Seagrass wrack dynamics in Geographe Bay, Western Australia Synopsis

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CE Oldham
PS Lavery
K McMahon
C Pattiaratchi
TW Chiffings

Edith Cowan University
The University of Western Australia
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INTRODUCTION

The shallow waters of Geographe Bay support extensive seagrass beds that contribute large amounts of wrack (detached leaves and stems) to the local beaches, predominantly during winter. Along most of the coast, the wrack that collects on the beaches does not unduly affect the people that live close-by.

However, at Port Geographe, a proportion of the wrack moving onshore is permanently trapped on the western side of the western training wall and in the two pocket beaches (Moonlight Bay, Figure 1). These accumulations, and the management interventions to remove them, have become major environmental and social issues, impacting severely on the amenity of the area for local residents.

This study aimed to improve knowledge of seagrass wrack dynamics in Geographe Bay to inform the development of seagrass management approaches. Ultimately, the objective should be to minimise the need for artificial wrack removal from the beach on the western side of the western training wall at Port Geographe.

Figure 1 Typical accumulation of wrack a) adjacent to the western training wall and b) Moonlight Bay.

THE STUDY OBJECTIVES

The study addressed a number of tasks designed to improve knowledge about seagrass wrack and to offer recommendations on the management of wrack at Port Geographe. Specifically, these were to:

a. define the existing wrack dynamics within Geographe Bay;

b. identify the properties of the wrack that impact its movement and decomposition;

c. determine the lifecycle of wrack, including the sources of wrack, the mechanisms whereby it becomes available for transport in the ocean, the mechanisms that bring wrack onto and off beaches;

d. identify the processes involved in the decomposition of wrack and the production of hydrogen sulfide (H_2S; "rotten egg gas");

e. Identify management mechanisms that would improve the natural removal of wrack from the beaches at Port Geographe, including a review of alternative groyne and entrance structures that were previously suggested by M J Paul and Associates Pty Ltd [2005]; and

f. Recommend any further work that is needed to improve the understanding of wrack movement in Geographe Bay in order for effective management decisions to be made at Port Geographe.

A two-pronged approach was used to address these tasks:

1. Extensive field and laboratory studies were undertaken in 2008 and 2009 (Figure 2), which dramatically improved our understanding of wrack dynamics and the physical properties of wrack relevant to its transport; and
2. The incorporation of that new knowledge into a numerical model allowed predictions to be made about the movement of wrack in the vicinity of Port Geographe. The model was subsequently used to assess the effectiveness of a number of different groyne configurations, for allowing the natural bypassing of wrack.

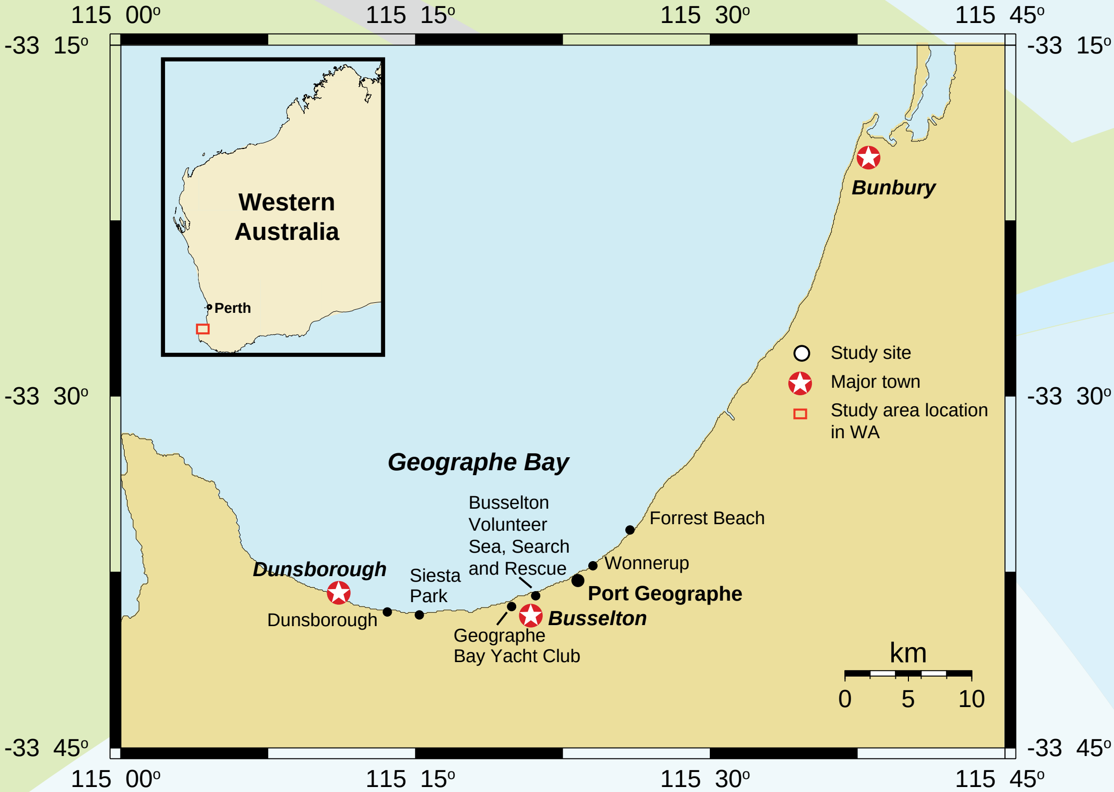


Figure 2 Map showing locations and sites used for the Geographe Bay seagrass study.

THE LIFECYCLE OF WRACK IN GEOGRAPHE BAY

Geographe Bay contains extensive meadows of seagrass, predominantly *Posidonia sinuosa* (ribbon weed) and *Amphibolis antarctica* (wire weed) (Figure 3). These plants continuously shed leaves or stems that are subsequently transported to the beaches, and referred to as wrack. This wrack is an important natural asset which serves a range of ecological functions, including nutrient recycling, the provision of food and habitat for beach fauna and, possibly, coastal protection.

