits are assessed on a willingness to pay (WTP) basis or on some revealed cost such as the cost of travel to the location. A WTP estimate reflects how much individuals would pay to maintain the coastal assets. This could be based on an appropriate survey estimate where the benefit is assessed as the aggregate stated WTP for the coastal area by the potential beneficiaries of the asset. Alternatively, as noted, it could be based on some revealed value basis such as a premium paid for a house adjacent to the coastal area or with clear views of the coastal landscape over a similar property further away without the views, or it could be deduced from the cost a visitor is prepared to incur to visit the coastal area (Travel Cost Method, TCM).

A number of the reports referenced in this paper provide useful information on valuation methodologies and evaluation calculations. Worley Parsons (2013) report for the VCC, URS (2007) Final report for the VCC, Stanley et al. (2013) A case study of Inverloch and Sandy Point, and BASTRA Vulnerability and Adaptation (Raybould et al.2013).

Some findings from these reports may be able to be used in the valuation estimates. However, this may not be straight forward due to the range of methodologies used.

A value can be derived by the benefit transfer method where a value or values are obtained from a valid economic valuation approach, such as contingent valuation or choice modelling or TCM for a similar location and coastal assets, is used as a proxy for the value of the particular project, in this case the Inverloch coastal area. To transfer a 'value' from another study requires a number of conditions to be met such as, that the 'value' has been determined by an acceptable methodology and that the project valued is sufficiently similar to the new project to support an assumption that a similar value would be reasonable.

5.1 Use of Regional Economic Impact to assess the net Economic Benefit of Climate Change Mitigation Options

The NCCARF-Monash University study (Stanley et al. 2013) assesses the impact for two case study areas, Inverloch and the relatively close coastal settlement at Sandy Point using a different approach to the contingent valuation or TCM estimates and CBA approach discussed above. It uses a regional economic model to value a proposed mitigation or management action compared with a base case of no action. The difference is then assumed to be the value to the community of protecting the assets for continued use.

This difference in approach makes it difficult to undertake a straightforward Benefit Transfer of the difference in value of the regional economy. However, the findings may be able to be compared to provide evidence to support an estimated value and allow a robust estimate of value to be provided and to justify a proposed mitigation and/or management approach.

The study evaluates two cases:

- Abatement case: investment totaling $4m over 10 years is undertaken, which preserves the ambience and recreational amenity of the foreshore, even if not its precise configuration. The result would be that the foreshore survives a great storm with amenity intact and, perhaps, improved vis-à-vis alternative Victorian resorts. Costs will be incurred: $4m over the next (say) 10 years. Partial benefit will be received if the event occurs during the construction period, and complete benefit if it occurs after completion. Benefits can be modelled by keeping the tourism and retirement economic base at trend levels
- Complacency case: No direct costs incurred but a dip in tourism and retirement if the event occurs with the consequent reduction in regional income.

The paper then goes on to assess the potential impacts of climate related effects including high winds and inundation due to severe storms with and without abatement measures and allowing for the possible mitigation effects of insuring some risks. However, as discussed in this paper, as climate change worsens the comfort of insurance may prove to be a chimera with damage and loss from climate issues becoming increasingly uninsurable.

The model looks at two types of expenditure, restoration expenditure to repair the damage and the expenditure on abatement measures to mitigate potential damage prior to an event. The researchers then use the NIEIR's Regional Economic Impact Model to compare the different scenarios.

