

# Seagrass friendly boat moorings

## Feasibility assessment

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**DISCLAIMER:**

This report does not represent NSW DPI (Fisheries) policy with regard to sea grass. It is intended as a scoping study into sea grass friendly boat mooring designs, and their potential viability at locations within the Hunter / Central Rivers, Hawkesbury-Nepean, and Sydney Metropolitan Catchment Management Authority areas. The information contained in this publication is based on knowledge and understanding at the time of writing (March 2008).

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## 1. INTRODUCTION

Seagrass has undergone significant declines in Australia (Fyfe and Davis 2007), with around 50% of original extent left in NSW (Zann 1995). While not considered the major cause of this decline, damage from boat moorings is considered a significant threat to remaining beds (Reed and Hovel 2006, Hammerstrom *et al.* 2007, Walker *et al.* 1989, Hastings *et al.* 1995, Williams and Meehan 2004).

The growing coastal population and affluence in NSW is placing increased demand on recreational boating facilities, including spaces for moorings (for example, the Sydney Harbour Foreshore Authority (2005) estimated that the annual average increase in NSW boat registrations is around 4,700, with an increasing trend towards larger boats (7m+)). Waiting lists for mooring sites reach up to 100 applicants in some areas (NSW Maritime website). These factors may place a greater importance on the need to manage mooring related environmental, safety and space availability issues in NSW.

The purpose of this study is to assess the feasibility of seagrass friendly boat moorings (SFMs) with regard to costing and technical constraints as well as legislative and liability issues. Literature on seagrass ecology, conservation and impacts from boat moorings is examined and case studies of SFM and positions of major stakeholders are documented.

## 2. MAJOR CONSIDERATIONS

### 2.1. ROLE OF SEAGRASS IN COASTAL ECOSYSTEM FUNCTION

Seagrass plays a crucial role in coastal ecosystem function, being vital for primary production, nutrient cycling, stabilisation of sediments, and provision of food and habitat for a wide variety of species (Francour *et al.* 1999; Fyfe and Davis 2007; Reed and Hovel 2006; Hammerstrom *et al.* 2007; Wear 2006; Kikuchi 1980).

A number of studies have observed higher species richness and density in seagrass beds compared with unvegetated habitats (Guidetti 2000; Jenkins *et al.* 1997; MacArthur and Hyndes 2001; Gray *et al.* 1998).

### 2.2. SIGNIFICANCE OF SEAGRASS FOR COMMERCIAL AND RECREATIONAL FISHING

The importance of seagrass as nursery grounds for the juvenile and sub-adult stages of commercial and recreational fishing species is well documented. In NSW such species include yellowfin bream, luderick, sea mullet, eastern king prawn, school prawn, blue swimmer crab, leatherjacket, garfish, whiting, tarwhine, trevally, flathead and groper (NSW Fisheries 2003; EPA NSW 1997; Saintilan 2004; Jenkins *et al.* 1997; Pollard 2003; Williams and Meehan 2004; Trnski 2006; Lynch *et al.* 2005; Meehan and West 2002).

The potential consequences of seagrass loss for commercial and recreational fishing have been demonstrated in Western Port Bay, Victoria. Between 1973 and 1984, seagrass cover declined by 70% in Western Port Bay (the cause of this decline is not fully understood). At the same time commercial fish catches from Western Port Bay declined by about 40% (Jenkins *et al.* 1993). Jenkins *et al.* (1993) concluded that decline in commercial catch was more than likely attributed to seagrass decline, particularly as “*the strong parallel decline in fish catches and seagrass loss occurred in species which were specifically adapted to life in a seagrass habitat [six-spined leatherjacket, grass whiting and King George whiting]. Species with a reduced ecological link with seagrass habitat did not show a clear parallel decline with seagrass.*”

McArthur and Boland (2006) examined the economic impact of seagrass loss on commercial fishing in South Australia. It was concluded that the loss of just 16% of seagrass in one fishing block could result in an economic loss of up to \$235,000 per year (note: a fishing block refers to a spatial reference site in the SARDI South Australian Research and Development Institute’s ‘GARFIS’ database, which records catch and effort data collected by commercial fishers. GARFIS fishing blocks are based upon approximate grid sizes of 1 degree latitude and longitude).

## 2. 3. CONSERVATION STATUS OF SEAGRASS

Seagrass meadows have undergone significant declines in Australia. South-eastern Australian estuaries have lost up to 85% of beds in the last 30-40 years (Fyfe and Davis 2007). While some species of seagrass are known to undergo natural fluctuations it is considered that human induced disturbance is the most serious cause of seagrass loss (Hammerstrom *et al.* 2007; Williams and Meehan 2004). While eutrophication, increased sedimentation, herbicide, petrochemical and heavy metal contamination, and hydrology changes are noted as major causes of decline (Francour *et al.* 1999; Hammerstrom *et al.* 2007; EPA WA 1997; Fyfe and Davis 2007). Mechanical damage from boat propellers, anchors and moorings also causes significant damage to remaining beds (Walker *et al.* 1989; Hastings *et al.* 1995; Lukatelich *et al.* 1987; Hammerstrom *et al.* 2007; Reed and Hovel 2006; Williams and Meehan 2004; Francour *et al.* 1999; Fyfe and Davis 2007).

Zann (1995) estimated that around half of the seagrass in NSW estuaries has been lost and states that the decline of temperate seagrass is one of the most serious issues in Australia's marine environment.

Conservation efforts may need to differentiate between seagrass species. There are six species of seagrass found in NSW. These include *Posidonia australis* (strapweed), *Zostera capricorni*, *Zostera muelleri*, *Heterozostera tasmanica* (eelgrass), *Halophila ovalis* and *Halophila decipiens* (paddleweed) (West 1985). *Zostera spp* are the most common species in NSW. *Zostera spp* and *Halophila spp* both occur relatively extensively along the entire NSW coast. *Posidonia* on the other hand only occurs south of Wallis Lake and occupies fewer habitats (in marine dominated waters with stable sediments) (Stewart and Fairfull 2007, Zann 1995).

The composition and abundance of fauna inhabiting seagrass meadows is known to vary depending on the species of seagrass. For instance, Young (1981) found significant differences in the composition and abundance of epibenthic fauna between *Z. capricorni* and *P. australis* beds. Young (1981) also found that the fauna of *P. australis* beds often contained the most species.

*P. australis* beds are considered a climax community (Westphalen *et al.* 2005) and less likely to undergo natural fluctuations. *Zostera spp.* and *Halophila spp* fluctuate seasonally in some areas and can grow back relatively fast (Meehan and West 2000). *P. australis* is particularly fragile and takes much longer to grow back than the other types (Larkum and West, 1990, Meehan and West 2002). Meehan and West's (2000) study found that it took 25 years to recolonise a 0.4ha area of a damaged *P. australis* bed in Jervis Bay. They concluded that it may take over a century for the bed to be completely repaired.

## 2. 4. EFFECT OFF BOAT MOORINGS ON SEAGRASS

Traditional block and chain, swing moorings are known to damage and fragment seagrass beds that may otherwise be intact. The traditional swing mooring apparatus consists of a heavy block that sits on the seafloor, attached to a tackle, which is a heavy chain attached to a riser chain and rope, which is then attached to a mooring buoy. The vessel is secured at the bow to the rope and as the water current changes, the vessel swings around the mooring block, dragging the chain along the seafloor with it. The ground chain can cause a deep scouring of the seafloor which, according to Walker *et al.* (1989) and Hastings *et al.* (1995) can range from an area of 3m<sup>2</sup> to 300m<sup>2</sup>, depending on the length of chain (which is a function of boat size). Walker *et al.* (1989) also observed that the floor of a scour was depressed below the sediment surface level of surrounding seagrass meadow by ~0.5m and scours as deep as 1m were observed.