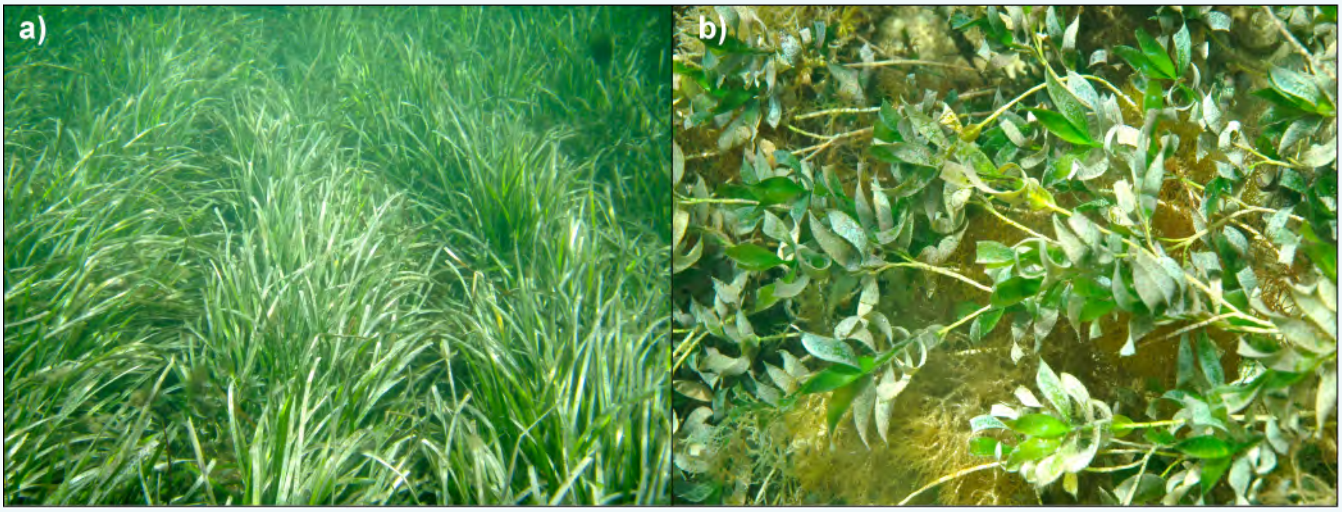


Figure 3 a) *Posidonia sinuosa* (ribbon weed) and b) *Amphibolis antarctica* (wire weed), the two seagrasses in Geographe Bay which contribute most of the wrack accumulating on beaches and at Port Geographe.

A conceptual diagram of seagrass wrack dynamics in Geographe Bay is shown in Figure 4. Wrack is generated in offshore seagrass meadows and accumulates in the meadows and unvegetated zones until autumn (Figure 4, process 1). The first significant storms suspend wrack in the water column and transport it to adjacent habitats, including the beaches of Geographe Bay (Figure 4, process 2). The wrack moves on and off the beaches depending on local hydrodynamic and meteorological conditions (Figure 4, process 3). When transported off the beaches and while suspended in the near shore water column, longshore currents move the wrack towards Port Geographe (Figure 3, process 4). While the wrack is being transported in the water and when it is accumulated on beaches, it undergoes natural degradation and transformation, including the release of the gas hydrogen sulfide (H_2S).

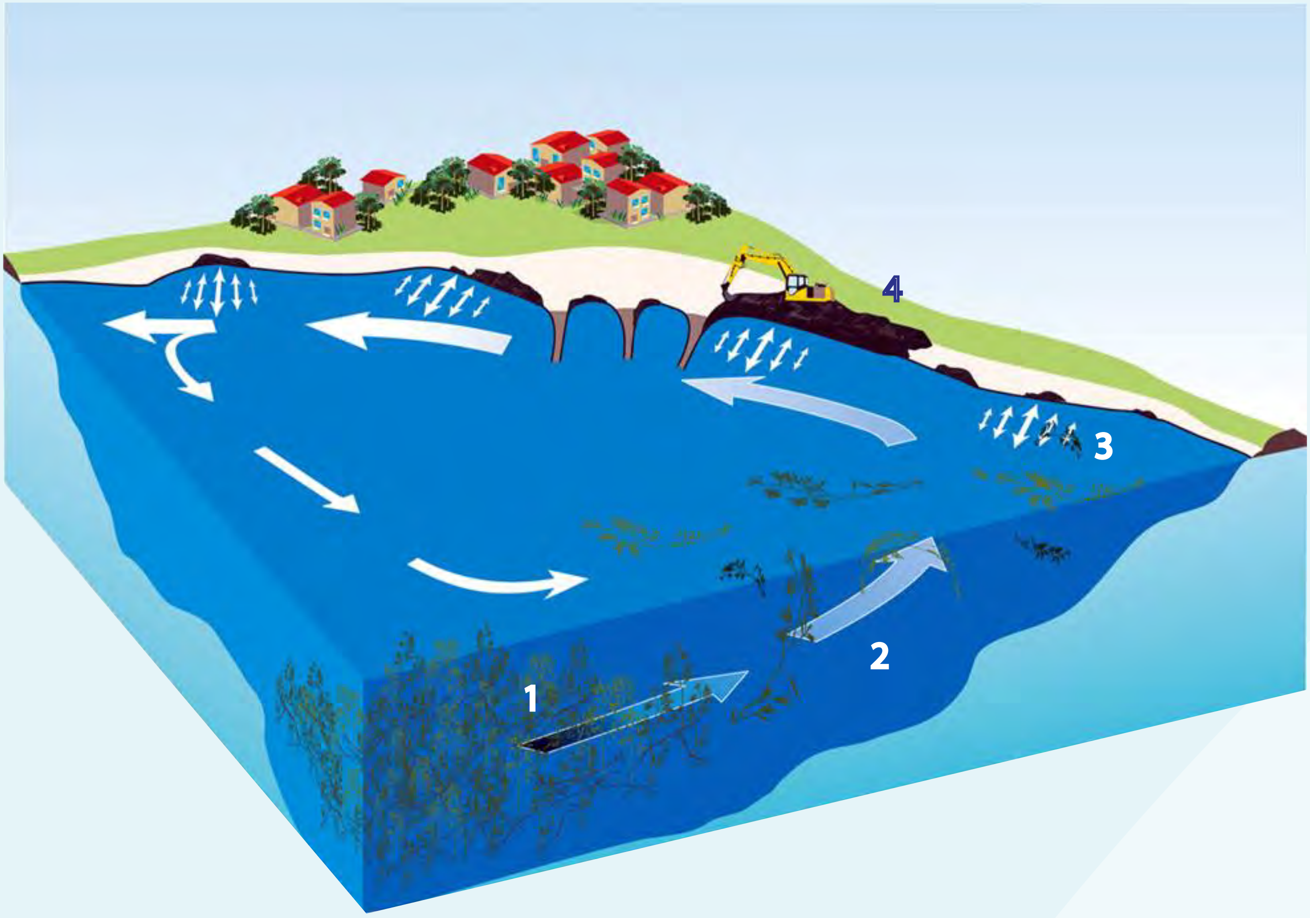


Figure 4 The lifecycle of seagrass wrack in Geographe Bay.

At most beaches of Geographe Bay, the wrack accumulations are highly transient, usually persisting for a few days to weeks before being washed back to sea (Figure 4). The accumulations vary from thin sheets of less than 1 gram per square metre, through to 1 metre-deep accumulations containing over 3.5 kg per square metre.

The wrack accumulations at Port Geographe are unusual in two ways: they are significantly greater than elsewhere in Geographe Bay, occasionally reaching almost two metres in depth, and they are much more persistent. This is a result of the coastal structures engineered at Port Geographe, which are highly efficient at trapping wrack and preventing the normal processes that cause wrack to be removed from beaches.

Figure 5 Wrack accumulations on a section of beach between Harvest Rd and Holegate St, Busselton on a) 29 May, b) 1 June, c) 15 June and d) 16 June 2008. Typical of many sites in Geographe Bay, the accumulations persist for days to weeks before being washed back to sea and transported eastwards where they may again be deposited on beaches.

Based on the results of the study for 2008-09, up to 35 x 10^6 kg of wrack are produced from the seagrass meadows; part of this accumulated at Port Geographe. By the end of May more than 98% of the wrack that had been produced since the previous winter was located in the offshore habitats (Figure 6) and less than 2% was on the beaches. Wrack is denser than seawater and so it sat on the seabed until the first storms of autumn and winter, when it was lifted out of the meadows and transported towards the beaches (Figure 4, process 2). Importantly, most wrack was transported to the beaches as individual particles suspended in the water column, not as large aggregations rolling along the bottom. By mid-winter there was a 150-fold increase in the amount of wrack accumulated on beaches and an 80% decrease in the amount found in the offshore habitats. About 46% of the wrack that was present offshore at the end of May could not be accounted for and was presumably transported out of the bay, or was degraded through fragmentation and microbial decomposition over the autumn and winter.