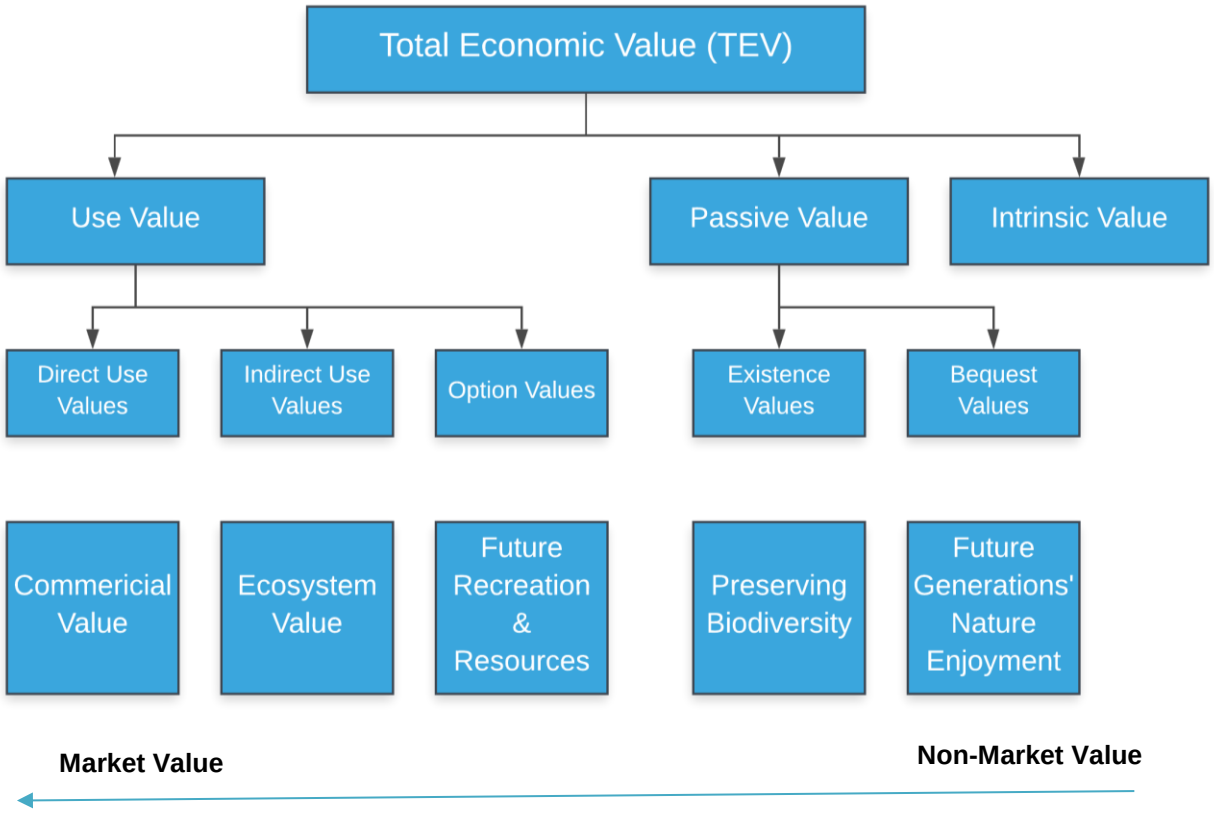

Fig. 1: Total Economic Value

For this study, the total economic value of an environmental asset is based on the following equation:
Total economic value = direct-use value + indirect-use value + options value+ existence value + bequest value
Where:

- Direct Use Values refer to values arising from the consumptive and non-consumptive uses of the environment - e.g. for recreation and tourism „
- Indirect Use Values refers to values arising from the environmental services - e.g. including habitat support, biodiversity value, physical protection and carbon capture
- Option Values refers to the willingness to pay to conserve the option of retaining the environmental asset for use at a later date„
- Existence Value reflects the willingness to pay for the satisfaction of knowing that something exists even if one has no intention of visiting the site. The Amazon in South America is a common example of an asset that people may be willing to pay for its preservation even if they know that they will never visit it
- Bequest value reflects the value gained through the ability to endow a natural resource on future generations.

Figure 1 indicates the two types of economic value, market and non-market. Market transactions relate to activities, goods and services that are traded in organised markets and hence the benefits and costs of market goods and services are observed from market transactions and can be measured directly in "$" terms from the prices and costs of those transactions. The value of non-market transactions are more difficult to estimate. However, a number of methods have been developed to allow values to be estimated.

5.2 Market based techniques

Direct observable market values are generally preferred as a valuation technique. For example, where there is an accredited and liquid offset market for environmental services (e.g. biodiversity or offset markets), this market value can be used to estimate the value of the degraded ecosystem. This approach is not considered acceptable for the purposes of measuring the Total Economic Value of the Inverloch beach and sand dune system, as there is no accredited offset market currently that could be used for this purpose.

Market based techniques can also be used to measure part or all of the value of an environmental asset, if the benefit generated can be bought and sold on the market. For example, polluted water can have a direct impact on the fishing industry, and thus the impact can be directly measured based on the impact that increased pollution will have on fish harvest. This approach is not applicable to the beach and dunes given that there is no commercial price for any of their environmental services. However, if these assets are reduced or degraded residents and visitors may be prepared to pay directly for their use and protection, thus creating a market that can be directly measured. Property prices may also be adversely affected. Any fall in value can be determined and used as a cost of environmental degradation.

Proxy market measures are also used where a market asset receives a direct and measurable market value from its association with the environmental asset. For example, a house with a direct access to a beach

and associated dune system that includes coastal views and ability to view a range of interesting coastal flora and fauna may command a premium over properties without or with fewer of these advantages. The premium can be used to determine a value of the coastal assets. This approach is known as hedonic pricing and is a revealed preference method (see below). Revealed preference results are generally deemed to be a "better" method of measuring value and often preferred to stated preference estimates.

In addition to the use of direct market based techniques where there are observable market values for the environmental asset/service, two types of valuation approaches dominate the environmental economic literature:

- Revealed preference methods – which estimate Willingness to Pay (WTP) or Willingness to Accept Compensation (WTA) indirectly in terms of consumers' choice between environmental and associated market goods and services; and
- Stated preference methods – which directly estimate WTP/ WTA via survey questionnaires.

The major revealed preference methods include in addition to the hedonic pricing approach, the travel cost method and averting behaviour.

In the current case it is difficult to see a revealed preference price and therefore a stated preference approach to valuation is required to elicit the community's WTP for the protection and appropriate use of coastal dunes. However, direct estimation of WTP using stated preference methods is expensive and likely to be beyond the scope of this project. In addition, there are a large number of published studies that offer plausible values, that are either likely to be directly transferable or transferable with appropriate modification to increase their relevance. On this basis, it is proposed this study assesses the use of the Benefit Transfer approach to value the benefits of the Inverloch dune system. The Benefit Transfer approach can be summarised in five steps[2]:

- Define the values to be estimated at the policy site;
- Undertake a through literature search to obtain economic value measures;
- Assess the suitability for transfer;
- Assess the quality of the study site estimates; and
- Transfer the benefit estimates from the study site to the policy site.