As a result the landscape is broken into fragmented habitat patches, whereby mean habitat patch size is low and mean patch isolation is high (Reed and Hovel 2006; Hammerstrom *et al.* 2007). The fragmentation of seagrass beds caused by mooring damage can have the following physical and biological consequences.

### 2. 4. 1. Consequences of fragmentation

#### Erosion

An intact meadow is able to baffle current speed and absorb wave energy, preventing sediment loss (Lukatelich *et al.* 1987). According to Hammerstrom *et al.* (2007) even small scars may leave seagrass habitat susceptible to severe erosion by wind and wave-driven currents and storms. It has been noted by Hastings *et al.* (1995), Hammerstrom *et al.* (2007) and Walker *et al.* (1989) that seagrass edge exposed

from mooring damage will migrate down-current and the 'blow-out' associated with the mooring will grow. Under extreme conditions it will coalesce with neighbouring blow-outs.

Erosion exacerbates the following consequences.

#### Loss of detritus and nutrients

Intact meadows trap and maintain organic detritus within the system. Associated microbial populations also constitute a nutrient rich food source for filter feeders. This is of considerable biological significance to detrital food chains and nutrient recycling. Increased edges caused by mooring damage are less effective at baffling water movement, resulting in the loss of detritus and nutrients extending further into the meadow. Leaf litter decomposes elsewhere (eg. on beaches) and nutrients are unavailable for seagrass growth (Lukatelich *et al.* 1987; Walker *et al.* (1989).

#### Habitat loss and resulting affects on species abundance, diversity and composition

The effect of seagrass habitat fragmentation on associated organisms is well documented. Reed and Hovel (2006) tested the effects of experimentally cleared seagrass plots on abundance and diversity of epifauna. Plots cleared of 90% vegetation were made to represent mooring damage (using measurements from Walker *et al.* 1989). These plots had drastic reductions in species richness and total epifaunal density compared to plots with 0, 10, 50% removal. MacArthur and Hyndes (2001) found that patchy landscapes of seagrass (25%-50% cover) housed far fewer fish of almost all species when compared with homogenous meadows (75%-100% cover).

The structure provided by an intact seagrass canopy acts as a refuge from predation for juvenile and small-sized fish and crustaceans. Fragmentation of the bed can change predator-prey dynamics (Lukatelich *et al.* 1987). Fernandez *et al.* (2005) compared fish assemblages associated with differently fragmented *Posidonia oceanica* beds in Italy, following damage by excavation. They concluded that generalist visual predators benefited from fragmented beds as they could detect prey easier along the seagrass edges. Fernandez *et al.* (2005) found that individual sizes of fish were smaller in continuous beds and once the beds became fragmented these smaller fish declined.

It is important to note here that there is anecdotal evidence in NSW for increased fish catches by recreational fishers targeting patchy seagrass landscape around mooring areas (Boat Owners Association 2004). This may support the theory that larger predatory fish exploit fragmented areas of seagrass at the expense of smaller individuals, rather than indicating that seagrass fragmentation is beneficial to recreational fish species in general.

Epiphytic biota are an important part of the food chain. The leaf surface of seagrass provides a stable surface area (which is up to 15 times greater than that of the bottom on which the seagrass grows) for settlement of these biota (Lukatelich *et al.* 1987). As observed by Walker *et al.* (1989), up to 15m<sup>2</sup> of leaf surface is lost for each m<sup>2</sup> of seafloor scoured. This not only leads to habitat loss for epiphytic biota but also affects associated food chains.

#### Reduced productivity

Seagrass meadows have high rates of productivity. As plants absorb nitrogen and phosphorus from water column and sediments, these nutrients enter the food chain and are recycled within meadows by decomposition, allowing high rates of production to be maintained in nutrient poor conditions. Rapid production and shedding of leaves and calcareous epiphytes contribute significantly to substrate and sediment production (Lukatelich *et al.* 1987). Reduction in an intact canopy reduces productive capacity.

### **2. 4. 2. Extent of damage caused by moorings**

Studies specifically on extent of mooring damage to seagrass beds in Australia have been carried out in Western Australia. Walker *et al.* (1989) recorded the extent of seagrass loss from current moorings at Rottnest Island, Cockburn Sound and Warnbro Sound. At Rottnest Island 2.4ha or 1.4% of seagrass had been lost, at Cockburn Sound 1.8ha or 1.9% had been lost and 0.45ha or 2.1% had been lost at Warnbro Sound. Walker *et al.* (1989) notes that while relatively small areas were damaged by moorings, the effect is much greater than if the equivalent area was lost from the edge of the meadow. The fragmentation observed in this study resulted in an increase of 8.5 km in the length of eroding edge at Cockburn and Warnbro Sounds; and 13.5km at Rottnest Island. Walker *et al.* (1989) observed numerous 'blowouts'

and thinning of seagrass within all mooring regions (caused by undercutting erosion). It was also noted that seagrass damage from moorings at Warnbro Sound in WA had a high visual impact.

Hastings *et al.* (1995) determined loss of seagrass caused by mooring damage at two sites at Rottneest Island using aerial photographs taken between 1941 and 1992. The results were dramatic at one of the sites (Rocky Bay), where 18% of seagrass area had been lost between 1941 and 1992, 13% had been lost between 1981 and 1992 and exposed edge of beds had increased by 230% between 1981 and 1992. Less than 5% of seagrass area had been lost between 1941 and 1992 at the second site (Thompson Bay), however the exposed edge of the beds doubled between this period.

While such studies have not been carried out in NSW, there is visual evidence of the extent of damage caused by moorings. Google Earth™ images of mooring areas in Belmont Bay (Lake Macquarie), Manly Cove, Clareville (Pittwater) and Great Mackerel Beach (Pittwater) clearly show a large number of circular scours throughout the seagrass meadows (see figs. 2, 5, 10, and 11). Recent GIS mapping by West (2007) shows several seagrass beds (occurring in mooring areas) with similar circular scour patterns (see figs. 1, 3, 6, 7, 8 and 9).

According to Williams and Meehan (2004) in NSW boat moorings have caused significant seagrass loss in Port Hacking, particularly in Gunnamatta Bay and Burraneer Bay where numerous holes in the beds are consistent with moorings blocks.

## **2. 5. LEGISLATION AND POLICY RELATING TO THE PROTECTION OF SEAGRASS IN NSW**

Seagrass is protected under s204-s205 of the *Fisheries Management (FM) Act 1994*, which states that a person must not harm protected marine vegetation (including seagrass), except under the authority of a permit issued by the Minister.