Figure 6 Wrack accumulations in seagrass meadows at the end of summer. The dead or damaged upper parts of leaves fall off and accumulate on top of or within the seagrass canopy. They subsequently are transported to and accumulate in unvegetated depressions adjacent to the meadows (lower right).

Wrack is deposited onto beaches largely during storm events, when water levels are high. If it remains on the beach long enough, it gradually becomes compacted, incorporating sand, making it denser and more difficult to be washed off the beach. At the same time, however, the wrack particles dry and become more buoyant. At the next high water event that covers the wrack, or during storms, which erode deep wrack accumulations, wrack particles are returned to the water and many remain buoyant for up to 18 hours, during which time they can be transported away from the beach.

While wrack is suspended in the near-shore water, longshore currents move it to the east until its passage is blocked by Port Geographe's western groyne. By late July about 97% of all the wrack on beaches in the Geographe Bay study area was found at Port Geographe.

As wrack accumulates on beaches and compacts, the ability for oxygen to penetrate into the accumulation is reduced. At the same time, the degrading wrack releases significant amounts of nutrients that support bacterial growth. In some wrack accumulations, the combination of bacterial growth and reduced oxygen penetration can result in conditions ideal for the bacterial generation of H_2S.

This study has revealed that H_2S generation is most likely to occur in wrack accumulations more than 0.5 m deep and when some or all of the wrack is in contact with water (i.e. in the saturated zone, Figure 7). Note that conditions suitable for H_2S production were also recorded in buried bands of wrack, at about 15 - 45 cm below the sediment surface, that were in contact with the saturated zones.

The levels of H_2S recorded within seagrass banks were highly variable, but frequently very high, particularly in the large accumulations that had fresh wrack material in them. The fluxes of H_2S from these accumulations were comparable to those recorded in other ecosystems such as salt marshes. Controlling the saturation of wrack may be an effective means of limiting H_2S production.

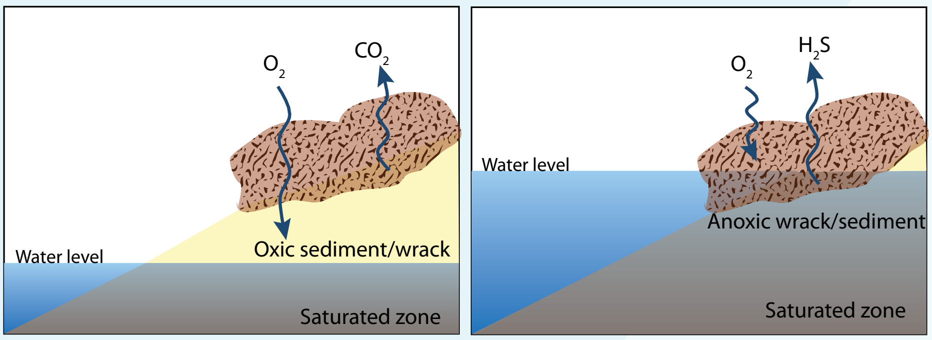


Figure 7 Conceptual figure of the production of H_2S from seagrass wrack piles. As water levels rise (from rain infiltration, rising groundwater tables, tides or storm surges) the seagrass wrack becomes saturated. This inhibits oxygenation of the wrack piles and promotes production of H_2S.

MANAGEMENT OPTIONS

The current accumulation of seagrass wrack to the west of Port Geographe and the current management approach creates a number of issues:

1. The loss of amenity and access to beaches west of the Port Geographe development during the accumulation period and to the east of the harbour entrance following bypassing operations;

2. The considerable financial cost of by-passing the wrack each year; and

3. The challenges of ensuring that the harbour entrance is navigable at all times.

Fundamentally, the presence of the large accumulations of wrack and sediment is a result of the coastal structures at Port Geographe preventing the normal process of wrack removal. Management should focus on those aspects of the lifecycle of wrack that can reduce the amount of wrack accumulating at Port Geographe (Figure 8).

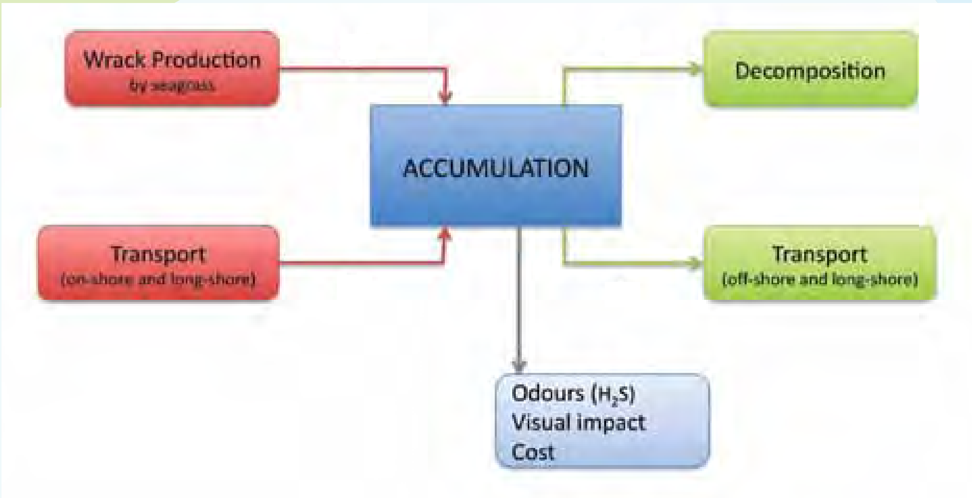


Figure 8 Factors influencing the accumulation of wrack at Port Geographe. The red boxes indicate factors leading to an increase in wrack accumulation; the green boxes indicate factors leading to a reduction in the size of accumulations.

Factors that lead to an increase in the amount of wrack accumulating at Port Geographe are:

1. The production of wrack in the offshore seagrass meadows; and

2. The transport of wrack from the offshore meadows to Port Geographe. This principally occurs during the first major storms of autumn-winter and subsequently long-shore transport moves it to Port Geographe.

Processes that act to reduce the size of wrack accumulations at a beach include:

3. The transport of wrack offshore and eastwards of the Port; and

4. The degradation of wrack.

Scenarios to improve management of seagrass wrack should aim to optimize processes leading to a decrease in wrack accumulation (1 & 2, above) or increase processes leading to the removal of wrack accumulations (3 & 4, above). While it may theoretically be possible to manipulate all of these controlling factors, significant logistical or environmental constraints mean that only a few of the options are feasible (Table 1).

Table 1 Summary of management approaches available to address the accumulation of wrack at Port Geographe, and key feasibility issues.