5.3 Stated vs Revealed preference debate

There has been widespread acceptance of revealed preference methods, and equally widespread criticism of stated preference methods. However, both ultimately rely on subjective judgements by the valuer. Stated preference methods are also able to estimate benefits derived without direct or indirect use of the resource, such as existence, bequest and option values. Environmental valuation studies conducted only on resource users will, unless carefully designed, only determine the expenditure and consumer surplus associated with on-site activities.

[2] A comprehensive discussion of the Benefit Transfer approach is included in: Desvousges *et al*. (1992), Brookshire and Neill (1992) Boyle and Bergstrom (1992), *Water Resources Research,* Vol. 28, No.3.

Stated preference methods therefore provide a more holistic valuation than revealed preference methods, and remain an essential component of any attempt to determine the total economic value of an environmental resource. Bennett summarised the role of contingent valuation eloquently in the early eighties, and concluded that it:

"is not perfect…It is however, an attempt to gain a more or less objective valuation of a benefit which in the past has been at best subjectively valued by the deciding politician or bureaucrat, or at worst been completely ignored." (p235) (Bennett, 1982).

It should be noted that while stated preferences have the potential to value non-use values, this does not always mean that this potential is fully realised. Even where surveys are accurately designed, there is a tendency for non-use values such as bequest values to be disregarded or underestimated. This does not capture all of the private or social benefits or costs of recreation. This is likely to result in a significant underestimation of the social benefits accruing from setting aside areas for recreation. Non-market commodities, such as social benefits from recreation, can be more economically significant than the profits generated through commercial resource use.

David Anning in his PhD thesis sets out a very valuable[3] discussion on evaluation methods, research approaches including site selection, development of research questions and tools to answer these questions. Discussion on these issues from the Anning paper is included below. This notes the process of discussion and consultation to determine and refine the research objectives, process and program. The reference is included as it provides a valuation of a similar location to this project.

The paper notes that further discussions with the project partners and consultation with the Working Group, refined the research questions that framed the scope of research. The key questions which the research sought to explore were:

- What is the existing economic importance of daytrip visitation and recreation at the case-study beaches?
- What aspects of beaches are drivers of tourism and recreation demand? How will visitors respond to the absence of sand at the case-study locations?
- Are beach users willing to pay to prevent the loss of sand?
- What is the effect of beach amenities on the local property market, and how are these influenced by building design criteria and coastal planning zones?

The paper additionally sought to explore the following questions:

- What can be said about the impact of climate change on the values previously identified?
- How will these values be affected by management interventions or coastal policy changes? and
- What are the implications for current and future coastal management?

[3] see Estimation of the economic importance of beaches in Sydney, Australia, and implications for management, *David Anning, School of Biological, Earth and Environmental Sciences, UNSW, Submitted in fulfillment of the requirements of the award of the degree Doctorate of Philosophy, March 2012.*

Appropriate valuation tools were suggested by the research questions, and were essentially self-selecting. Estimation of tourism revenue and to a lesser extent visitation, suggest some form of travel cost model. A desire to understand the magnitude of visitation to Sydney beaches led to attempts to develop a beach visitation model. The process is described in Chapter 4 of the thesis document. Understanding the drivers of beach choice and response to site quality changes required either an attribute-based site choice model (Random Utility or Hedonic Travel Cost), or direct sampling via a contingent visitation survey instrument.

Given the concurrent desire to gather stated preference information regarding willingness to pay for erosion prevention, a contingent valuation instrument was employed. The survey instrument included questions about beach choice, and gathered qualitative responses about previous experience with and future responses to beach erosion. This was incorporated with the travel cost method in a survey that was administered to beach visitors both online and onsite. The combined survey instruments used in the online and onsite surveys are provided in full in the research thesis as Appendices 5 and 6, respectively, and details of the contingent valuation survey design process are discussed in Chapter 5.

This approach could be considered to obtain more detailed information for the current Inverloch work.

Satisfactorily answering the fourth research question above requires a hedonic pricing approach. Further details on data sources and methodology are contained within Chapter 6 of the research thesis.

5.4 Valuing recreational use – the travel cost method

The travel cost method (TCM) was selected. The particular model applied in this project is an Individual Travel Cost Model (ITCM). The exact methodology employed is explained further in Chapter 4 of the research thesis.

5.4.1 Underlying theory and origins

The method was originally proposed by Hotelling in a letter to the US National Parks Service, as a means of valuing recreation at natural sites. Clawson and Clawson and Knetsch expanded up on the suggestion by Hotelling.

The theory behind the TCM is that people will not take a trip unless utility (welfare/happiness) they gain from the trip is more than the trip costs. These expenses include travel costs, onsite costs, and time. In empirical surveys (normally on-site surveys of resource users e.g. fishermen), people are asked the origin of their trip and onsite expenditure, and the number of trips they take in a given time period. It is also possible to construct a TCM using visitation records, such as those maintained by protected area managers. The assumption is that visitation will decrease with increasing distance from the site, as this will result in increased travel costs both financially and in travel time.

From this, the (inferred) demand curve for recreation at different prices can be constructed and the value of the environmental resource is estimated. This method can also be used to investigate the effect of

increases in costs (such as raising the entrance fee of a national park) on visitor numbers and thus overall revenue.

