Regional threats, actions and priorities
The previous sections provided detailed information for each of the 46 cells. However, those individual cell descriptions did not provide information at a more regional scale that may be useful in terms of catchment management, local government area management and identifying generic threats, and they also do not consider cumulative threats within each cell. In an attempt to address these issues, the present section provides information on threats, actions and priorities at a more regional scale.

In order to account for cumulative threats within each cell, a cumulative risk score was calculated by summing all of the risk values for all habitats and issues within each cell (Table 7). These cumulative risk scores were then categorised as none (=0), low (1–15), medium (16–30) and high (>30) to provide a visual summary of regional threats (Figure 4). The highest cumulative risk scores were located off the Adelaide metropolitan coast (Cells MA8–10 and MA12–19), in Rapid Bay (Cell F21) and in Encounter Bay (Cells F10–11) (Figure 4, Table 7). Regions with medium cumulative risk scores were located off southern metropolitan Adelaide, in Yankalilla Bay, from Cape Jervis to Rapid Head and in Encounter Bay (Figure 4). Outside of these areas, threats were low to none (Figure 4).

The high cumulative risk scores for the Adelaide region were due to a combination of stormwater, catchment water and wastewater as well as various other issues that threaten the reef, seagrass and sand habitats (see individual cell summaries). The high score for Rapid Bay was mainly driven by the extreme risk rating (RV=24) given to ongoing smothering of reef habitat from the Rapid Bay quarry gravel train (see Cell F21). The high and medium scores for Encounter Bay were mainly due to the threat to reef and seagrass habitats from stormwater and catchment water via the Hindmarsh and Inman Rivers (see Cells F10 and F11). The medium scores for Yankalilla Bay were mainly due to the threat to reef and seagrass habitats from stormwater and catchment water via the Yankalilla River, Bungala River and/or Carrickalinga Creek (see Cells F22–26).

Using a similar rationale to Bryars (2003) in the Fish Habitat Inventory, the AMLRNRM region was divided into six geographical areas (Table 8, Figure 5). These geographical areas enable a more holistic approach to threat mitigation in terms of catchment management, generic threats and local government area actions (Figure 5). It is apparent that five of the six geographical areas have a high level of cumulative threats to nearshore marine habitats: northern Adelaide, Holdfast Bay, southern Adelaide, Yankalilla Bay and Encounter Bay. The southern Fleurieu area has a relatively low level of cumulative threats to nearshore marine habitats.

Table 9 provides a summary of issues, proposed actions, priority of actions and key players across the six geographical areas based upon the combined information from the 46 individual cell descriptions. When summarising this information across a geographical area, generic issues were combined and the highest priority rating (Low, Medium or High) across the cells within a given area was presented for each issue. While each geographical area has a differing number of issues, many of the issues are consistent across areas, e.g. sediments and nutrients from catchment water and stormwater (Table 9). Nonetheless, the priority of action for such issues often differs between geographical regions (Table 9).

Table 10 provides a list of those marine cells that are adjacent to each local government area with a coastal boundary (see also Figure 5). It is apparent that some local government areas are adjacent to
just one or two marine cells, while others are adjacent to many cells (e.g. City of Onkaparinga). Table 11 then provides a list of which local government areas are relevant to the six broad geographical areas; these local government areas include both those with coastal boundaries (as in Table 10) and those that lie inland but within a catchment that connects to the coast within that geographical area. When this information is used in conjunction with the identified marine cell and regional threats/issues, local government areas can gain some insight to their links with (and responsibilities to) the marine environment. It is apparent that the Encounter Bay, Southern Fleurieu, Yankalilla Bay and Southern Adelaide geographical areas are each associated with few local government areas, but for the Holdfast Bay and Port Adelaide areas, the situation is more complicated due to the higher number of relevant local government areas.

**Table 7.** Cumulative risk scores and ratings for the 46 marine cells based upon individual risk values for all habitats and issues within each cell.