The importance of seagrass for commercially and recreationally important fish, as well as for the maintenance of water quality, nutrient cycling and sediment stabilisation, is highlighted in the *Fish Habitat Protection Plan No. 2* (The Protection Plan) (NSW Fisheries 1997), which regulates developments/activities that cause direct and indirect damage to seagrasses including moorings. The Protection Plan states:

*“The Waterways Authority [now NSW Maritime] and NSW Fisheries [now NSW DPI] will generally not approve any new or replacement moorings over seagrass beds. Existing moorings (except navigational aids such as port and starboard markers) in or adjacent to (i.e within 10m) to seagrass may be required to be relocated over time. Where relocation is not possible, swing moorings may be required to be replaced with environmentally friendly mooring apparatus.”*

In theory a Part 5 assessment under the *Environmental Planning & Assessment (EP&A) Act 1979* is required every time a mooring is placed in a seagrass bed. According to S. Carter (*pers. comm.* Dec 2007), it is common for moorings to be placed in seagrass areas without a Part 5 EP&A Act assessment and without referral to the NSW DPI. There is also anecdotal evidence from mooring contractors that moorings are occasionally placed in un-scoured areas of seagrass (R. Sexton *pers. comm.* Feb 2008). Furthermore, it must be noted that when moorings are serviced they are removed from the water and then placed back in, not necessarily in the exact same position as before, thus the scour patch may be increased with every service (S. Carter *pers. comm.* Dec 2007).

## **3. SEAGRASS FRIENDLY MOORING DESIGNS**

SFMs are relatively expensive when compared with traditional block and chain moorings. There are currently a number of SFM designs on the market in Australia. Table 1 compares each SFM design with the traditional block and chain mooring style.

**Table 1 Comparison of mooring designs.**

Mooring type	Description	Cost / holding capacity	Trials / comments
Seaflex  Mats Gamby, Seaflex Australia: 03 9397 0118 or 0417 525 332, <a href="mailto:mgamby@optusnet.com.au">mgamby@optusnet.com.au</a>	Rod with a rubber core (acting as a dampener) is screwed into seabed. Polyester cord with float (to avoid bottom drag) attaches rod to mooring buoy. Mooring connection held above water for easy collection.  Diver not required for installation but is required for service.	Supply cost (does <b>not</b> include GST, anchors, installation and delivery): Seaflex type 2015 BP, \$1700.00 (boats up to 8m/26ft) Seaflex type 4015 BP, \$2400.00 (boats up to 10m/33ft) Seaflex type 4020 BP, \$2680.00 (boats up to 14m/46ft) Seaflex type 6020 BP, \$3980.00 (boats up to 16m/52ft).	Gippsland Ports Vic, replacing 4 courtesy moorings a year in Gippsland Lakes. So far, no problems reported in regards to safety in all conditions.  Gippsland Ports prefers Seaflex over EzyRider as they are more user-friendly.  See Section 4 and Appendix 2 for and further information and diagram.
EzyRider  <a href="http://www.ezyridermoorings.com">www.ezyridermoorings.com</a>	Three chains connected to a base (which, depending on vessel size, is either a plate screwed into seabed or concrete block/s) form tripod and connect to single, link proof coil chain. Steel shaft connects chain to mooring buoy. Strong rubbers connected from base of buoy to bottom of shaft act as dampener and hold chain off sea bed.  Diver required for installation and service.	\$2500 for supply and installation.	MPA installed one mooring in Jervis Bay Marine Park. Elasticised component experienced wearing problems (F. Clements <i>pers. comm.</i> , Feb 2008).  Gippsland Ports Vic, trialled an EzyRider against a Seaflex. Seaflex was preferred as it was more user-friendly. The EzyRider remained in use and did not experience any safety problems.  NSW Maritime trials show positive results. There are a number of courtesy moorings in Botany Bay and Pittwater. Note: while recent heavy storms damaged some of these moorings, this is not unusual for boat moorings in general (S. Black <i>pers. comm.</i> Dec 2007).  Several moorings in use at Rottneest Island. Results have been positive (K. Shadbolt <i>pers. comm.</i> Feb 2008).  Since 1999 more than 450 units have been installed throughout Australia in various locations and substratums (EzyRider website).  See Section 4 and Appendix 2 for further information and diagram.
Jeyco  <a href="http://www.jeyco.com.au">www.jeyco.com.au</a>	Three lengths of chain (forming a tripod), secured using an anchor.	Approx. \$5000 for supplies and about an extra \$500 for installation (F. Clements, <i>pers. comm.</i> Feb 2008).	MPA installed three courtesy moorings in Jervis Bay Marine Park and are about to install two more. MPA has found they work well and are very strong (F. Clements, <i>pers. comm.</i> , Feb 2008).  See Section 4 and Appendix 2 for further information and diagram.

Mooring type	Description	Cost / holding capacity	Trials / comments
Port-a-Moor <a href="http://www.portamoor.com.au">www.portamoor.com.au</a>	Base plate sits on seabed. Three screws (forming a tripod) drilled, through holes in base plate, into the seabed. Mooring 'sling' then attaches this to mooring buoy.	Two types: Model 240.64.850: For vessels up to 6m/20ft. Provides up to 2500lbs deadweight. Temporary mooring installed and removed by owner in shallow water. Model 380.128.885: For vessels to 12m/39ft. Provides up to 4500lbs deadweight. Both designs retail for \$499, no servicing required as they are not designed for long term mooring.	Parks Victoria installed several lightweight moorings (model: 240.64.850) to hold 5 knot buoys in rough environmental conditions. Moorings were eventually pulled out (but did last longer than other moorings used for the buoys in this area).  See Section 4 and Appendix 2 for further information and diagram.
Seagrass Friendly Mooring Systems  Des Maslen, 0418232854, <a href="mailto:desmond@seagrassmooring.com.au">desmond@seagrassmooring.com.au</a> , <a href="http://www.seagrassmooring.com.au">www.seagrassmooring.com.au</a> .	Single mooring post screwed into place. Set of load spreaders attached to mooring post just below the sea bed. Shock absorber attached to a swivel head. Hawser rope running from shock absorber to surface buoy.  No diver required for installation or service.	\$1500 for supply and installation. Price may be brought down to \$1250-1300 if mass produced. \$150 service fee (not including parts).  Designed to hold boats up to 40'; but has shown to successfully hold an 80' vessel for a few hours a day.	Two boat moorings currently in use and show positive results, with one of them used by an 80' commercial catamaran. The catamaran uses this mooring temporarily during the day, before returning to a nearby marina (note: the owner of this boat was concerned that the hold rope was not sufficient, so it was upgraded. There have been no more concerns).  MPA installed 45 marker anchor point and light duty moorings in Port Stephens – Great Lakes Marine Park. Results are positive (they withstood the July 2007 storms) (D. Maslen <i>pers. comm.</i> , Dec 2007, Jan 2008).  MPA about to trial 20 courtesy moorings in the PSGL Marine Park. Hunter/Central River CMA planning to replace 20-30 private moorings in demonstration sites.  See Section 4 and Appendix 2 for further information and diagram.
Traditional block and chain	Heavy block sits on seafloor, attached to heavy chain attached to riser chain and rope, attached to mooring buoy.	According to Central Coast Moorings & Salvage ( <i>pers. comm.</i> Dec 2007) supply and installation costs \$750 + GST for boats up to 30ft. Boats around 40ft would cost about \$900 + GST (it generally goes up in \$250 increments per extra block). \$150 service fee (not including parts).	Further information: Central Coast Moorings & Salvage, <a href="http://www.centralcoastmoorings.com.au/">www.centralcoastmoorings.com.au/</a>  Robbie Sexton, Mooring contractor, Ph (02) 9973 4938, Mobile 0415 412 330.