5.4.2 Advantages and limitations

A potential advantage of the TCM is that it is a revealed preference method, based on actual behaviour. It also provides information that can assist in selecting management options, through estimating the effect the alternatives will have on visitation, and thus economic revenue. The method also has advantages in the fact that the data requirements are relatively small and easily obtainable for managed natural areas.

Travel cost has not been applied often in urban environments, as there is insufficient variation in travel costs for them to be a significant determinant of visitation (Edwards and Gable, 1991). Hence estimating a demand curve is problematic, as the curve is flat. This leaves aside the issues of travel time, which may vary substantially more than the monetary costs. This is particularly true in congested cities such as Sydney. With consideration of all travel costs, including onsite costs and travel time, it is possible to apply a travel cost approach even to visitors from nearby locations (Lockwood and Tracy, 1995). It is also possible to examine the tradeoffs that individuals make between choice of travel modes to determine the value of this time, given the implicit time and cost attributes that are linked to the alternative forms of transport. Hence, the method has substantial potential for application under these conditions (Lockwood and Tracy, 1995).

Table 3 indicates the valuation of non-market coastal resources and activities discussed in this report. Further information and additional valuation estimates are provided in Appendix 2 of reference 6: Assessing the value of Coastal Resources in Victoria, Worley Parsons, The Victorian Coastal Council (VCC), 2013. The table includes estimates adjusted to December 2018 dollars using ABS CPI data as the inflator.

The data used relates to general CPI and the CPI for recreational activities. These numbers can be revised to reflect more specific activities where relevant.

Table 3: Comparison of relevant values of coastal resources

Valuation Source (see references)	Valuation Process	Date of Valuation	Unit of Valuation	Unit of Valuation	Est. Current Value Dec. 2018
Pitt	CV (WTP)	1993	Initial valuation $17 pa per person	Valuation extended in URS 2007 to 2006 values as $24 per person per annum the original valuation was extended in 2007/8 to $.008 ha/resident/pa $.001ha/tourist/pa	$31.12 per person pa
URS	TCM Consumer Surplus	August 2007	Average CS $48 per visitor day $154 per trip for average person	Range$43-$54	$168.54 per person per trip
BASTRA	Actual Expenditure. CS would be in addition.	2013	Annual value of resident recreation ($A, million)	Sunshine Coast $69.59 Surf Coast $6.09 Clarence Valley $31.60 Augusta-Margaret River$ 3.72	N/a different estimation method
NCCARF	N/A				
IPSOS	TCM Consumer Surplus		$154 per trip	$48 per visitor day	$168.54 per person per trip
AECOM	N/A				

5.5 Bass Coast Shire

Bass Coast comprises the localities of Phillip Island and Bass Coast mainland. The population of Bass Coast Shire by 5 Year census period from 2016 to 2036 is shown in Figure 2.

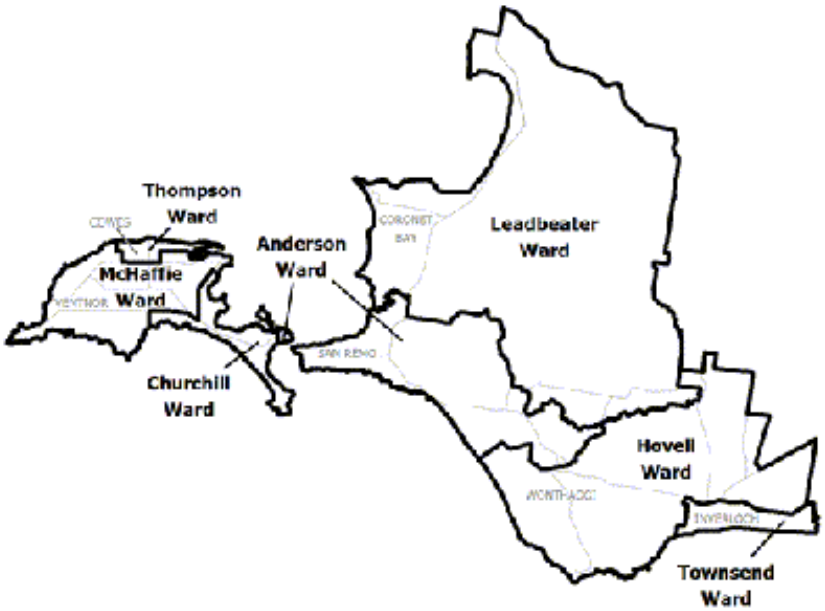

Fig. 2: Bass Coast Shire Map

5.5.1 Bass Coast Population

The main areas are Phillip Island and Bass Coast mainland including Inverloch, Cape Patterson, San Remo, Wonthaggi, Pound Creek, the townships on Westernport and the rural balance (Table 4).

Table 4 below indicates that the total population of Bass Coast at the 2016 census was 33,311 and was projected to increase to some 46,429 by 2036, an annual average growth of some 1.7%. The total population comprises the sum of the local populations of Phillip Island, Inverloch-Pound Creek, Wonthaggi and balance of the Bass Coast Shire including San Remo, Waterline and the rural balance. The Bass Coast mainland is defined as the areas not on or directly associated with Phillip Island. This table suggests that the Bass Coast Mainland has a significantly higher growth rate than Phillip Island and Bass Coast as a whole.