<table>
<thead>
<tr>
<th>Marine cell</th>
<th>Cumulative risk score</th>
<th>Cumulative risk rating</th>
<th>Marine cell</th>
<th>Cumulative risk score</th>
<th>Cumulative risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>F4</td>
<td>0</td>
<td>None</td>
<td>F27</td>
<td>14</td>
<td>Low</td>
</tr>
<tr>
<td>F5</td>
<td>0</td>
<td>None</td>
<td>MA1</td>
<td>12</td>
<td>Low</td>
</tr>
<tr>
<td>F6</td>
<td>11</td>
<td>Low</td>
<td>MA2</td>
<td>7</td>
<td>Low</td>
</tr>
<tr>
<td>F7</td>
<td>0</td>
<td>None</td>
<td>MA3</td>
<td>24</td>
<td>Medium</td>
</tr>
<tr>
<td>F8</td>
<td>15</td>
<td>Low</td>
<td>MA4</td>
<td>11</td>
<td>Low</td>
</tr>
<tr>
<td>F9</td>
<td>12</td>
<td>Low</td>
<td>MA5</td>
<td>6</td>
<td>Low</td>
</tr>
<tr>
<td>F10</td>
<td>33</td>
<td>High</td>
<td>MA6</td>
<td>14</td>
<td>Low</td>
</tr>
<tr>
<td>F11</td>
<td>45</td>
<td>High</td>
<td>MA7</td>
<td>20</td>
<td>Medium</td>
</tr>
<tr>
<td>F12</td>
<td>21</td>
<td>Medium</td>
<td>MA8</td>
<td>38</td>
<td>High</td>
</tr>
<tr>
<td>F13</td>
<td>12</td>
<td>Low</td>
<td>MA9</td>
<td>37</td>
<td>High</td>
</tr>
<tr>
<td>F14</td>
<td>3</td>
<td>Low</td>
<td>MA10</td>
<td>54</td>
<td>High</td>
</tr>
<tr>
<td>F15</td>
<td>2</td>
<td>Low</td>
<td>MA11</td>
<td>16</td>
<td>Medium</td>
</tr>
<tr>
<td>F16</td>
<td>4</td>
<td>Low</td>
<td>MA12</td>
<td>80</td>
<td>High</td>
</tr>
<tr>
<td>F17</td>
<td>6</td>
<td>Low</td>
<td>MA13</td>
<td>86</td>
<td>High</td>
</tr>
<tr>
<td>F18</td>
<td>12</td>
<td>Low</td>
<td>MA14</td>
<td>86</td>
<td>High</td>
</tr>
<tr>
<td>F19</td>
<td>9</td>
<td>Low</td>
<td>MA15/16/17</td>
<td>70</td>
<td>High</td>
</tr>
<tr>
<td>F20</td>
<td>19</td>
<td>Medium</td>
<td>MA18</td>
<td>80</td>
<td>High</td>
</tr>
<tr>
<td>F21</td>
<td>35</td>
<td>High</td>
<td>MA19</td>
<td>44</td>
<td>High</td>
</tr>
<tr>
<td>F22</td>
<td>17</td>
<td>Medium</td>
<td>MA20</td>
<td>4</td>
<td>Low</td>
</tr>
<tr>
<td>F23</td>
<td>19</td>
<td>Medium</td>
<td>MA21</td>
<td>8</td>
<td>Low</td>
</tr>
<tr>
<td>F24</td>
<td>19</td>
<td>Medium</td>
<td>MA22</td>
<td>8</td>
<td>Low</td>
</tr>
<tr>
<td>F25</td>
<td>19</td>
<td>Medium</td>
<td>MA23</td>
<td>12</td>
<td>Low</td>
</tr>
<tr>
<td>F26</td>
<td>6</td>
<td>Low</td>
<td>MA24</td>
<td>12</td>
<td>Low</td>
</tr>
</tbody>
</table>
Figure 4. Distribution of cumulative risk scores and ratings for each of the 46 marine cells across the AMLRNRM region. See Figures 1 and 2 for cell details and Table 7 for exact scores.
Figure 5. Distribution of cumulative risk scores and ratings across the AMLRNRM region in relation to geographical areas, local government areas and catchments.
Table 8. Geographical areas within the AMLRNRM region showing their associated marine cells and equivalent fisheries habitat areas from Bryars (2003)

<table>
<thead>
<tr>
<th>Geographical area</th>
<th>Associated marine cells</th>
<th>Equivalent fisheries habitat area (from Bryars 2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encounter Bay</td>
<td>F4–F13</td>
<td>Encounter Bay</td>
</tr>
<tr>
<td>Southern Fleurieu</td>
<td>F14–F20</td>
<td>Tunkalilla Beach</td>
</tr>
<tr>
<td>Yankalilla Bay</td>
<td>F21–F27</td>
<td>Yankalilla Bay</td>
</tr>
<tr>
<td>Southern Adelaide</td>
<td>MA1–MA11</td>
<td>Port Noarlunga</td>
</tr>
<tr>
<td>Holdfast Bay</td>
<td>MA12–MA14</td>
<td>Holdfast Bay</td>
</tr>
<tr>
<td>Northern Adelaide</td>
<td>MA15–MA24</td>
<td>Port Adelaide</td>
</tr>
</tbody>
</table>