Francour *et al.* (2006) summarises various mooring types that are suitable for different environments in marine protected areas of the Mediterranean Sea. For *Posidonia* seagrass areas they recommend a mooring design called the 'steel coil anchor Harmony type P'. This design involves a steel corkscrew-like structure/s that screws into the seabed, with an attached cord that does not drag on the ground. The cost of this mooring type is relatively expensive. Francour *et al.* (2006) estimates that the cost of supplies range from 300 to 1500 Euros (\$515 – \$2575) depending on boat size. This price does not include installation, tax and delivery. Divers are required for installation.

## 4. CASE STUDIES

The following provides examples of past, current and planned future SFM use in various jurisdictions.

### 4.1. GIPPSLAND LAKES, VICTORIA

For the past few years Gippsland Ports has been replacing 4 courtesy moorings every year with the Seaflex design. Originally they had trialled one Seaflex mooring and one Ezyrider mooring. The public preferred the Seaflex design because it held the mooring connection above water where it was easy to collect. The Seaflex moorings have so far proven to work well and there have not been any problems in terms of their capacity to hold boats in all conditions (S. Campisi *pers. comm.* Feb 2008).

In the past 6-8 months, Gippsland Ports has been introducing the requirement for all new and replacement moorings to be a seagrass friendly design (not necessarily Seaflex). New boat owners have not voiced any opposition, but it has been observed that old and current boat owners are now paying extra attention to the maintenance of their (block and chain) moorings, so they do not require replacement (S. Campisi *pers. comm.* Feb 2008).

Gippsland Ports plans to eventually set a cut off date for all moorings in Gippsland Lakes to be replaced with SFM designs. The purpose of the switch to SFMs is not only for the protection of benthic habitat but also for space. Block and chain moorings take up a larger space than SFMs and this is becoming a greater problem as demand for mooring sites increases in Gippsland Lakes (S. Campisi *pers. comm.* Feb 2008).

Further information:

Stephen Campisi, Works Inspector, Gippsland Ports, Vic, Ph (03) 51556914, Mobile 0409 423 121, Email [stevec@gippslandports.vic.gov.au](mailto:stevec@gippslandports.vic.gov.au).

### 4.2. PORT PHILLIP BAY & WESTERN PORT, VICTORIA

Parks Victoria previously purchased several Port-a-Moor moorings (model 240.64.850) to anchor several 5 knot buoys occurring in a problematic area (strong currents, hard sand etc). While these moorings held tight for a significant amount of time, they did eventually let go (W. Hill *pers. comm.* Mar 2008). It was concluded that these moorings were suitable for temporary rather than permanent mooring. Parks Victoria has not used the Port-a-Moor model designed for larger vessels (model 380.128.885) (W. Hill, *pers. comm.* Mar 2008).

Parks Victoria has installed several EzyRider moorings (for courtesy moorings) in Port Phillip Bay and Western Port. These moorings occur in a range of environments including areas that are exposed to strong currents and abrasive sediments. The moorings are serviced annually and have not experienced any problems (W. Hill *pers. comm.* Mar 2008).

W. Hill (*pers. comm.* Mar 2008) mentioned that there are several issues relating to moorings that need to be addressed: it is not uncommon for moored vessels to break free (if they are not maintained properly); there is increasing demand on space for moorings (SFMs use a much smaller swing space than traditional block and chain moorings); block and chain moorings in sensitive benthic environments are environmentally unacceptable. W. Hill (*pers. comm.* Mar 2008) suggested that a national standard is required for moorings to address all these issues. The standards could involve an efficiency rating (relating to space), safety rating and environmental rating. The ultimate goal would be that the states require mooring designs to pass the national standards, in order for a licence to be issued.

Further information:

Wayne Hill, Parks Victoria, Ph 0419 211 503, Email [whill@parks.vic.gov.au](mailto:whill@parks.vic.gov.au).

### 4.3. JERVIS BAY MARINE PARK, NSW

The MPA in collaboration with NSW Maritime and the Jervis Bay Cruising Yacht Club have installed 3 courtesy Jeyco moorings in Jervis Bay Marine Park. The purpose of the trial is to demonstrate environmental best practice for mooring design and installation to boat owners. The project is also involving community education on the impacts associated with poor mooring design. MPA are hoping

that the demonstration will instil confidence among boat owners to upgrade to environmentally friendly designs over time. The project will compliment the development of a JBMP Mooring and Anchoring Strategy, which is being prepared in partnership with NSW Maritime.

Jervis Bay MPA had originally planned to install EzyRider moorings. However, when drilling them into the seabed they hit a shale/rock substrate and were only able to install one of these moorings (it would be expensive to hire mechanical assistance to get the rest in). The EzyRider mooring subsequently experienced problems with the wearing of the elasticised component of the apparatus. The Jeyco moorings have so far worked well and there are plans to install three more (F. Clements *pers. comm.* Feb 2008).

Further information:

Fran Clements, MPA Jervis Bay Marine Park, Ph (02) 4441 8525.

#### **4. 4. HUNTER / CENTRAL RIVERS REGION, NSW**

Hunter/Central Rivers CMA is committing \$65,000 to set up demonstration site/s to trial Des Maslen's Seagrass Friendly Systems design. At this stage they are planning to replace 20 to 30 existing (private) moorings. The location of these sites has not yet been determined (B. Hughes *pers. comm.* Feb 2008).

Further information:

Brian Hughes, Hunter /Central Rivers CMA, Ph (02) 6551 8994 ext. 222, Email [brian.hughes@cma.nsw.gov.au](mailto:brian.hughes@cma.nsw.gov.au)

#### **4. 5. PORT STEPHENS – GREAT LAKES MARINE PARK, NSW**

The MPA are about to replace 20 courtesy moorings in the PSGL Marine Park with Des Maslen's (Seagrass Friendly Systems) SFM. The project will commence once engineering certification of the SFM design is completed (M. Haste *pers. comm.* Feb 2008).

Further information:

Max Haste, Manager, PSGL Marine Park, Ph (02) 4916 3970.

#### **4. 6. ROTTNEST ISLAND, WA**

Hastings *et al.* (1995) indicated that moorings had caused the loss of 18% of seagrass at Rottneest Island, with individual scour circles ranging from 3m<sup>2</sup> to 300m<sup>2</sup> in area. Moorings have since been regulated under standard environmental and safety criteria set by the Rottneest Island Authority Moorings Policy 1 July 1997 (the Policy) (Note: the Policy is currently under review and is confidential at this stage). The Policy was developed to address a range of mooring related issues, including seagrass damage. The Policy required all mooring apparatus to be of an “*environmentally friendly low-impact type approved by the Authority*” by July 2000. The Policy also stated “*the mooring licensee will be responsible for any upgrade required*”.

Moorings licensees are required to have their mooring certified annually, against the criteria, by a mooring contractor. Part of this certification requires that the riser chain does not scour the seafloor (Rottneest Island Authority 2003).

The Rottneest Island Authority manages approximately 900 swing moorings under issue of licence. Licensees are generally achieving environmental certification by installing apparatus that involve pinning ground chains to minimise movement and erosion, with the inclusion of a mid-water float to stop the riser chain coming in contact with the seabed. A number of mooring sites also use the EzyRider system (K. Shadbolt, *pers. comm.* Feb 2008).

According to K. Shadbolt (*pers. comm.* Feb 2008) the EzyRider system is preferred over the pinned down ground chains as it incorporates a rubberised dampener. The apparatus incorporating pinned down chains does not have dampening capabilities. The mooring sites at Rottneest Island occur in sheltered bays without extreme weather conditions, so there has not been any problems, however in a more exposed area a dampener system would be necessary. The EzyRider system also holds a greater effect on minimizing impact on the surrounding seabed.