Table 4 shows the current and projected population for Bass Coast Shire by district from the last census (2016) and 2036 by 5 Year increments. These projections are provided by *Id and published on the Bass Coast Council Web site.

This resident population can be used to extend the valuation estimates to provide a total value.

Table 4: Bass Coast Population Summary

	Forecast Year					Change between 2016 and 2036	
Area	**2016**	**2021**	**2026**	**2031**	**2036**	**Total Change**	**Avg. Annual % Change**
Bass Coast Shire	33,311	36,083	38,939	42,543	46,429	+13,118	1.7
Cowes – Ventnor & District	6,431	7,017	7,575	8,379	9,219	+2,789	1.8
Phillip Island Balance	4,234	4,218	4,209	4,357	4,550	+316	0.4
Phillip Island	10,665	11,235	11,784	12,737	13,769	+3,104	1.3
Inverloch – Pound Creek	5,525	5,972	6,392	6,887	7,413	+1,889	1.5
North Wonthaggi	2,824	3,303	3,786	4,374	5,086	+2,263	3.0
San Remo	1,272	1,366	1,548	1,788	2,025	+752	2.3
Waterline (Westernport Townships)	3,997	4,318	4,698	5,137	5,579	+1,583	1.7
Wonthaggi – South Dudley – Cape Paterson	6,349	7,106	7,816	8,534	9,269	+2921	1.9
Rural Balance	2,680	2,784	2,915	3,086	3,288	+607	1.0
Bass Coast Mainland	22,646	24,848	27,154	29,806	32,660	+10,014	1.8%
Bass Coast Shire Total	33,311	36,083	38,939	42,543	46,429	+13,118	1.7%

5.5.2 Inverloch Population

Table 5 indicates the location of the Inverloch population within the suburban areas and the population density in each area. Table 5 indicates the Inverloch population over the same period. The Inverloch- Pound Creek area represents some 16.5% of Bass Coast at present but is estimated to decrease to just under 15% by 2036.

Table 5: Inverloch Population as proportion of Total Bass Coast Population

	2016	2021	2026	2031	2036
Inverloch - Pound Creek	5,525	5,972	6,392	6,887	7,413
Bass Coast Shire Total	33,311	36,083	38,939	42,543	46,429
Inverloch as Percent of Bass Coast by Population	16.59%	16.55%	15.34%	15.02%	14.83%

Table 6 indicates the estimated increase in dwellings over the twenty years between 2016 and 2036. The estimates suggest an increase of some 5,700 dwellings over the period for the whole of Bass Coast and nearly 500 for the Inverloch area. The additional development could provide additional risk of property damage with consequent costs and potential trauma for householders and the relevant regulatory authorities. As noted earlier, regular or frequent significant climate events that cause property damage and/or personal injury could lead to the inability to obtain appropriate insurance. This could include commercial and community operations as well as private residents.

The potential for increased property damage due to climate change events is highlighted by the increase in residential dwellings in Bass Coast and Inverloch over the 20years between 2016 and 2036 as shown in Table 6. Properties in Inverloch are forecast to increase by over 33% or some 500 new properties and the whole of Bass Coast by 31% and nearly 2,500 new properties.

Table 6: Estimated Change in the number of dwellings between 2016 and 2036

Area	2016 Dwellings	Increase %	2036 Dwellings	Increase
Bass Coast Shire	+8,0838	+30.9	10,522	2,484
Cowes – Ventnor & District	+1,566	+22.4	1,917	351
Inverloch – Pound Creek	+1,468	+33.9	1,966	498
North Wonthaggi	+1,069	+84.6	1,973	904
Phillip Island Balance	+469	+10.7	519	50
Rural Balance	+479	+33.9	641	162
San Remo	+615	+66.1	1,022	407
Waterline (Westernport Townships)	+957	+34.5	1,287	330
Wonthaggi – South Dudley – Cape Paterson	+1,415	+35.9	1,923	508
Total Region	**+16,076**	**5694**	**21,770**	**5,694**

5.5.3 Value of the Inverloch Coastal area to Residents

The potential value of the Inverloch Coast and the activities it allows for residents can be estimated based on the values set out in Table 7. Table 7 estimates the value of the Inverloch coastal area to residents in Inverloch and to residents in the total Bass Coast Shire. This may over estimate the value as residents who live further from Inverloch are likely to value Inverloch lower than people who live nearer. To offset this, the per person value figure is likely to be low in the years 2021-2036 as it reflects the 2019 estimate.

Table 7: Value of Inverloch Coastal area to Bass Coast and Inverloch Residents

$	2016	2021	2026	2031	2036
Bass Coast Shire	1,036,649	1,122,907	1,211,779	1,323,946	1,444,883
Inverloch - Pound Creek	171,924	185,839	198,904	214,321	230,699
Value pp/pa	31.12				

Note: The Inverloch Figures are included in the total for Bass Coast

5.5.4 Bass Coast Tourism

The Bass Coast tourism region includes the major tourism destination of Phillip Island including the iconic Phillip Island Nature Park (PINP). The PINP includes the internationally popular Penguin Parade, the Koala Conservation Centre, the Antarctic Journey an immersive virtual reality experience located at the Nobbies Centre, Churchill Island with its heritage farm and Ecoboat tours of the key natural sites around Phillip Island. Phillip Island attracted over 1.85 million visitors per annum in the year ended December 2015. This visitation appears to be a combination of domestic overnight visitor nights and domestic day visitors. The visitation is projected to reach over 4 million visitors by 2035.