Table 9. Regional issues, proposed actions, priority of actions and key players

<table>
<thead>
<tr>
<th>Geographical area</th>
<th>Issue</th>
<th>Proposed action</th>
<th>Priority of action</th>
<th>Key players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encounter Bay</td>
<td>Sediments and nutrients from catchment water and stormwater</td>
<td>Support initiatives for catchment revegetation and improved land management practices (e.g. see Victor Harbor Environmental Management Plan 2010–2014, Inman River Catchment and Landcare Group)</td>
<td>Medium</td>
<td>Alexandrina Council / City of Victor Harbor / AMLRNRM Board</td>
</tr>
<tr>
<td></td>
<td>Erosion of beach at Victor Harbor</td>
<td>Support initiatives to collect and reuse stormwater (e.g. see Victor Harbor Environmental Management Plan 2010–2014, Alexandrina Council’s Stormwater Detention and Retention Standards)</td>
<td>Medium</td>
<td>Alexandrina Council / City of Victor Harbor / AMLRNRM Board</td>
</tr>
<tr>
<td>Southern Fleurieu</td>
<td>Sediments and nutrients from cliff top erosion and small creeks</td>
<td>Support initiatives for catchment revegetation and improved land management practices (e.g. see Victor Harbor Environmental Management Plan 2010–2014, District Council of Yankalilla Development Plan 2013)</td>
<td>Low</td>
<td>City of Victor Harbor / District Council of Yankalilla / AMLRNRM Board</td>
</tr>
</tbody>
</table>
Table 9 (cont.). Regional issues, proposed actions, priority of actions and key players

<table>
<thead>
<tr>
<th>Geographical area</th>
<th>Issue</th>
<th>Proposed action</th>
<th>Priority of action</th>
<th>Key players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yankalilla Bay</td>
<td>Sediments and nutrients from cliff top erosion and small creeks</td>
<td>Support initiatives for catchment revegetation and improved land management practices (e.g. see District Council of Yankalilla Development Plan 2013)</td>
<td>Medium</td>
<td>District Council of Yankalilla / AMLRNRM Board / Adelaide Brighton Cement / EPA</td>
</tr>
<tr>
<td></td>
<td>Smothering by gravel train from Rapid Bay quarry</td>
<td>Support initiatives to prevent further deposition of quarry material into the sea and investigate possibility of removal of gravel from sea</td>
<td>High</td>
<td>District Council of Yankalilla / AMLRNRM Board / Adelaide Brighton Cement / EPA</td>
</tr>
<tr>
<td></td>
<td>Sediments and nutrients from the Yankalilla River, Bungala River and Carrickalinga Creek</td>
<td>Support the implementation of the stormwater management plan for Yankalilla Bay and the Bungala River Estuary Action Plan</td>
<td>High</td>
<td>District Council of Yankalilla / AMLRNRM Board</td>
</tr>
<tr>
<td></td>
<td>Smothering of reef by sand at the mouth of the Myponga River</td>
<td>Support initiatives for catchment revegetation and improved land management practices (e.g. see District Council of Yankalilla Development Plan 2013)</td>
<td>Low</td>
<td>District Council of Yankalilla / AMLRNRM Board</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Encourage environmental flows from Myponga Reservoir</td>
<td>Low</td>
<td>District Council of Yankalilla / AMLRNRM Board / SA Water</td>
</tr>
</tbody>
</table>
Table 9 (cont.). Regional issues, proposed actions, priority of actions and key players