Approach	Management Option	Technique	Feasibility Issues
Reduce wrack production	Reduce area of sea-grass	Dredging	Environmentally unacceptable given the significance of the seagrass resource for Geographe Bay and the importance of wrack for natural beach ecosystems
	Reduce leaf production	Reduce water clarity	As above. No proven method
Reduce transport to shore	Interception in offshore traps	Dredge interception trenches adjacent to meadows	Not useful in winter due to re-suspension of wrack Requires offshore harvesting and disposal of material
	Retardation of long-shore transport	Construct 'low-crested' groynes to intercept and re-tard wrack at a number (to be determined) of locations west of Port Geographe Dispose offshore, higher up the beach profile or off site	Community response to 'low cresting groynes'. Cost Dispersal of (smaller) accumulations over many areas may be viewed either positively or negatively by local communities Disposal of wrack: Moving the wrack to a higher location up the beach profile to decompose, may not be feasible if no beach area is available. Relocation to a point higher on the beach may also reduce the recycling of nutrients back into Geographe Bay and off-site disposal will definitely have this effect.
	Interception of long-shore transport	Nets, regularly dragged and emptied offshore Pump wrack from surf-zone Floating harvester	Logistically difficult with high labour costs. Navigation hazard Issues of disposal, as above
Enhance decomposition	Maintain oxygenated conditions in wrack	Aerate beach accumulations or drain the saturated zone to prevent anoxia (absence of oxygen)	Requires detailed design to determine appropriate aeration or drainage volumes Protection of infrastructure: It will be necessary to protect the aeration or drainage pipes, pumps and other infrastructure from damage by heavy vehicles, storm action and erosion on the beaches Amenity issues: The presence of the infrastructure necessary to provide aeration or drainage may limit public access or use of the beach areas
	Enhance bacterial activity	Addition of nutrients and aerobic bacterial slurries Aeration to increase oxygen availability	Untested approach: This would require background research and development to determine the amount of aeration and promotion of bacterial growth that would optimize the rate of decomposition without causing a depletion of oxygen and the subsequent generation of H_2S
Enhance natural bypassing	Groyne reconfiguration	Re-orient Port Geographe groynes and possibly construction of additional hard walls	Cost Community response to change in structural elements Requires additional studies to analyse the implications for sand movement and canal water quality
Reduce H_2S production	Maintain aerobic conditions in wrack	Aerate the saturated zone of wrack accumulations or drain the underlying saturated zone to prevent anoxia	Requires detailed design to determine appropriate aeration or drainage volumes Protection of infrastructure: It will be necessary to protect the aeration or drainage pipes, pumps and other infrastructure from damage by heavy vehicles, storm action and erosion on the beaches Amenity issues: The presence of the infrastructure necessary to provide aeration or drainage may limit public access or use of the beach areas
	Move wrack to higher part of beach profile	Excavate wrack to higher, dry portion of beach profile Has similar effect as above	Availability of sufficient beach area Costs associated with handling of wrack Amenity issue: Possible loss of amenity due to accumulations of wrack on higher portions of the beach profile

None of the possible approaches for reducing the inputs of wrack to Port Geographe are considered feasible, either because they would compromise important ecological values associated with the offshore seagrass meadows, interfere with the natural provision of wrack to beach ecosystems elsewhere in Geographe Bay or they are logistically difficult and unlikely to be cost-effective.

Management efforts focussing on enhancing the loss of wrack from Port Geographe are likely to be more feasible. The options with the greatest potential are described below.

Enhancing natural bypassing

The Port Geographe groynes are the primary structural cause of the wrack accumulations west of the development and in the pocket beaches (Moonlight Bay). Removing the structural cause of the problem will achieve a reduction in wrack accumulation, maintain amenity in the areas currently affected by accumulations and ensure a close to natural supply of seagrass wrack to beaches east of the development. It should be noted that the structures are in place to maintain sufficient depth through the marina entrance channel, to ensure safe navigation and the depth of the marina entrance channel is mainly governed by sand transport.

MJ Paul and Associates [2005] proposed six possible groyne re-configurations (Figure 9). Four key design features were contained within the MJ Paul configurations:

1. Variable length of the western training wall,
2. Addition of a groyne on the eastern side of the marina entrance channel,
3. Addition of a spur groyne to the east of the development, and
4. Modification of the pocket beach groynes to the east of the marina entrance channel.

Three additional design features were also considered for testing as part of the present study:

5. Varying the orientation of the western beach,
6. Varying the width of the marina entrance channel, and
7. Pumping of water into the canals to enhance ebb velocities through the marina entrance channel.

MJ Paul Configurations

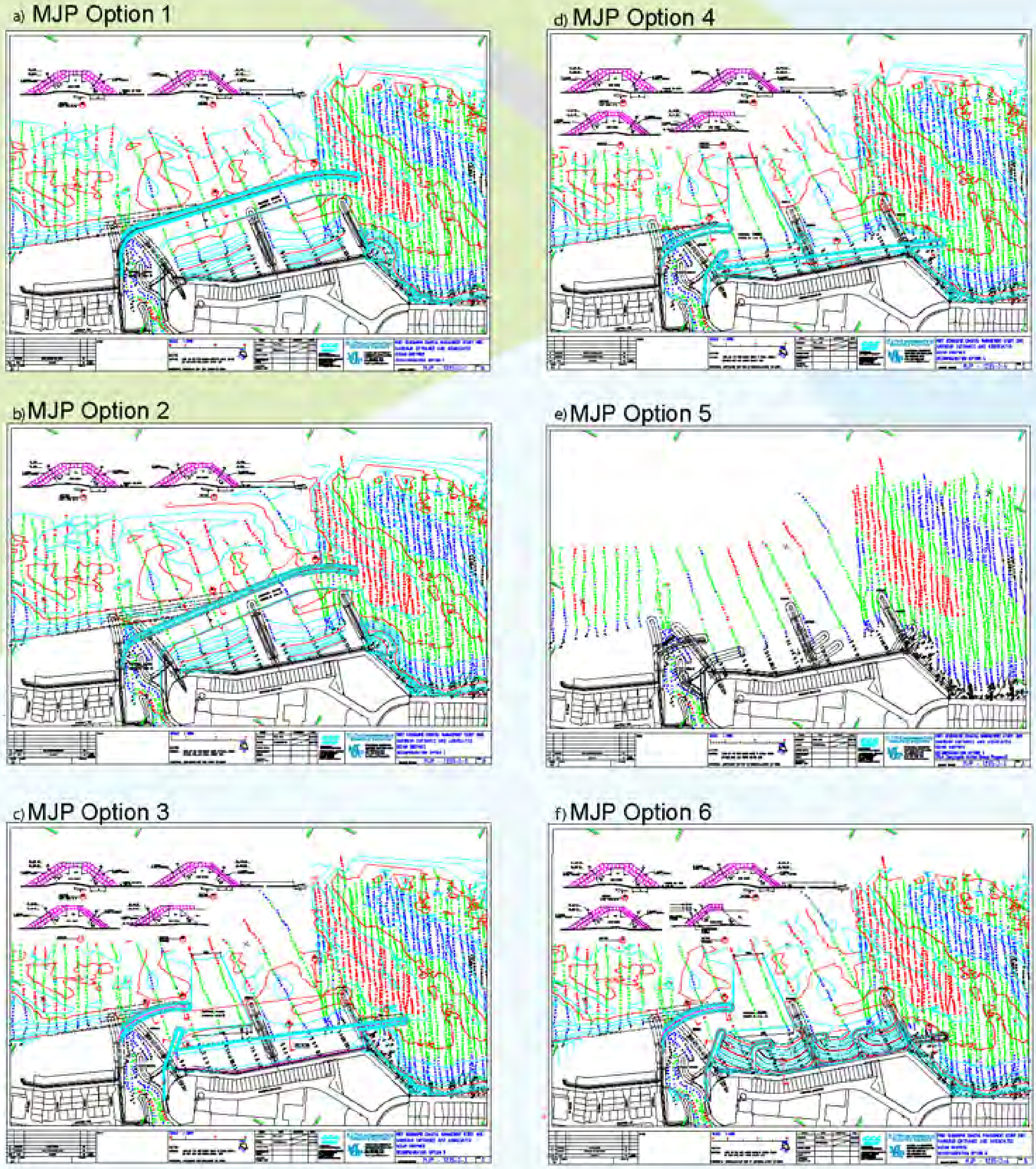


Figure 9 The six groyne configurations originally proposed by MJ Paul and Associates Pty Ltd [2005].