In addition to Phillip Island, Bass Coast includes French Island and the Mainland area of Inverloch and Wonthaggi and the small townships round the east of Westernport Bay. The Bass Coast area including the mainland part was estimated to attract some 2.1 million domestic, international and day tripper visitors and 2.6 million domestic and international visitor nights in the year to December 2017.

Official tourism metrics for Bass Coast are shown in Table 8.

Table 8: Bass Coast Tourism Metrics 2017

Bass Coast Tourism Metrics 2017	International	Domestic Overnight	Domestic Day	Total
Visitors ('000)	44	837	1,280	2,162
Nights ('000)	152	2,465	-	2,616
Average stay (nights)	3.43	2.94	-	2.97
Spend ($m)	15.61	302.76	101.20	419.58
Average spend per trip ($)	353.63	361.61	79.04	194.08
Average spend per night ($)	103.03	122.84		121.69
Average spend (commercial accommodation) per night ($)	138.99	183.37		180.17

5.5.5 Inverloch Tourism

Inverloch offers a wide range of attractions for residents, holiday home owners and visitors. The beach is attractive and offers a range of activities. Until recently parts of the beach offered safe bathing and water play while the main surf beach offered an attractive and at times challenging surfing experience. More recently increased storm activity has reduced the beach area and pushed the dunes back towards the back of beach access road. Access tracks to the beach have been reduced and in some cases new tracks have had to be built.

The Inverloch beach is used by a range of commercial and community organisations and individuals for a number of activities including surfing, stand up paddling, snorkeling, small boat hire, fishing, swimming, diving, ecotours, etc.

Inverloch offers a range of holiday accommodation including holiday houses and apartments, hotels and camping opportunities and also a wide range of shopping and dining experiences.

It is important to obtain reasonably accurate visitor estimates for Inverloch which can be used to calculate the value of the beach, dunes and the area between the sea shore and the access road. As noted earlier this calculation is based on a transfer of the benefit estimated from studies of similar areas to the current study.

On this basis, estimates have been made of the visitation to different parts of Bass Coast based on visitation to the four regional Visitor Information Centres (VICs). These are or were located at Newhaven on the entry road to Phillip Island just after exiting the entry bridge (Phillip Island VIC), at Cowes, Inverloch and until the 2015-16 at Wonthaggi. The Wonthaggi VIC was then closed. These figures suggest annual visitation of some 40-45,000 to Inverloch and some 200,000 for Bass Coast as a whole.

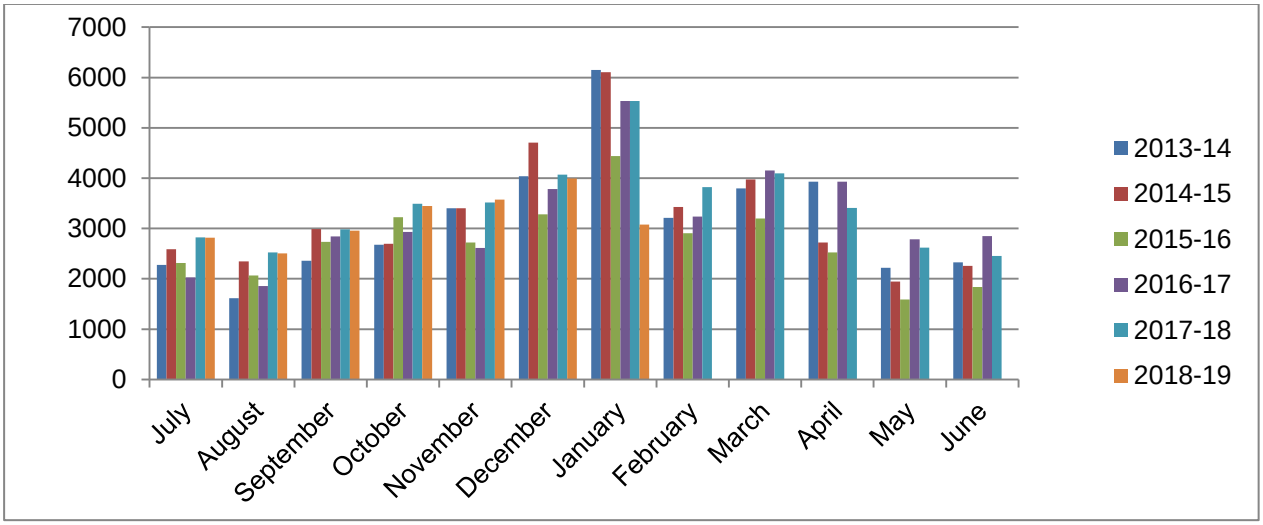

Fig. 3: Visitation to Inverloch Visitor Information Centre 2013-14 to Dec. 2018 by Month

Figure 3 Provides visitation data to the Inverloch VIC between 2013 and year end 2018. These data show the expected summer peak and winter through but also suggest a solid shoulder visitation from September

to November and March and April. The anticipated change in the weather may offer incentives to increase the shoulder visitation while reducing summer and winter visitation.