<table>
<thead>
<tr>
<th>Geographical area</th>
<th>Issue</th>
<th>Proposed action</th>
<th>Priority of action</th>
<th>Key players</th>
</tr>
</thead>
</table>
| Southern Adelaide | Sediments and nutrients from cliff top erosion, small creeks, Onkaparinga River, and stormwater | Support initiatives for catchment revegetation and improved land management practices  
Support initiatives to collect and reuse stormwater (e.g. Water Proofing the South initiative)  
Continue support for Council Cliff Stability Program  
Support the Onkaparinga River estuary management plan and rehabilitation action plan | High  
High  
Medium  
High | City of Onkaparinga / City of Marion / AMLRNRM Board  
City of Onkaparinga / AMLRNRM Board / SA Water  
City of Onkaparinga / Coast Protection Board  
City of Onkaparinga / AMLRNRM Board |
|                   | Anchor damage at Aldinga Reef                                          | Explore potential for deployment of permanent mooring(s) at the drop-off area of Aldinga Reef  
Develop a code of conduct for anchoring (e.g., encourage anchoring on shallow part of reef where macroalgal habitats occur or away from reef on adjacent sand rather than directly on drop-off where delicate sessile invertebrates occur) | Medium  
Medium | PIRSA Fisheries / DEWNR / AMLRNRM Board  
PIRSA Fisheries / DEWNR / AMLRNRM Board |
<p>|                   | Nutrients from the Christies Beach WWTP outfall                      | Support initiatives to reuse wastewater (e.g. Aldinga Wastewater Storage and Recovery Scheme) and to reduce total nutrient loads (e.g. Christies Beach WWTP Upgrade) | High | City of Onkaparinga / AMLRNRM Board / SA Water |
|                   | Sediments from dredging at O’Sullivan Beach boat ramp               | Ensure best practice with dredging and dredge spoil dumping                      | Low | EPA |
|                   | Wastewater from Port Stanvac desalination plant                      | Continue monitoring for potential impacts                                          | Low | EPA / SA Water |</p>
<table>
<thead>
<tr>
<th>Geographical area</th>
<th>Issue</th>
<th>Proposed action</th>
<th>Priority of action</th>
<th>Key players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holdfast Bay</td>
<td>Nutrients from the Glenelg WWTP outfall</td>
<td>Support initiatives to reuse wastewater and to reduce total nutrient loads (e.g. Glenelg to Adelaide Park Lands Recycled Water Project)</td>
<td>High</td>
<td>Local Government Areas / AMLRNRM Board / SA Water</td>
</tr>
<tr>
<td></td>
<td>Nutrients from the Penrice soda factory</td>
<td>Support initiatives to reduce inputs to the Port River (NB the Penrice soda factory is apparently closing down in 2013)</td>
<td>High</td>
<td>EPA / Penrice Soda Holdings Ltd</td>
</tr>
<tr>
<td></td>
<td>Sediments and nutrients from the Patawalonga / Barcoo outlets, Torrens River, Port River and stormwater drains</td>
<td>Support initiatives for catchment revegetation and improved land management practices</td>
<td>Medium</td>
<td>City of Holdfast Bay / City of West Torrens / City of Charles Sturt / City of Port Adelaide Enfield / Other Local Government Areas within the catchment / AMLRNRM Board</td>
</tr>
<tr>
<td></td>
<td>Ongoing erosion of beach and seagrass meadows</td>
<td>Support initiatives for erosion control and sand removal from Largs Bay (e.g. Adelaide’s Living Beaches program)</td>
<td>High</td>
<td>City of Holdfast Bay / City of West Torrens / City of Charles Sturt / City of Port Adelaide Enfield / AMLRNRM Board / Coast Protection Board</td>
</tr>
<tr>
<td></td>
<td>Ongoing sedimentation in Largs Bay</td>
<td>Support initiatives for seagrass rehabilitation</td>
<td>Low</td>
<td>AMLRNRM Board / Coast Protection Board</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support initiatives that improve water quality and which may lead to natural seagrass recovery (see above)</td>
<td>High</td>
<td>Local Government Areas / AMLRNRM Board / SA Water</td>
</tr>
</tbody>
</table>
Table 9 (cont.). Regional issues, proposed actions, priority of actions and key players

<table>
<thead>
<tr>
<th>Geographical area</th>
<th>Issue</th>
<th>Proposed action</th>
<th>Priority of action</th>
<th>Key players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Adelaide</td>
<td>Nutrients from the Bolivar WWTP outfall</td>
<td>Support initiatives for reuse of wastewater and reduction of nutrient loads (e.g. Bolivar Environment Improvement Program)</td>
<td>High</td>
<td>Local Government Areas / AMLRNRM Board / SA Water</td>
</tr>
<tr>
<td></td>
<td>Nutrients from the Penrice soda factory</td>
<td>Support initiatives to reduce inputs to the Port River (NB the Penrice soda factory is apparently closing down in 2013)</td>
<td>High</td>
<td>EPA / Penrice Soda Holdings Ltd</td>
</tr>
<tr>
<td></td>
<td>Sediments and nutrients from catchment and stormwater</td>
<td>Support initiatives for catchment revegetation and improved land management practices (e.g. Playford Greening and Landcare Group)</td>
<td>Medium</td>
<td>City of Port Adelaide Enfield / City of Salisbury / City of Playford / District Council of Mallala / Other Local Government Areas within the catchment / AMLRNRM Board</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support initiatives to collect and reuse stormwater (e.g. Barker Inlet Stormwater Scheme, Salisbury Wetlands, Water Proofing Northern Adelaide initiative)</td>
<td>Medium</td>
<td>City of Port Adelaide Enfield / City of Salisbury / City of Playford / District Council of Mallala / AMLRNRM Board / SA Water</td>
</tr>
<tr>
<td></td>
<td>Off-road vehicles in intertidal</td>
<td>Support initiatives to reduce off-road vehicle use</td>
<td>Low</td>
<td>District Council of Mallala / AMLRNRM Board</td>
</tr>
<tr>
<td></td>
<td>Erosion in boating channel at Port Parham</td>
<td>Undertake further investigations of potential erosion in the boating channel</td>
<td>Medium</td>
<td>District Council of Mallala / AMLRNRM Board</td>
</tr>
<tr>
<td></td>
<td>Bombing in Defence Force Range</td>
<td>Liaise with Defence Force to better understand nature of bombing and potential threat</td>
<td>Low</td>
<td>District Council of Mallala / AMLRNRM Board / Defence Force</td>
</tr>
</tbody>
</table>
Table 10. Local government areas with coastal boundaries and their adjacent marine cells