Liability is handed to the mooring licensee who must ensure that the service frequency of their mooring suits local environmental conditions. Moorings must be, as a minimum, serviced annually along with certification, however mooring contractors may recommend more frequent servicing if local environmental conditions warrant it. While there are currently no set standards in Australia guiding appropriate frequency of mooring servicing in different environments, the Authority provide licensees with a list of experienced contactors that can provide advice based on years of experience in the field. The Authority manages 25 rental moorings and has these serviced every 3 months as best practice. Since the inception of the Policy, there have been no major problems in Rottnest Island, with the holding capacity of either type of SFM (aside from the occasional situation, which is common for all types of moorings. These have all related to minor wearing of EzyRider shackles and swivels).

Keith Shadbolt (*pers. comm.* Feb 2008) from the Rottnest Island Authority is currently convening a Moorings Management Forum with the Great Barrier Reef Marine Park. The purpose of this Forum is to share ideas on how the issue of moorings management (in terms of environmental impact) is addressed, particularly with increasing pressure on maritime infrastructure and facilities. It is intended that the forum will take place in April/May 2008 in Airlie Beach, Qld. Representatives from all related Government agencies are invited to take part. Keith suggested that NSW become involved in the Forum.

Further information:

Keith Shadbolt, Rottnest Island Authority, Ph (08) 9372 9723, Email [keith.shadbolt@rotnnestisland.com](mailto:keith.shadbolt@rotnnestisland.com).

#### 4.7. MORETON BAY MARINE PARK, QLD

The Qld Transport Agency is responsible for the issuing of mooring licences in Qld. The Agency refers all mooring licence applications to the Qld DPI, to ensure the mooring is not placed in seagrass (fisheries legislation in Qld prohibits damage to marine vegetation). In theory, DPI does not allow any type of mooring to be placed in seagrass (even SFMs as they may cause some damage). DPI requires a statement from the applicant that the mooring will not be placed in a seagrass area. Random checks are carried out to ensure compliance and have revealed that applicants often state that the mooring will not occur in seagrass when in fact they do. Furthermore, mooring blocks are often not placed in the exact position they were meant to and cause scouring to adjacent seagrass (S. Mckinnon *pers. comm.* Feb 2008).

The Qld EPA is currently revising the zoning plan for the Moreton Bay Marine Park and is looking at the possibility of including designated seagrass areas where private moorings are required to be seagrass friendly. In conjunction with this, DPI plan to develop a self assessable code whereby a maximum 1m<sup>2</sup> area of disturbance will be permitted during mooring installation. The Qld EPA and Qld DPI will treat Moreton Bay Marine Park as a trial for this system (S. Mckinnon *pers. comm.* Feb 2008).

Nicola Udy (*pers. comm.* Feb 2008) from EPA (Moreton Bay Marine Park) has suggested getting the engineering section of University of Qld (and possibly a university in NSW) involved in research on the effect of different sediments, weather patterns, etc. on SFM apparatus, in order to determine how well they work.

Further information:

Nicola Udy, Qld EPA, Moreton Bay Marine Park, Ph (07) 38219024, Email [nicola.udy@epa.qld.gov.au](mailto:nicola.udy@epa.qld.gov.au).

Scott Mckinnon, Qld DPI, Ph (07) 3817 9528, Email [scott.mckinnon@dpi.qld.gov.au](mailto:scott.mckinnon@dpi.qld.gov.au).

## 5. PRIORITY SITES

For reasons outlined in section 2.3 of this report, protection of *P. australis* from boat moorings may need to be considered a priority over other species of seagrass.

Priority areas have been suggested for each CMA area using information from West's (2007) mapping of seagrass distribution in NSW and NSW Maritime information on mooring locations (NSW Maritime website). Pure and mixed *P. australis* stands occurring in mooring areas are considered highest priority.

Pure *P. australis* beds are referred to as *Posidonia*; mixed assemblages of *P. australis* and *Halophila spp* are referred to as *Posidonia/Halophila*; mixed assemblages of *P. australis*, *Zostera spp* and *Halophila spp* are referred to as *Posidonia/Zostera/Halophila*.

The number of moorings in each priority area has been recorded as well as the number of applicants on waiting lists (information obtained from NSW Maritime website). Note that in several areas the demand for mooring sites exceeds the number of moorings available. Using Google Earth™ it was possible to make rough estimates of the number of boats moored in some seagrass areas but this can not be confirmed without further on-ground assessment.

Note that the selection of priority sites may also need to take into account other factors such as local boating community consideration.

Locations of these sites are shown in Appendix 1.

## 5.1. HUNTER / CENTRAL RIVERS CMA AREA

### Lake Macquarie

#### BELMONT BAY

- 250 private moorings, 7 applicants on waiting list.
- West's (2007) mapping in Belmont Bay clearly shows a fragmented distribution that is likely to be caused by moorings (see fig. 1). Google Earth™ images show a large number of circular scours throughout the seagrass meadow (see fig. 2). Note that several of these scours have joined to form larger holes.
- Belmont Bay has some of the state's most significant beds of *Posidonia* (Waterways Authority, no date).
- The Lake Macquarie Mooring Management Plan (Waterways Authority, no date) states in response to the need to mitigate impacts on seagrass: "*Once a suitable EFM [environmentally friendly mooring] is approved this style of apparatus would be phased in gradually following extensive consultation with the boating public and government agencies. Upon releasing their findings a strategy will be developed to best manage the introduction of EFMs in Lake Macquarie.*"
- The area is used extensively by vessels involved in organised races and regattas, with Belmont 16' Sailing Club and Lake Macquarie Yacht Club using this waterway intensively. Members of the Yacht Club value moorings in close proximity to the club (Waterways Authority, no date).

#### SWANSEA

- There are 2 mooring areas in Swansea: Swansea Flats – 49 moorings, 1 applicant on waiting list and Swansea Caravan Park – 3 moorings, no more applications accepted.
- *Posidonia* occurs off the coast a bit with a very fragmented distribution. It is unclear as to what mooring area/s the seagrass may occur in.

Posidonia areas in Lake Macquarie that aren't affected by moorings:

Spectacle Island

Pelican Island

#### Some extra information on Lake Macquarie

Steffe and Chapman (2003) carried out a recreational fishing survey in Lake Macquarie during the annual period, March 1999 to February 2000 and found that fishing effort was relatively high when compared to other estuarine studies. The daytime recreational harvest was 8% greater than the declared commercial catch. The study indicates that the Lake Macquarie fishery is an extremely important and popular recreational fishery, despite complaints from recreational fishers about perceived declines in the quality of this fishery. Blue swimmer crab, luderick and yellowfin bream made up the greatest proportion of catch, dusky flathead, common squid, sand mullet, trumpeter whiting, yellow-finned leatherjacket, snapper and tailor are also important.

Newham *et al.* (2005) reviewed the effectiveness of the Lake Macquarie Improvement Project (the Project) that was established in 1998 to address issues affecting health of Lake Macquarie. The Project included stormwater treatment, erosion protection works, dredging, water quality monitoring and community education. Newham *et al.* (2005) found that the project led to a 72% increase in *Posidonia* coverage, particularly in northern areas.

## Port Stephens:

### SHOAL BAY

- 72 moorings, 0 on waiting list.
- Strip of *Posidonia* on eastern half of bay. Strip of *Posidonia/Zostera/Halophila* next to that.
- Google Earth™ images show circular scours caused by moorings within the *Posidonia* and *Posidonia/Zostera/Halophila* patches.
- MPA are about to replace courtesy moorings in Shoal Bay with SFMs (see section 4 of this report).