Options 3 and 6 (Figure 9c and Figure 9f) were considered representative of the key design elements within the MJ Paul configurations and were therefore selected for modelling. The additional design features were included in a further five configurations as summarised in Table 2. A total of seven scenarios were modelled, plus the current groyne configuration; Figure 10 compares the groyne configurations used for each modelled scenario.

Table 2 Summary of main features of the current configuration and the re-configurations of the Port Geographe coastal structures for each of the modelled scenarios. See Figure 10 for illustration of the different groyne configurations used.

Scenario (Figure)	Origin	Western beach added	Western training wall	Entrance channel	Eastern groynes	Eastern spur groyne	Pumping	Canal development stages
0 (Fig 9a)	Current configuration							
1 (Fig 9b)	MJ Paul Option 3	No	Curved to the east	Wide	No	Yes	No	Stage 1
2 (Fig 9c)	MJ Paul Option 6	No	Curved to the east	Wide	Yes	Yes	No	Stage 1
3 (Fig 9d)	Steering Committee	Yes	Curved to the east	Narrow, eastern side concave	No	No	No	Stage 2
4 (Fig 9d)	Steering Committee	Yes	Curved to the east	Narrow, eastern side concave	No	No	Yes, from high to low tide	Stage 2
5 (Fig 9e)	Steering Committee	Yes, with further smoothing	Curved to the east	Narrow, eastern side convex	No	No	No	Stage 2
6 (Fig 9f)	Steering Committee	No	Oblique, easterly orientation	Narrow, eastern side convex	Yes, but shortened	No	No	Stage 2
7 (Fig 9g)	Steering Committee Option 5	Yes, with additional extension	Current configuration	Current configu-ration	Yes	No	No	Stage 1

A two-dimensional numerical model (MIKE 21) was first used to simulate the local hydrodynamics under the current groyne configuration at Port Geographe and then to examine the impact on the hydrodynamics, of several re-configuration options for Port Geographe. The model domain (Figure 11) extended from Bunbury to Cowaramup Bay with enhanced resolution along the Busselton coastal region. Water levels recorded at Bunbury (including tides and storm surges), winds recorded at coastal stations and offshore waves recorded at Cape Naturaliste, were used as input data for MIKE 21, which predicts water levels and current speed and direction across the whole model domain. A computer-generated particle-tracking module was then created to predict the transport of seagrass wrack for each of the different groyne configurations simulated using MIKE 21.

Groyne Configurations

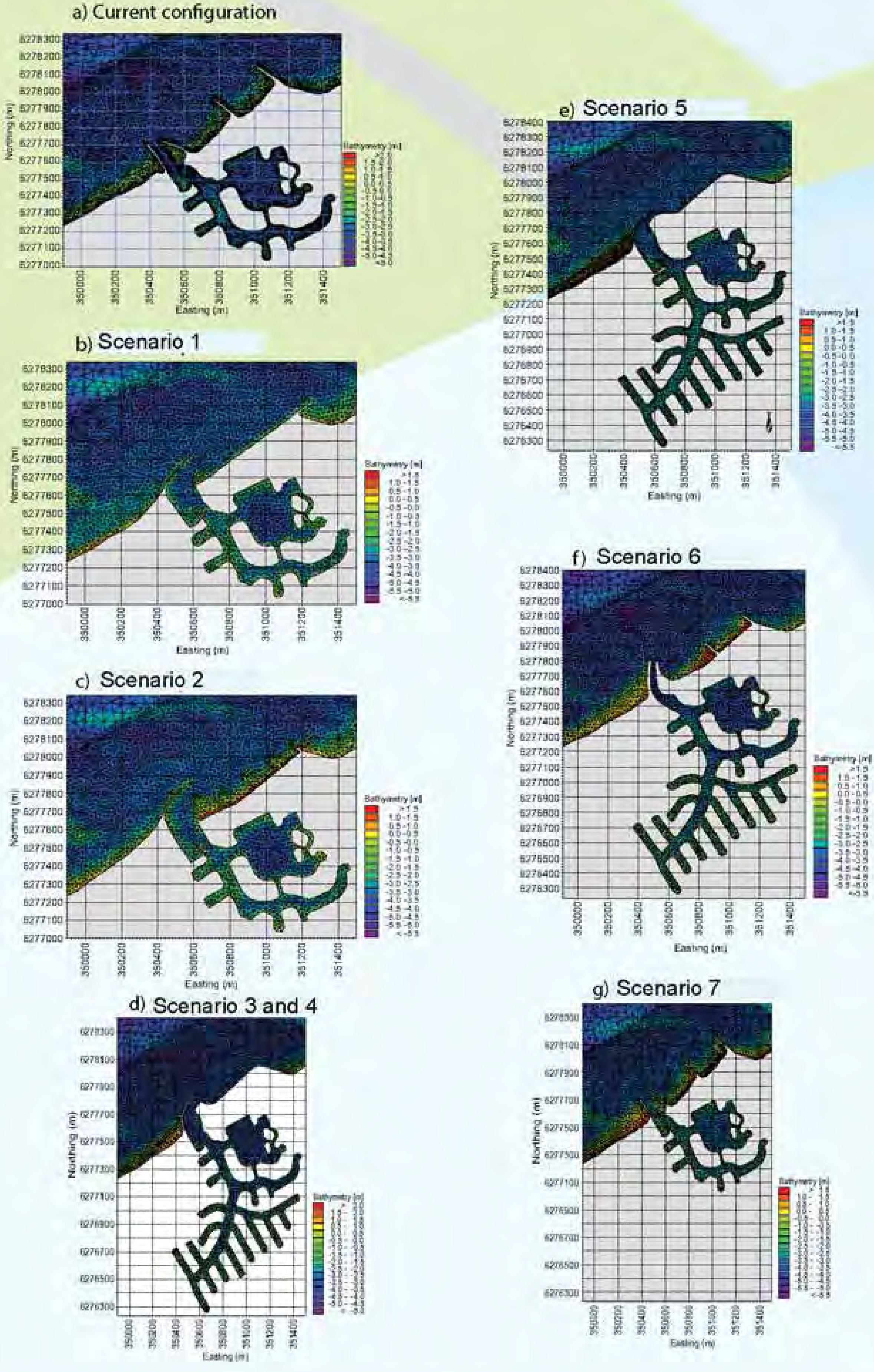


Figure 10 The groyne configurations used for modelling a) current conditions, b) Scenario 1, c) Scenario 2, d) Scenario 3 and 4, e) Scenario 5, f) Scenario 6 and g) Scenario 7.