<table>
<thead>
<tr>
<th>Local government area with coastal boundary</th>
<th>Adjacent marine cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexandrina Council</td>
<td>F4–F10</td>
</tr>
<tr>
<td>City of Victor Harbor</td>
<td>F10–16</td>
</tr>
<tr>
<td>District Council of Yankalilla</td>
<td>F16–27</td>
</tr>
<tr>
<td>City of Onkaparinga</td>
<td>MA1–MA10</td>
</tr>
<tr>
<td>City of Marion</td>
<td>MA10–MA11</td>
</tr>
<tr>
<td>City of Holdfast Bay</td>
<td>MA12–MA13</td>
</tr>
<tr>
<td>City of West Torrens</td>
<td>MA13</td>
</tr>
<tr>
<td>City of Charles Sturt</td>
<td>MA13</td>
</tr>
<tr>
<td>City of Port Adelaide Enfield</td>
<td>MA14, MA15/16/17</td>
</tr>
<tr>
<td>City of Salisbury</td>
<td>MA15/16/17, MA18</td>
</tr>
<tr>
<td>City of Playford</td>
<td>MA18</td>
</tr>
<tr>
<td>District Council of Mallala</td>
<td>MA18–MA24</td>
</tr>
</tbody>
</table>

Table 11. Geographical areas within the AMLRNRM region and relevant local government areas

<table>
<thead>
<tr>
<th>Geographical area</th>
<th>Relevant local government areas (both coastal and inland)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encounter Bay</td>
<td>Alexandrina Council, City of Victor Harbor</td>
</tr>
<tr>
<td>Southern Fleurieu</td>
<td>City of Victor Harbor, District Council of Yankalilla</td>
</tr>
<tr>
<td>Yankalilla Bay</td>
<td>District Council of Yankalilla</td>
</tr>
<tr>
<td>Southern Adelaide</td>
<td>City of Onkaparinga, City of Marion, District Council of Mount Barker</td>
</tr>
<tr>
<td>Holdfast Bay</td>
<td>City of Holdfast Bay, City of West Torrens, City of Charles Sturt, City of Port Adelaide Enfield, City of Marion, City of Mitcham, Adelaide City Council, City of Unley, City of Burnside, City of Norwood Payneham and St Peters, Campbeltown City Council, City of Prospect, The Corporation of the Town of Walkerville, City of Tea Tree Gully, Adelaide Hills Council</td>
</tr>
<tr>
<td>Northern Adelaide</td>
<td>City of Port Adelaide Enfield, City of Salisbury, City of Playford, District Council of Mallala, City of Tea Tree Gully, Adelaide Hills Council, Town of Gawler, Barossa Council, Light Regional Council</td>
</tr>
</tbody>
</table>
Discussion

Recommendations

A diverse mix of seagrass, reef and sand habitats exist within the AMLRNRM region and these nearshore marine habitats have considerable value. A number of local and regional actions to address threats to these valuable habitats were identified and it is recommended that these actions be considered by the various identified key players. It is also apparent that a general theme exists across the 46 marine cells in terms of generic threats and general recommended actions to mitigate these threats. In many cases the major threats to marine habitats within the AMLRNRM region are already recognised and mitigation actions are currently underway or outlined in existing action plans. For example, wastewater, stormwater and poor quality catchment water are accepted as threats to marine habitats and in many places considerable work has already been done or is underway to address these issues; it is highly recommended that these existing initiatives continue to be supported. Examples of existing initiatives that should benefit nearshore marine habitats within the AMLRNRM region include:

- Adelaide Coastal Water Quality Improvement Plan (McDowell and Pfennig 2011)
- Port Waterways Water Quality Improvement Plan (Pfennig 2008)
- Coastal Action Plans (Caton et al. 2007, 2009)
- Bolivar Environment Improvement Program (see SA Water website)
- Water Proofing Northern Adelaide initiative (see City of Salisbury website)
- Salisbury Wetlands (see City of Salisbury website)
- The planned closure of Penrice Soda Factory in 2013 (S. Gaylard, pers. comm.)
- Port Road Rejuvenation Project (see City of Charles Sturt website)
- Glenelg to Adelaide Park Lands Recycled Water Project (see SA Water website)
- Adelaide’s Living Beaches program (see DEWNR website)
- Water Proofing the South initiative (see City of Onkaparinga website)
- Aldinga Wastewater Storage and Recovery Scheme (see SA Water website)
- Southern Adelaide Wetlands (see City of Onkaparinga website)
- Christies Beach WWTP Upgrade (see SA Water website)
- Yankalilla, Normanville and Carrickalinga Stormwater Management Plan (AWE and SARDI 2012)
- Hindmarsh and Inman River Estuary Action Plans (SKM 2010a, b)