### LITTLE SALAMANDER

- 108 moorings, 6 on waiting list.
- Strip of *Posidonia* all around Salamander Bay and continues up Soldiers Point.
- Google Earth™ images indicate that approximately 15 moorings occur within *Posidonia* areas.

### SOLDIERS POINT WEST

- 62 moorings, 10 on waiting list.
- Several patches of *Posidonia*. Small patch of *Posidonia/Halophila* at tip of point.
- Google Earth™ images indicate that the majority of moorings do not occur in *Posidonia* areas. However a significant number do occur in bare sand areas in between *Posidonia* areas. This could either indicate that Boating Service Officers have intentionally avoided *Posidonia* areas or that seagrass has been reduced by moorings. Nearby, a number of moorings extend into a *Zostera* bed and seem to have resulted in a long line of bare sand through the bed.

### CORLETTE

- 29 moorings, 2 on waiting list.
- Strip of *Posidonia* along Corlette, stops at Marina and then starts again after Marina and continues around Corlette Point.
- At least 5 of these moorings occur in *Posidonia*.

### PINDIMAR

- 11 moorings, 0 on waiting list.
- Strip of continuous *Posidonia* all around Pindimar Bay, continuing around Orungall Point, Lower Pindimar and ending at Piggys Beach.
- It is unclear as to how many of these moorings occur in *Posidonia* areas.

### *Posidonia* areas in Port Stephens that aren't affected by moorings:

Tanilba Bay – while there are 36 moorings in the Tanilba none seem to occur in *Posidonia* areas (according to Google Earth™ images).

Nelson Bay and Fly Point – *Posidonia* and *Posidonia/Zostera/Halophila*. According to NSW Maritime website there are no private moorings and applications are closed. Also further out from the shore there is a large patch of *Posidonia/Zostera/Halophila*.

Bagnalls Beach – long, continuous *Posidonia* strip.

Winda Woppa – patch of *Posidonia/Halophila*.

Corrie Island and Cut Feet Island there are 2 large patches of *Posidonia* and some patches of *Posidonia/Halophila*.

Mud Point – big patch of *Posidonia*.

North of Bulls Island – patch of *Posidonia*.

Mallabula, Lemon Tree Passage (away from mooring area) – strip of *Posidonia*.

Snapper Island – thin strip of *Posidonia/Halophila*.

Tanilba Point – thin strip of *Posidonia/Halophila*.

Carrington – thin strip of *Posidonia*.

Garden Island – thin strip of *Posidonia*.

Balberook Cove – *Posidonia* strips on either side of cove entrance.

Heroes Bay and Baromee point – Thin strip of continuous *Posidonia*.

Fame Cove – thin strip of *Posidonia*.

### **Forster/Manning**

There are no *Posidonia* areas affected by moorings in Forster/Manning.

Big Island – large patches of *Posidonia*.

Wallis Island – large patches of *Posidonia* out from the east side of the island.

Yahoo Island – patchy *Posidonia* around all sides of island.

Snake Island – patchy *Posidonia*

Coomba Park – small separated patches of *Posidonia*. While there are 13 moorings in the area, none appear to occur in *Posidonia*.

### **Brisbane Water**

#### **SARATOGA**

- 104 moorings, 5 applicants on waiting list.
- Very patchy, long *Posidonia* strip which continues along Paddy's Channel.
- Impact from moorings is visible in fig. 3.

#### **POINT CLARE**

- 37 moorings, 1 applicant on waiting list.
- The long continuous *Posidonia* strip occurring here is very patchy in some areas.

#### **TASCOTT**

- 31 moorings, 0 applicants on waiting list.
- Long strip of *Posidonia* occurs just around the corner from the Point Clare strip and is patchy in some areas.

#### **GREEN POINT**

- 56 moorings, 0 applicants on waiting list.
- Very long, continuous *Posidonia* strip.

#### **YATTALUNGA**

- 16 moorings, 1 applicant on waiting list.
- Continuous, big *Posidonia* strip.

## KINCUMBER

- 12 moorings, 0 applicants on waiting list.
- Long, very continuous *Posidonia* strip occurs on the north/west side as well as a very fragmented long *Posidonia* strip on Kincumber South.

## BENSVILLE

- 18 moorings, 0 applicants on waiting list.
- Very patchy but large *Posidonia* area.

## EMPIRE BAY

- 41 moorings, 0 applicants on waiting list.
- Large, patchy *Posidonia* in some areas.

## DAVISTOWN

- 72 moorings, 0 applicants on waiting list.
- Large *Posidonia* patch towards the west, along the side of the point.

## LINTERN STREET

- 15 moorings, 0 applicants on waiting list.
- Very patchy *Posidonia*.

## VETERAN HALL

- 5 moorings, 0 applicants on waiting list.
- Little patchy bits of *Posidonia*.

### *Posidonia* areas in Brisbane Water that aren't affected by moorings:

Point Frederick (tiny patches of *Posidonia*).

Peaks Point (tiny patches of *Posidonia*).

Woy Woy (*Posidonia* occurs along the Woy Woy inlet but not in Woy Woy Bay).

## Summary

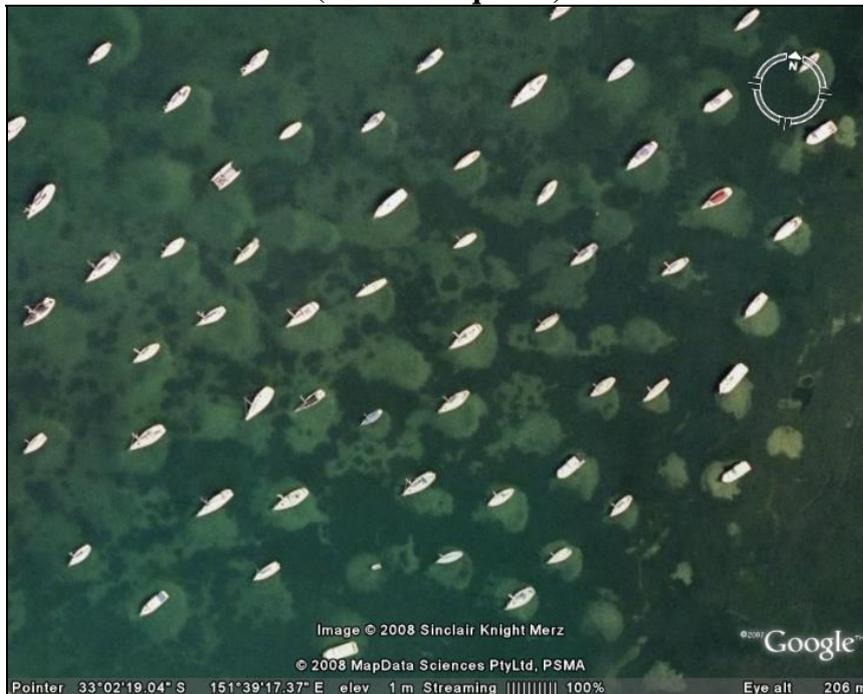
The highest priority area in the Hunter / Central Rivers CMA area is clearly Belmont Bay in Lake Macquarie. West's (2007) mapping and Google Earth™ images clearly indicate a significant amount of mooring damage to the *Posidonia* bed in Belmont Bay. Belmont Bay is used intensively by the boating community and Lake Macquarie provides an important recreational fishery. While areas in Port Stephens are lower priority, there are sites that warrant attention (particularly Shoal Bay and Little Salamander). Overall though, *Posidonia* is relatively well represented in areas of Port Stephens that are free of moorings. There are no priority sites in the Forster /Manning area, whilst in Brisbane Water, Saratoga may be considered highest priority as damage caused by moorings is also visible.