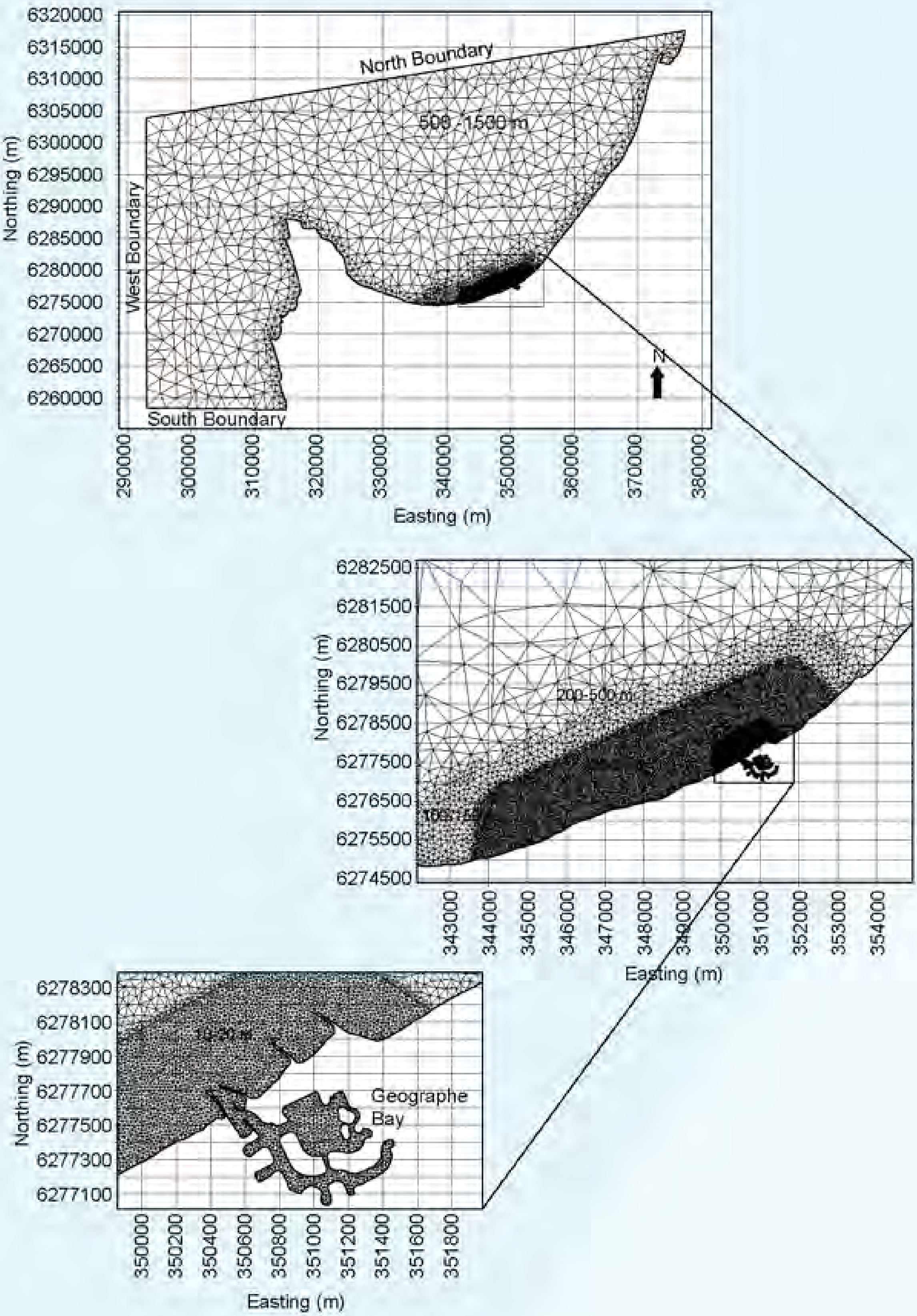


Figure 11 Model grids of Geographe Bay showing different scales used for the model domain. Finer grids were used in Port Geographe and the near shore region of Busselton.

The simulations of seagrass wrack accumulation indicated that:

Scenario 1: Altering the orientation of the western training wall of the Port Geographe marina entrance reduced accumulation of seagrass wrack on the beaches to the western side of the groyne. This design element was retained in subsequent scenarios. However, there was large wrack accumulation within the marina entrance channel.

Scenario 2: Modifying the pocket beach groyne configurations increased accumulation of seagrass wrack within the pocket beaches (Moonlight Bay) and in the marina entrance channel. No further modelling of Scenario 2 was undertaken.

Scenario 3: Creation of a concave shore on the eastern side of the marina entrance channel created an eddy in the entrance channel and increased accumulation of wrack on the eastern end of the development. This design element was not used in subsequent scenarios.

Scenario 4: Under the same configuration as Scenario 3, pumping had little effect on wrack accumulation. Therefore pumping was not included in any further scenarios.

Scenario 5: Used a curved western training wall (as in Scenario 1) but included a convex shore on the eastern side of the marina entrance channel. This minimized eddy formation and thus minimized accumulation of wrack within the channel.

Scenario 6: The addition of parallel groynes along a narrower entrance channel created eddies on either side of the channel and increased wrack accumulation to both the east and west of the development. This configuration was not modelled further.

Scenario 7: Used the current configuration but with saturation of the western beach. This improved natural bypassing of the wrack, however this is not the natural condition of the beach and would be unsustainable.

The hydrodynamic and particle transport modelling indicated that Scenario 5 was the optimal groyne configuration for improved management of seagrass wrack around Port Geographe (compare Figure 12 and Figure 13). The main features of the recommended configuration are:

- A smoother transition from the western beach to the end of western training wall;
- Changing the orientation and length of the western training wall;
- A convex breakwater on the eastern side of the marina entrance channel,
- Modification of the pocket beach groynes that currently exist to the east of the entrance channel,
- A smoother transition to Wonnerup Beach on the eastern side of the development, and
- The inclusion of the full canal development.