Table 9 provides annual visitor figures to the four regional VICs including Wonthaggi until 2015 when it closed. Table 9 shows the comparative numbers visiting the VICs at Newhaven and Cowes as Phillip Island, the Inverloch area including Wonthaggi while it was open and the combined figures as Bass Coast. Figure 4 provides the Table 9 data in a bar chart. Figure 5 shows a comparison of Phillip Island and Inverloch with the total Bass Coast.

Table 9: Visitation to the Bass Coast Visitor Information Centres over the period 2013-14 to YE 2018

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19 (Est.)
Inverloch VIC	37,996	39,153	32,835	38,547	41,330	44,742
Wonthaggi	20,059	20,098	2,105	0	0	0
Phillip Island VIC	158,825	145,132	133,046	117,752	99,992	109,566
Cowes VIC	30,107	29,565	30,303	23,570	21,607	22,444

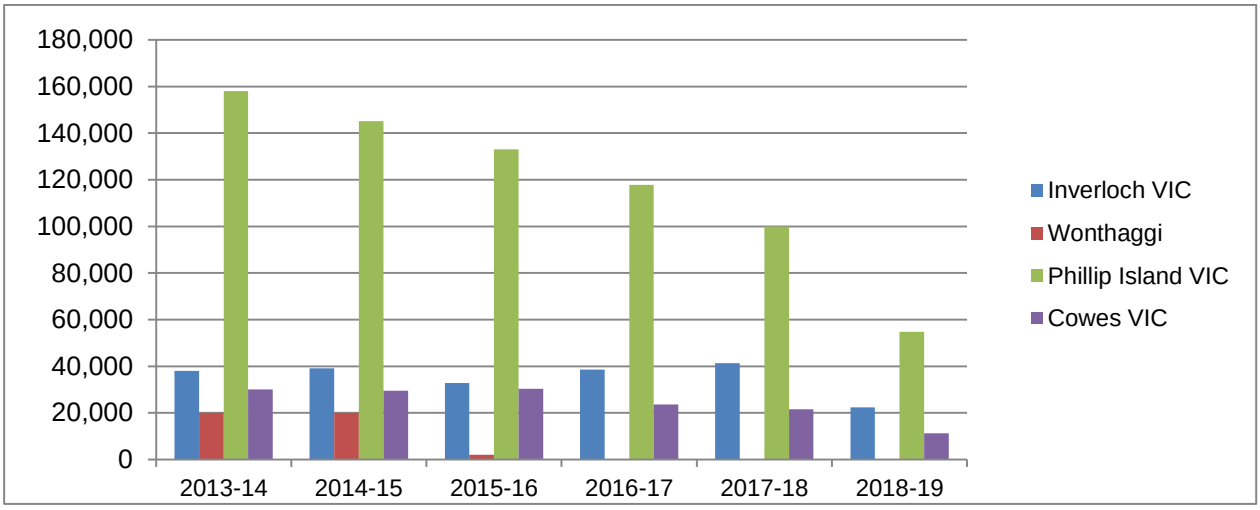

Fig. 4: Chart of Visitation to the Bass Coast Visitor Information Centres over the period 2013-14 to YE 2018

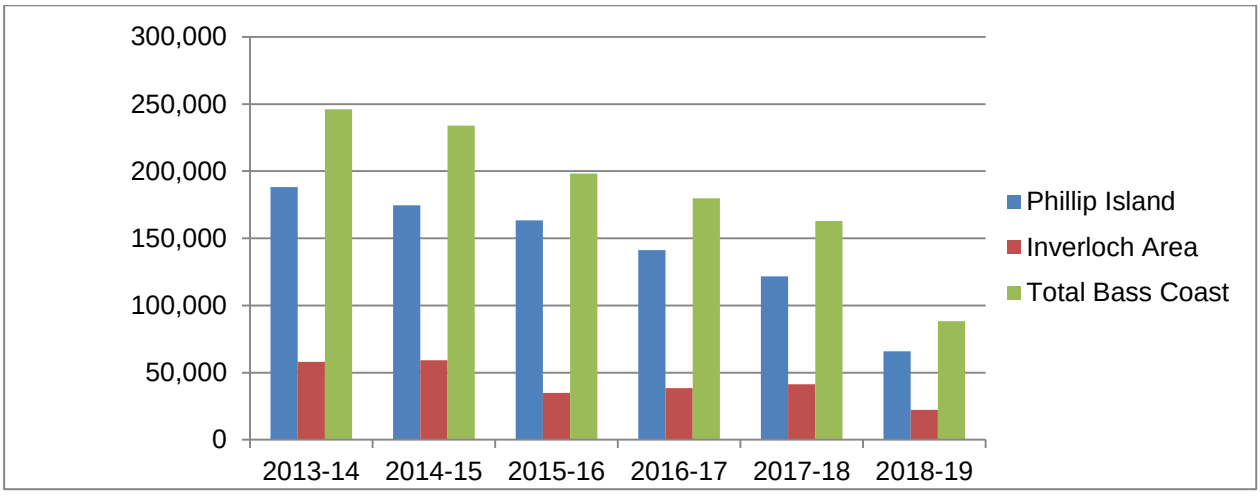

Fig. 5: Comparison of Phillip Island Visitor Information Centre and Inverloch Visitor Information Centre visitation with the Total Bass Coast visitation

5.5.6 Value of the Inverloch Coastal Area to Visitors

The number of visitors to Inverloch is difficult to estimate. Tourism Research Australia (TRA) do not produce regular visitor data for either domestic or international visitors or both. Bass Coast has provided data from their visitor centres which suggests that there are potentially at least 40,000 visitors to Inverloch per annum and that it could be as high as 60,000. The visitor numbers follow the usual Australian pattern with a peak in the summer months with a significant shoulder season and a lower winter period covering July and August and May-June.