**Figure 1: Seagrass distribution in Belmont Bay (Lake Macquarie)**

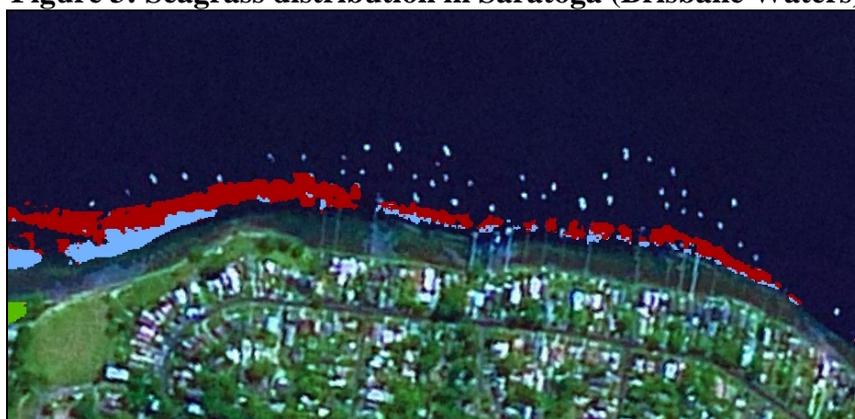


■ *Posidonia*    ■ *Zostera*    ■ *Ruppia*    ■ *Zostera/Halophila*

**Figure 2: Circular scours (in *Posidonia* bed) caused by moorings in Belmont Bay (Lake Macquarie)**



**Figure 3: Seagrass distribution in Saratoga (Brisbane Waters)**



1:4,781

West (2007)



## 5.2. HAWKESBURY-NEPEAN CMA AREA

### Pittwater

#### CAREEL BAY

- 250 moorings, 20 applicants on waiting list.
- Very large area of *Posidonia*. Fragmentation from moorings is evident from West's (2007) mapping (see figs 4 and 5).
- Council's Careel Bay Wetlands Plan of management states

*"Amongst the seagrasses, the presence of Posidonia is of high significance given the susceptibility of Posidonia to disturbance, and the fact that the site is approaching the northern limit of the species."*

*"Changes in the distribution of seagrasses at Careel Bay have been less pronounced. The most obvious change has been the reduction of the area of Posidonia seagrasses in the southwestern corner of the beds ... The loss corresponded to the increasing numbers of boats moored in this area." (Smith and Smith, 1997).*

- In the minutes to the Pittwater Water User Group meeting, 15<sup>th</sup> October 2007 it was noted that there is some concern that Careel Bay may not be a suitable site for SFM trials for the moment because of the controversial Marina proposal as well as *Calerpa* infestation. They suggested Barrenjoey/Station Beach, Great Mackerel Beach and Portugese Beach as alternative sites (note: Barrenjoey only has 2 moorings and further applications are closed).

#### CLAREVILLE

- 649 moorings, 12 applicants on waiting list.
- Very long strip of extremely patchy *Posidonia* extends along Paradise Beach, Long Beach and Taylors Beach, and around Taylors Point.
- Fragmentation from moorings is evident from West's (2007) mapping and Google Earth™ images (see figs. 4, 6 and 7).

#### REFUGE COVE

- 131 moorings, 0 applicants on waiting list.
- *Posidonia* only occurs on the southern, outer entrance and is patchy.

#### SALT PAN COVE

- 268 moorings, applications closed.
- Joins up with seagrass/moorings at Refuge Cove (along South Beach).
- A lot of *Posidonia* as well as *Posidonia/Halophila* around Salt Pan Point.

#### HORSE SHOE COVE (Green Point)

- 47 moorings, 30 on waiting list.
- Small, very patchy *Posidonia* bits.

#### BAYVIEW

- 268 moorings, 67 on waiting list.
- Big, long *Posidonia* patches on each side – one along the side and around Church Point, other one is more east but not as far as Bayview Wharf. In the middle of this there is a *Posidonia/Halophila* Patch.

#### SCOTLAND ISLAND

- 129 moorings, 0 on waiting list.
- Long *Posidonia* patches around south and north areas.

#### ELVINA BAY

- 26 moorings, 0 on waiting list.
- Small *Posidonia* area in along south side of bay and a continuous strip extending around Rocky Point.

#### LOVETT BAY

- 64 moorings, 0 on waiting list.
- *Posidonia* patches along southern side of bay, extending from Rocky Point. Some areas are patchy. Then a long continuous *Posidonia* strip in Little Lovett Bay and continuing around Woody Point.

#### MORNING BAY

- 13 moorings, 0 on waiting list. Applications for waiting list are closed.
- Good continuous *Posidonia* patches, extending from Woody Point and big patches along southern side of bay. A thin strip extends all around the bay, along Towlers Lookout and stops at Longnose Point.

#### COASTERS RETREAT

- 39 moorings, 0 on waiting list.
- *Posidonia* only occurs along the north western side where there is a very big, long continuous bed which extends up to Currawong Beach. *Posidonia* in the bay area is patchy.

#### GREAT MACKERAL BEACH

- 30 moorings, 0 on waiting list.
- Small bits of pure *Posidonia*. Most of it is *Posidonia/Halophila*.
- In the minutes to the Pittwater User Group Meeting, 15<sup>th</sup> Oct, Mackerel Beach was suggested as a preferred site for SFM trials (instead of Careel bay).
- Fragmentation from moorings is evident from Google Earth™ image (see fig. 8).

Posidonia areas in Pittwater that aren't affected by moorings:

Barrenjoey – Massive area of *Posidonia* (largest patch in Pittwater). There are only 2 moorings in the area and applications for more are closed.

Sandy Beach – strip of *Posidonia/Halophila*.

Horseshoe Cove – small continuous *Posidonia* patch.

**Summary**

Pittwater is the main priority area in the Hawkesbury Nepean CMA with several mooring sites occurring in *Posidonia* beds (see fig. 7). In particular, Careel Bay and Clareville are visibly affected by moorings. Further on-ground assessment may find that several other sites in Pittwater may also be high priority.