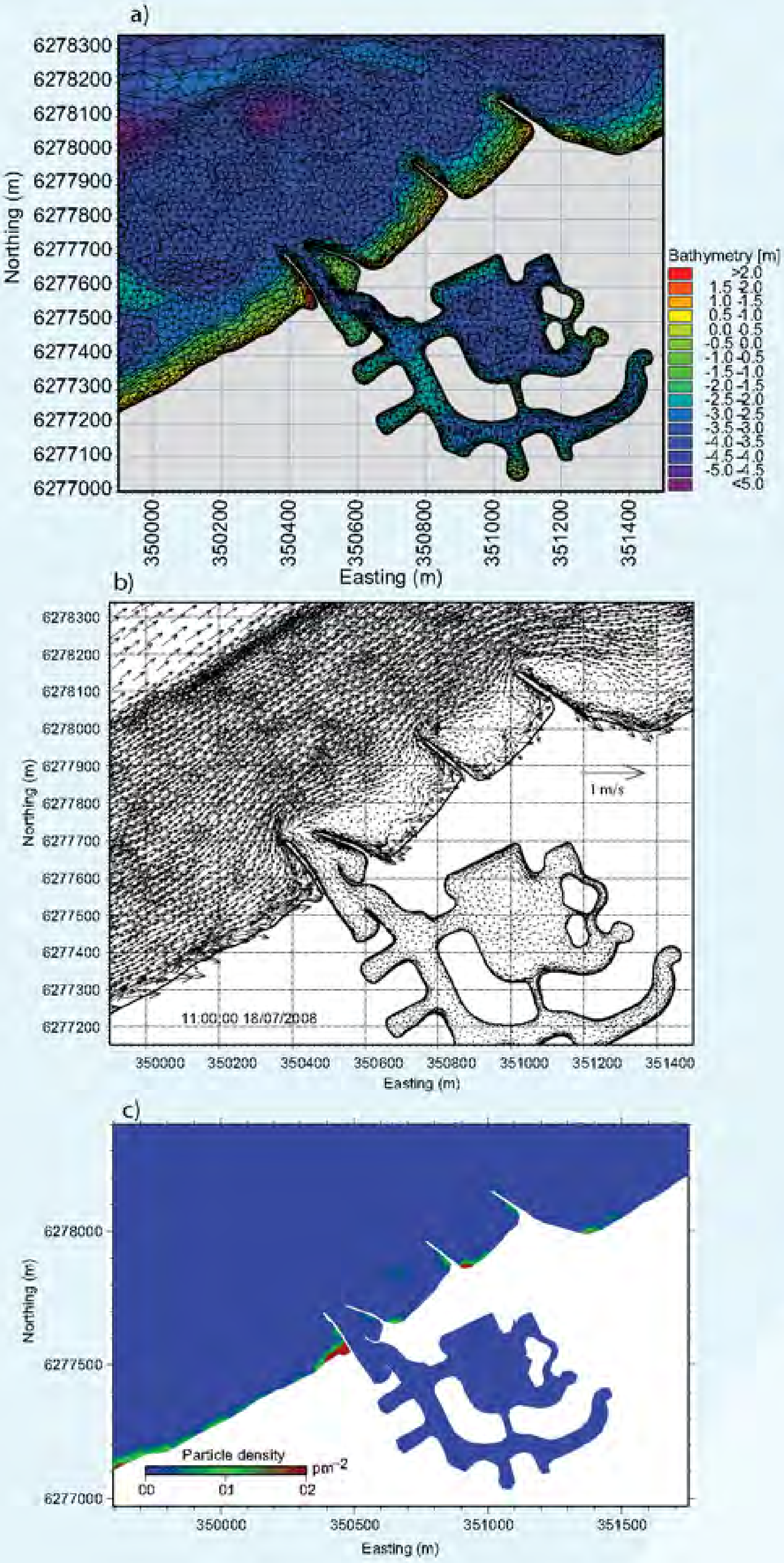


Figure 12 a) The bathymetry used for scenario modelling.

b) a snapshot of the predicted water currents during the peak of a winter storm.

c) a snapshot of the locations of predicted wrack accumulations at the end of August 2008.

Scenario 5

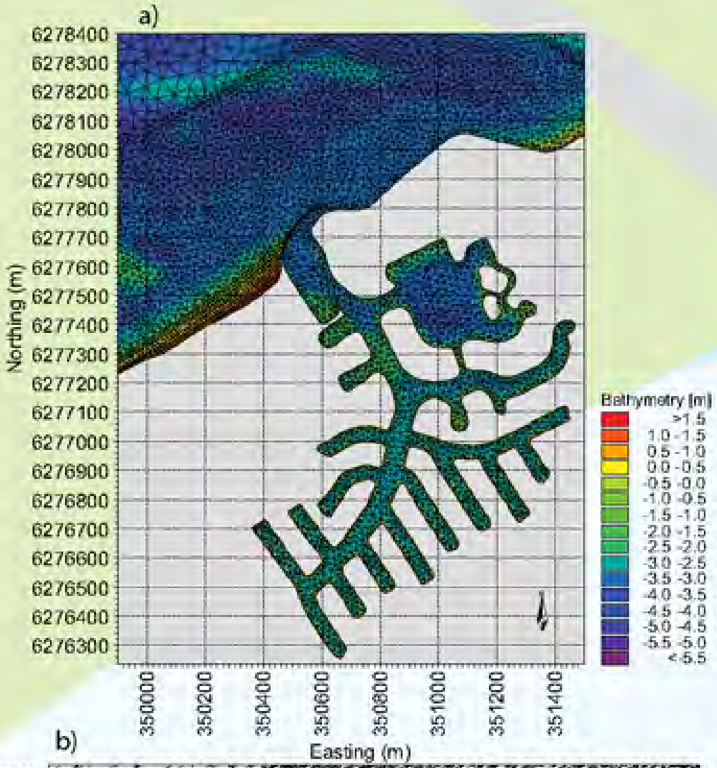
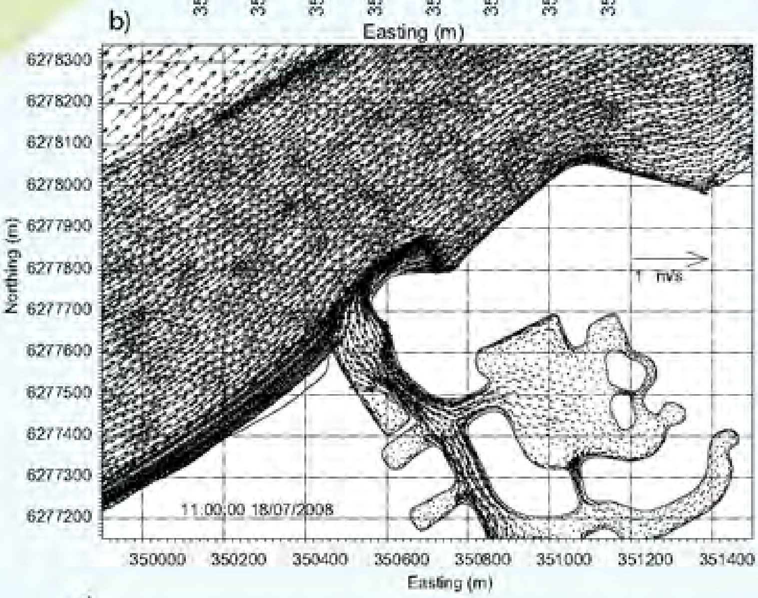
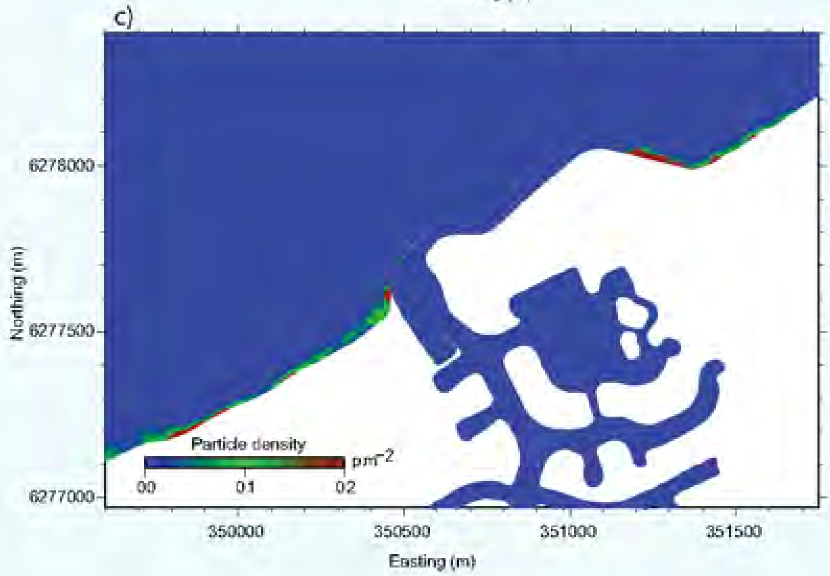


Figure 13 a) The bathymetry used for scenario modelling.



b) a snapshot of the predicted water currents during the peak of a winter storm.



c) a snapshot of the locations of predicted wrack accumulations at the end of August 2008.