‘Water Sensitive Urban Design’ (WSUD) is a concept which integrates the use and management of stormwater, groundwater and wastewater into urban design (see Beecham 2010) and which can reduce environmental harm to receiving coastal waters; WSUD should therefore be encouraged in the AMLRNRM region. It is also recommended that future developments and activities are undertaken in a manner that:

- Enables stormwater retention and/or natural filtration before freshwater enters the marine environment (if at all).
- Does not disturb or degrade coastal landscapes (e.g., dunes, cliffs, hills)
- Does not degrade coastal catchments
- Does not discharge any wastewater to the marine environment
• Minimises or eliminates the need for dredging

(See Brown (2001) for a guide to reducing the impacts of land-based developments on nearshore marine habitats).

The above recommendations may seem obvious but the motto “prevention is better than cure” is particularly pertinent for the marine environment where recovery of degraded habitats can be slow (e.g. Bryars and Neverauskas 2008) or even non-existent. In some respects many of the right things are already being done but more effort is required to ensure that the same mistakes are not repeated and that actions are commenced to address issues that are not currently being addressed or which have not been recognised until now. Nonetheless, in some cases it will be very difficult to address existing threats such as:

• Coastal urban centres with hard surfaces that slope towards the ocean and where there is little or no potential to retain stormwater following heavy rains.
• Cliff top and coastal erosion where natural processes may be exacerbating the problem (e.g. sea level rise) and there is little potential for local intervention.

Opportunities

During the preparation of the present report, it became apparent that a number of opportunities exist through ongoing or new programs and initiatives that may assist with implementing the proposed actions from the present report, assist with the recovery of degraded habitats, or assist with future protection of habitats. Such opportunities include marine parks, seagrass rehabilitation, wetland construction, wastewater reuse, catchment revegetation, and research programs.

Marine parks

The zoning arrangements and management plans for SA’s system of marine parks have recently been finalised with full implementation of the management plans by October 2014. Together the Upper Gulf St Vincent Marine Park and the Encounter Marine Park encompass a large proportion of nearshore waters of the AMLRNRM region. In fact, of the 46 marine cells created for the current study, just eight of them lie entirely outside of the marine park outer boundaries. The marine parks are multiple-use with a range of zone types that restrict various uses and offer a range of increasing protection levels for habitats across General Managed Use Zone (GMUZ), Habitat Protection Zone (HPZ), Sanctuary Zone (SZ) and Restricted Access Zone (RAZ). Restrictions on future activities and uses within SZs that may benefit habitat protection include:

• No benthic trawling
• No infrastructure (marinas, jetties, pontoons, breakwalls)
• No outfalls and pipelines
• No dredging
• No depositing of dredged materials
• No wastewater discharges
• No extraction or disposal for a desalination plant
• Specific limits on some types of resource exploration and production that are damaging to habitats
It is apparent that a number of the SZs in the Upper Gulf St Vincent and Encounter Marine Parks will offer a higher level of protection for habitats in the AMLRNRM region than existed under pre-park management arrangements:

- The Light River delta (which includes a small part of marine Cell MA20 but a significant portion of the coastal Cells MA19, MA20 and MA21 from the CAPs).
- An extension to (and inclusion of) the existing Port Noarlunga Aquatic Reserve (which includes all of marine Cell MA8 and the lower part of the Onkaparinga River estuary within coastal Cell MA8).
- An extension to (and inclusion of) the existing Aldinga Reef Aquatic Reserve (which includes most of marine Cell MA3).
- The region north of Carrickalinga Head (which includes a significant part of marine Cell F26).
- The Rapid Head region (which includes parts of marine Cells F20 and F21).
- The region offshore from Bashams Beach in Encounter Bay (which includes significant portions of marine Cells F7, F8 and F9).

Thus, the new marine parks system represents an opportunity for additional habitat protection within the AMLRNRM region.

**Seagrass rehabilitation**

Seagrass rehabilitation trials have been ongoing off the Adelaide metropolitan coastline for a number of years (see Bryars et al. 2008 for a summary). If large-scale seagrass rehabilitation were successful it would represent not only an increase in the spatial area of existing seagrass meadows, but it would also benefit other ongoing issues such as beach erosion in Holdfast Bay, sedimentation in Largs Bay, and seagrass fragmentation from erosion in southern Holdfast Bay. Thus, rehabilitation trials represent an opportunity for recovery and protection of habitats in the AMLRNRM region and ongoing support for the trials should be seriously considered.