The estimated value of Inverloch is provided below based on the IPSOS consumer surplus value of $48 per visitor day extended to the start of 2019 value to give a value per visitor day of $68.54 for the visitation band between 40,000 and 60,000.

This suggests that the Tourism benefit in total is somewhere between $2.74m and $4.11m per annum. There are issues with adding this estimate directly to the residents' benefit but both are still significant. As before these figures are likely to understate the total benefit as the expenditure figure is only estimated until the start of 2019.

6 Summary and Conclusions

Inverloch offers a very distinctive and valuable coastal resource for both residents and tourists.

6.1 Values of the Inverloch Coastal area to Residents and Visitors

Table 10 summarises the estimated values for the recent estimated visitor numbers and the Inverloch residents from the 2016 Census (Bass Coast Shire Community Statistics website) at the values per person transferred from values developed for similar locations and coastal assets in recent published studies (see references). The combined resident and visitor values should be treated with caution as the values are derived by different methodologies that may not be compatible.

Table 10 indicates the potential value of the coastal areas to visitors as above and to residents of Inverloch and potentially residents of the wider area of Bass Coast Mainland including Inverloch. This table provides an indication of possible total value of between $3m and $5m subject to the cautionary note above.

Table 10: Value of Inverloch Coastal Area

Category	Population Estimates 2016-2031	Value per Person Per Annum	Lower Bound	Upper Bound
Visitors pa	40,000-60,000	$68.54	$2,741,600	$4,112,400
Residents 2016-2031 Inverloch	5,525(2016)-7,413(2031)	$31.12	$171,938	$230,693
Bass Coast Mainland including Inverloch	17,122(2016) 25,247 (2031)	$31.12	$532,837	$785,687
Total			$2,913,538	$4,343,093
			$3,274,437	$4,898,087

This attractive residential, recreational and residential asset has been seriously down- graded by climate events in recent years. There is no reason to assume these were one-off and won't happen again. In fact, the probability is that similar events will happen at least as often and may be more damaging. This situation will increasingly require more expenditure to mitigate and repair damage from the Victorian Government, residents, Council and the community.

Some of the cost may be reduced through appropriate insurance. However, the cost of insuring properties and infrastructure is likely to increase over time with impacts initially on insurance premiums and excesses but could impact further through reducing the ability to obtain insurance. Some developments may become uninsurable. The costs of Council and other services are likely to increase with the consequent increase in rates and other charges.

Planning and building regulations are likely to get stricter reducing the ability to develop properties at higher risk locations or at least constraining them to specific areas probably further from the coast and possibly on higher land. Covenants may be required to reduce Council and developers' liability.

The key findings in this report suggest the main risks and impacts include:

- Increased storm activity and coastal erosion leading to a number of detrimental effects including but not limited to:
  - reduced safe access to the beach
  - reduction in coastal vegetation, decreasing visual amenity and general use attractiveness
  - increased requirement to reroute and remediate access tracks
  - Increased damage to important Coastal infrastructure such as the SLSC and Inverloch access roads
  - Saline intrusion into surface and groundwater
- Increased storm damage
- Increasing need to consider coastal protection development options.

While of lesser importance at present the on-going changes in climate have the potential to lead to:

- Increased periods of higher temperatures and consequent drought possibly leading to more fire activity across South Gippsland potentially impacting on Inverloch and surrounding areas with consequent:
  - Smoke impacts and other adverse air pollution effects of fires including controlled burns that reduce the risk of more aggressive grass or wild fires
  - Potential health and other hazards of air borne smoke and dust particles
  - Potential for higher levels of smoke and smog to impact adversely on traffic
- Increased frequency of flooding and more extreme inundation.

While lengthy periods of drought or longer periods of dry weather are also possible, although less likely for Inverloch and the southern coastal area. This could be an issue if streams and other water sources remain dry for a lengthy period. Protection of isolated pools that develop is important as they may offer refuge for fauna and some flora during drought periods and provide a source for broader recovery of the ecosystem

when the drought breaks. EPA Victoria in collaboration with other government and scientific experts, has initiated work to identify the characteristic of a good refuge in times of drought. This information will be used to improve the resilience of relevant environments and strengthen any post drought recovery.

On-going consideration needs to be given to the risks and likely effects of climate change and its impacts on Inverloch and on local area mitigation and management plans developed to minimise adverse effects across the area.

6.2 Next Steps

The next steps include building on the current study and the implementation of the Inverloch Coastal Protection Plan to develop appropriate community structures and resources to assist the Victorian and Local Governments to determine the on-going actions and resources needed to protect the Inverloch coastal zone and increase the local and regional resilience to manage the on-going and potentially more drastic impacts of climate change.

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