Enhancing decomposition

Enhancing decomposition has the advantage that the end products are natural bacteria, nutrients, water and gases. If decomposition is performed under aerobic conditions, then the gases released are not noxious. Enhancing the rate of decomposition would require managing the environmental conditions to promote rapid, aerobic bacterial activity, possibly through:

- aeration of the wrack; or
- relocating the wrack out of the saturated zone.

Optimising the conditions to maximise degradation would require additional research to determine the precise conditions that enhance decomposition without generating H_2S. If it were being implemented only to reduce wrack accumulations, it would not normally be recommended. However, the same techniques would have the advantage of managing H_2S generation (see below), and so are worth consideration in that context, with associated reduction of wrack mass being an additional benefit.

Reducing H_2S Production

Implementing any re-configuration of the Port Geographe groynes will require additional engineering assessments, design, approval processes and construction. During that time, wrack will continue to accumulate and produce H_2S emissions. It is also likely that a successful re-configuration of the coastal structures at Port Geographe will continue to have an ongoing coastal management requirement, though to a much smaller extent. As such, H_2S emissions may continue to be an issue in the area. For these reasons, and in consideration of the public focus and potential health implications, it is critical that H_2S emissions be managed.

Our work has clearly shown that H_2S emissions occurred from wrack accumulations that were wholly or partially saturated with water, where oxygen depletion could occur. Maintaining aerobic conditions within the wrack accumulations will prevent the formation, accumulation and release of H_2S. Aerobic conditions can best be maintained in two ways:

1. Relocation of the wrack out of the saturated zone to a point higher up the beach profile; and
2. Aeration/drainage of the near-shore water and sediment in the area of wrack accumulation to prevent the formation of saturated zones.

A combination of both approaches may be required since relocation may be limited by the availability of space and the effectiveness of aeration is likely to increase with shallower accumulation depths.

RECOMMENDATIONS

Recommendation 1

It is recommended that the Port Geographe groynes be re-configured to ensure the adequate bypassing of wrack arriving at the western training wall.

Having assessed a number of alternative management options this study considers that non-structural solutions are either unfeasible or impractical. Conversely, numerical modelling of a number of proposed options for structural change has indicated that significant improvements in wrack management should be achievable.

This study has analysed options for physical changes to the Port Geographe groyne field. Scenario 5 is recommended as the optimum groyne configuration for natural wrack by passing. However, the final re-configuration will need to optimise outcomes for wrack by-passing, sediment by passing and water quality in the Port Geographe canals. Consequently, the most promising scenario from a wrack bypassing perspective is recommended as a starting point for detailed design consideration, commencing with sediment modelling.

Recommendation 2

As a pre-requisite to any re-configuration, further studies should be undertaken to:

- Determine the implications of the preferred groyne configurations to manage both sediment and wrack and also having regard to canal water quality, marina navigation and community interests; and
- Recommend the optimum re-configuration to achieve acceptable outcomes with respect to wrack and sediment bypassing and water quality in the Port Geographe canals.

Recommendation 3

In recognition of the medium to long term nature of Recommendation 1 and the possible need for ongoing, though reduced, coastal management at Port Geographe post structural modification, it is recommended that management of wrack accumulations to the west of Port Geographe and in the pocket beaches continue (including via bypass operations) until such time as Recommendation 1 has been implemented and any conditions and revised management strategies attached to its implementation have been satisfied.

It is recommended that a number of modifications to the existing management be considered:

a. More continual bypassing of wrack during the typical accumulation period may reduce the size of accumulations, maintain amenity and a more natural input of wrack to beaches east of Port Geographe. It is noted however that the implementation of this suggestion would mean an extended impact to beach amenity with possible additional cost implications.

b. Associated with more regular bypassing, relocation of wrack that is not bypassed or which is accumulated during bypassing operations to a position higher up the beach profile, where the lower layers will not intersect the saturated zone.

Recommendation 4

It is recommended that short-term management of H_2S be implemented through:

a. Drainage/aeration of the areas in which wrack accumulates, to prevent the creation of anoxic, saturated zones within wrack accumulations;

b. The re-location of wrack to a position on the beach profile where it does not intercept the saturated zone (as per Recommendation 3). Consistent with a) and b), management practices which result in the storage of wrack in saturated conditions should be avoided; and

c. The monitoring of H_2S emissions from the wrack following winter accumulation and during bypass operations should continue and be used to assist in informing wrack management decisions so as to have proper regard for community health concerns.

CONCLUSIONS

This study has provided four management recommendations to alleviate seagrass wrack accumulation around the Port Geographe development, minimise the loss of amenity for local residents and reduce H_2S emissions from decomposing wrack.

While the modelling indicated that Scenario 5 optimised natural wrack bypassing (**Recommendation 1**), it must be stressed that the modelling did not consider the implications of groyne re-configurations for the transport of sand past the entrance channel or for water quality within the Port Geographe canals. Sand volumes well in excess of the originally predicted 50,000 cubic metres are trapped each year adjacent to the western breakwater. Scenario 5 should be viewed as one option with the potential to address the wrack problem, but which must now be used for simulation of sand (sediment) transport in the Port Geographe area and to evaluate its effect on canal water quality (**Recommendation 2**).

It is further recognised that the sand erosion and wrack problems occurring on the beaches at Wonnerup are intrinsically linked and affected by any management options proposed and therefore must be included in the further sediment modelling work. Ultimately, the hydrodynamic, particle (seagrass wrack) transport and sediment models must be used together to identify the optimal groyne configuration for improved management of both seagrass wrack and sand around Port Geographe.

While structural re-configuration options are progressed, we recommend that additional management options (**Recommendations 3 and 4**) be further assessed and implemented to provide shorter-term relief from the problems associated with seagrass wrack decomposition.

For a detailed description and analysis of the results from this study, please refer to Oldham *et al.* (2010) *Seagrass wrack dynamics in Geographe Bay*, *Western Australia*, Report to WA Department of Transport/Shire of Busselton. The study report can be found at ***www.transport.wa.gov.au/portgeographe*** or by contacting the Department of Transport on **(08) 9216 8018**.

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Seagrass wrack dynamics in Geographe Bay, Western Australia April 2010

Seagrass Wrack Dynamics

The shallow waters of Geographe Bay support extensive seagrass beds that contribute large amounts of wrack (detached leaves and stems) to the local beaches, predominantly during winter. Along most of the coast, the wrack that collects on the beaches does not unduly affect the people that live close-by. However, at Port Geographe, a proportion of the wrack moving onshore is permanently trapped on the western side of the western training wall and in the two pocket beaches (Moonlight Bay). These accumulations, and the management interventions to remove them, have become major environmental and social issues, impacting severely on the amenity of the area for local residents. This study aimed to improve knowledge of seagrass wrack dynamics in Geographe Bay to inform the development of seagrass management approaches.