**Various programs**

In some cases, a potential threat to marine habitats is currently being addressed for reasons other than its impact on marine habitats and thus presents an opportunity to address recommended actions from the present report. For example, cliff erosion is a public safety issue in some places and management agencies are addressing the problem from that perspective. Nonetheless, mitigation actions that address cliff erosion will likely have benefits for adjacent marine habitats through reduced sedimentation. Thus it is recommended that programs that address the following general issues continue to be supported:

- Coastal cliff erosion (e.g., engineering works, revegetation programs)
- Coastal catchment erosion and eutrophication (e.g., revegetation programs)
- Coastal stormwater discharge (e.g., wetland construction, rainwater tank installation)
- Coastal wastewater discharge (e.g., wastewater reuse programs)

**Research programs**

A number of research programs currently exist that present opportunities to better understand human impacts on nearshore marine habitats and therefore enable better-informed management decisions to be made. In particular there should be support for:
Research that investigates causal mechanisms between nutrients and/or sediments and habitat degradation (e.g. Gorgula and Connell 2004, Bryars et al. 2012, Connell et al. 2012), including on different sub-categories within a habitat group (e.g. Posidonia coriacea versus Amphibolis antarctica within the seagrass habitat group).

Research that improves our understanding of ‘health’ condition indices for reef, seagrass and sand habitats across different locations within the AMLRNRM region (e.g. Collings et al. 2008, Irving 2009b).

Further work and knowledge gaps

Habitat values
Nearshore marine habitats have value from a number of perspectives including providing shelter, feeding and breeding opportunities for different species (i.e. species-habitat associations), providing primary production services (viz. photosynthesis), and providing coastal protection services (e.g. buffering of waves by coastal reefs). While nearshore marine habitats are generally accepted as having some value, during preparation of the present report it became apparent that for many parts of the AMLRNRM region, there is a paucity of information on location-specific species-habitat associations. Without such information it may be more difficult to convince managers of the importance of protecting habitat from damaging activities at specific locations. It is therefore recommended that further biological surveys be conducted in various locations; these are highlighted in each of the cell descriptions of the Results section.

In general for the AMLRNRM region there is a lack of seagrass surveys where the associated fauna are sampled, i.e. species-habitat associations are poorly understood. Faunal surveys of seagrass could include non-destructive techniques such as fish and invertebrate counts using scuba along belt transects or destructive techniques such as beam trawls. Surveys also need to discriminate between the dominant seagrass species and their associated habitat structure which influences the species assemblages within the meadow (e.g. Tanner 2006). For example, while the existence of substantial amounts of Posidonia coriacea habitat in the Sellicks Beach area may be regionally significant, the value of this habitat type for associated fauna is unknown in SA. In addition, while a substantial amount of work has been conducted at specific locations such as Outer Harbor, Section Bank, Christies Beach, Port Stanvac and Holdfast Bay in relation to various anthropogenic disturbances (see Loo and Drabsch 2008), in general there is a lack of biological surveys that assess the epifauna/infauna of seagrass and sand habitats (including bare sand, invertebrate, and macroalgae) across the AMLRNRM region. In particular, in some cells there is a significant amount of pebble/cobble habitat, but no biological surveys have been undertaken on this habitat type and thus their value is unknown.

Seagrass species composition is also undescribed or poorly known in many parts of the AMLRNRM region. For example, the present report has identified numerous new areas where the (apparently) relatively rare Posidonia coriacea may occur. The identification and discrimination of different seagrass species is important as different species likely have different tolerances to increased levels
of nutrients/sediments from land-based sources (Bryars et al. 2012) and also have different species-habitat associations (e.g. Tanner 2006). Thus, a targeted regional survey of seagrass species composition is warranted. Such a survey could also include the collection of data on associated fishes and macroinvertebrates (i.e. species-habitat associations). Some areas worthy of further investigation are:

- Fisherman Bay (Cell F7)
- Rosetta Harbor/The Bluff (Cells F12 and F13)
- Naiko Inlet (Cell F18)
- Fishery Beach (Cell F19)
- Cape Jervis to Rapid Head (Cell F20)
- Myponga Head to Sellicks Beach (Cell F27)
- Port Willunga (Cell MA4)
- Maslin Beach (Cell MA5)
- Port Noarlunga (offshore) (Cell MA8)
- Hallett Cove (inshore) (Cells MA10 and MA11)

While there may be many knowledge gaps in species-habitat associations, it also became apparent during preparation of the present report that a large amount of biological survey data does already exist for the AMLRNRM region in various disparate forms, including databases and reports. A useful exercise that was beyond the scope of the current project would be the integration of these data sources into a single GIS database such as the Biological Database of SA (BDBSA) which is maintained by DEWNR. Such a database would enable searches for species that are associated with different habitat types in different parts of the AMLRNRM region and would be invaluable for activities such as assessing development proposals and preparing environmental impact assessments.

**Links between potential threats and habitat condition**

The present report has highlighted numerous locations where there is potentially a threat to nearshore habitats from a land-based discharge but there were no habitat condition survey data available to inform the threat analysis. In general, cliff top erosion and poor quality catchment flows were identified as low to moderate threats to the condition of inshore reefs and/or seagrass around much of the Fleurieu Peninsula. Further investigation of reef and/or seagrass condition in specific locations is therefore recommended in the following regions:

- Parsons Beach to Deep Creek Conservation Park (reef)
- Deep Creek Conservation Park to Fishery Beach (reef, seagrass)
- Cape Jervis to Rapid Head (reef, seagrass)
- Rapid Head to Lady Bay (reef, seagrass)
- Yankalilla Bay (reef)
- Myponga to Sellicks (reef, seagrass)
- Seaford to Hallett Cove (seagrass)

Numerous reefs were also identified that have been surveyed specifically for reef condition (‘Reef Health’) previously, but which require an updated survey. Many of these reefs are currently being surveyed through initiatives by the AMLRNRM Board or as part of the Port Stanvac desalination monitoring program. However, the following reefs are not covered by these recent activities:
• Aldinga Reef (last surveyed in 2007 and requires an update on condition status)
• Southport (last surveyed in 2007 and requires an update on condition status)
• Seaciff Reef (last surveyed in 2007 and requires an update on condition status)
• Broken Bottom (last surveyed in 2007 and requires an update on condition status)
• Semaphore Reef (last surveyed in 2007 and requires an update on condition status especially in relation to impending closure of the Penrice Soda Factory)
• Parham Reef (surveyed once in 2007 and which provides a useful comparison for sites further south)

In addition, a number of locally-important reefs off Adelaide were identified which have not been surveyed previously for reef condition (although these are deeper than traditional reef health survey sites):

• Milkies
• Macs Ground
• Northern Outer

Other specific areas around the AMLRNRM region that were identified for further investigation of identified threats include:

• Rapid Bay (current status of quarry gravel train)
• Victor Harbor (historical nearshore seagrass loss and erosion of seabed adjacent to the Inman River)
• Wirrina Cove (sediments smothering seagrass adjacent to southern breakwater)
• Yankalilla River mouth (sediments smothering reef)
• Myponga River mouth (sediments smothering reef)
• Aldinga Reef (sediments smothering reef)
• Site of disused Port Adelaide WWTP sludge outfall (last surveyed in 2007 for natural seagrass recovery and requires an update on recovery status)
• Port Parham (seagrass scouring and erosion in boating channel)
• Middle Spit (impact of Defence Force range bombing)
**Glossary and abbreviations**

AMLRNRM = Adelaide and Mount Lofty Ranges Natural Resources Management

DEWNR = Department of Environment, Water and Natural Resources

CAPs = Coastal Action Plans by Caton et al. (2007, 2009)

EPA = Environment Protection Authority

ESD = Ecologically Sustainable Development

GIS = Geographical Information System

Inshore = intertidal and subtidal habitats closest to shore within a marine cell

Marine cell = one of 46 geographical units developed in the present report that cover nearshore marine habitats in the AMLRNRM region (not to be confused with CAPs coastal cells)

Midshore = subtidal habitat approximately midway between inshore and offshore boundaries of a marine cell

Nearshore = habitats covered by DEH (2008) mapping

Offshore = subtidal habitat farthest from shore within a marine cell

PIRSA = Primary Industries and Resources South Australia

Reef Health = a scientific program developed to assess the health condition of reefs in SA (see Turner et al. 2007)

Reef Watch = a community program developed to assess the health condition of reefs in SA (see Westphalen 2011)

SBPO = Simon Bryars, Personal Observation

WWTP = wastewater treatment plant

Blue swimmer crab = *Portunus armatus*

Southern rock lobster = *Jasus edwardsii*

Western king prawn = *Melicertus latisulcatus*

Goolwa cockle = *Donax deltoides*

Mud cockle = *Katelysia* spp.

Razorfish = *Pinna bicolor*
Southern calamary = *Sepioteuthis australis*

Greenlip abalone = *Haliotis laevigata*

Blacklip abalone = *Haliotis rubra*

King George whiting = *Sillaginodes punctata*

Yellowfin whiting = *Sillago schomburgkii*

School whiting = *Sillago bassensis*, and/or *S. flindersi*

Snapper = *Pagrus auratus*

Australian salmon = *Arripis truttacea*

Southern garfish = *Hyporhamphus melanochir*

Yelloweye mullet = *Aldrichetta forsteri*

Black bream = *Acanthopagrus butcheri*

Southern blue devil = *Paraplesiops meleagris*

Harlequin fish = *Othos dentex*

Long snout boarfish = *Pentaceropsis recurvirostris*

Port Phillip pipefish = *Vanacampus phillipi*

Leafy seadragon = *Phycodurus eques*
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