**Figure 4: Seagrass distribution in Pittwater**



1:48,638

West (2007)



*Posidonia*

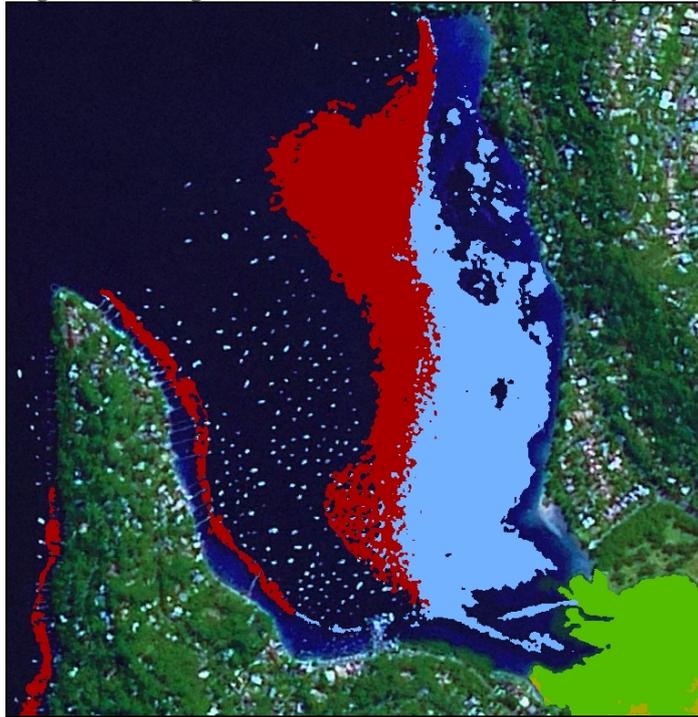


*Posidonia/Halophila*



*Zostera*

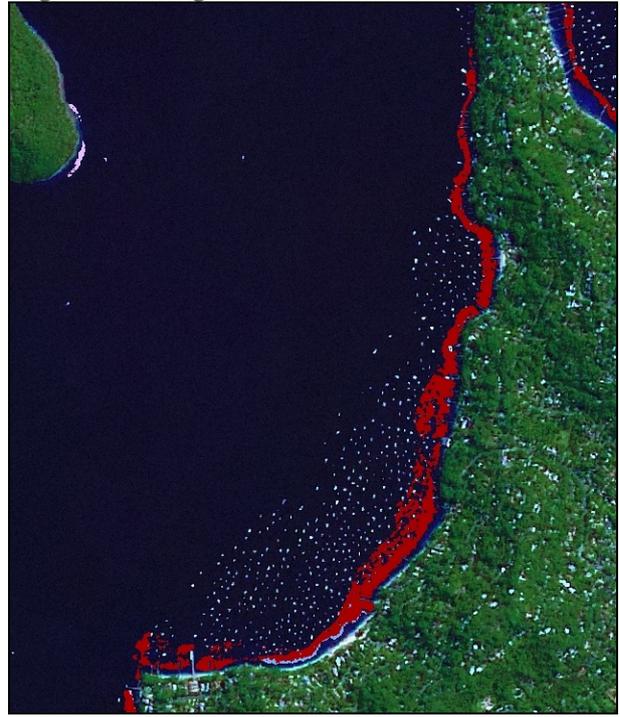
**Figure 5: Seagrass distribution in Careel Bay**



1:7,427

West (2007)

**Figure 6: Seagrass distribution in Clareville**



1:11,268

West (2007)



*Posidonia*



*Zostera*

**Figure 7: Circular scours (in *Posidonia* bed) caused by mooring in Clareville**



**Figure 8: Circular scours (in *Posidonia* bed) caused by moorings in Mackerel Beach**



## 5.3. SYDNEY METROPOLITAN CMA AREA

### East of Harbour Bridge, Middle Harbour

#### MANLY COVE

- 87 private moorings, 36 applicants on waiting list.
- Large majority of moorings occur in *Posidonia/Zostera/Halophila* area – very visible fragmentation is clearly caused by moorings (see figs. 9 and 11).
- Large patch of *Posidonia/Halophila* also on western side of Smedleys Point.

#### WATSONS BAY

- 131 private moorings, 36 applicants on waiting list.
- *Posidonia* only occurs along the northern side of bay (along southern side of Laings Point). *Posidonia/Halophila* occurs on the southern tips of bay (along Gibson's and Kutti Beaches).
- Approx 80 moorings may be in these seagrass areas.

#### VAUCLUSE BAY

- 72 private moorings, 36 applicants on waiting list.
- *Posidonia* occurs along the western side of the bay. Fragmentation is very visible in West's (2007) mapping and looks likely to be from boat moorings.
- Probably about 2 thirds of the moorings occur in *Posidonia* area.

#### NORTH HARBOUR

- 111 private moorings, 104 applicants on waiting list.
- *Posidonia* areas at The Manly Boatshed (approximately 20 moorings in *Posidonia*) and Forty Baskets Beach (approximately 4 moorings on *Posidonia*).
- *Posidonia/Halophila* occurs near Davis Marina. There are approximately 10 moorings in this bed.

#### HERMIT BAY

- 31 private moorings, 14 applicants on waiting list.
- *Posidonia/Halophila* covers a large area of the bay.
- Approximately 10 moorings occur in *Posidonia*.

#### LITTLE MANLY COVE

- 33 private moorings, 16 applicants on waiting list.
- *Posidonia/Halophila* only occurs on the west side of the cove, where most of moorings are.
- Approximately 7 moorings occur in *Posidonia/Halophila*.

#### SAILORS BAY

- 63 moorings, 15 applicants on waiting list.
- *Posidonia* only occurs in a small area on the north side of the bay entrance. About 6 moorings occur in this area.

#### SUGARLOAF POINT

- Approx 15 moorings in *Posidonia/Halophila* area.

#### POWDER HULK BAY

- 105 moorings, 5 on waiting list.
- Approximately 7 moorings occur in small *Posidonia/Halophila* bed.

*Posidonia* areas east of the Harbour Bridge and Middle Harbour that are not affected by moorings:

Sugarloaf Bay – couple of tiny patches of *Posidonia* on north side of bay. While there are 26 moorings, none occur in *Posidonia*.

Spring Cove – Quarantine Beach (small patch of pure *Posidonia*, the rest is *Posidonia/Halophila*), Store Beach and Collins Beach (large strip of *Posidonia/Zostera/Halophila* and a small strip of *Posidonia/Halophila*).

Fisher Bay and Sandy Bay – tiny *Posidonia* patches.

Chowder Bay, Chowder Head and Taylors Bay – tiny bit of *Posidonia*.

Queens Beach and north of Hermit Bay – tiny patch of *Posidonia*.

Jibbon Beach – massive *Posidonia* bed.

**Port Hacking:**

**GUNNAMATTA BAY**

- 276 private moorings, 53 applicants on the waiting list.
- Very patchy *Posidonia/Zostera/Halophila* at the entrance of the bay (no moorings occur here). *Posidonia* occurs at the back of the bay (near moorings).
- Has lost significant amounts of *Posidonia* since 1951 (Meehan and West 2002).
- Fig. 10 shows the current distribution of *Posidonia* in the bay.

**BURANEER BAY**

- 184 moorings, 5 applicants on waiting list.
- *Posidonia* occurs on either side of the entrance and at the back of the bay and is a bit patchy.
- Has lost significant amounts of *Posidonia* since 1951 (Meehan and West 2002).
- Fig. 10 shows the current distribution of *Posidonia* in the bay.

**LILLI PILLI**

- 32 moorings, 6 applicants on waiting list.
- Continuous long strip of *Posidonia*.
- Has lost significant amounts of *Posidonia* since 1951 (Meehan and West 2002).

**LITTLE TURRIELL BAY**

- 24 private moorings, 0 applicants on waiting list.
- Thin strip of *Posidonia*.
- Roberts and Lincoln Smith (2007) observed a large area of very dense *Posidonia*.

**GANNONS BAY**

- 26 moorings, 4 applicants on waiting list.
- Only a tiny strip of *Posidonia* occurs in the southern area of the bay.

**YOWIE BAY**

- 220 moorings, 21 applicants on waiting list.
- Strips of *Posidonia* occur along either side of the bay entrance. Tiny *Posidonia* strips occur at the back of the bay and one small strip along the east side.

**FISHERMANS BAY**

- 28 moorings, 0 applicants on waiting list.
- A strip of *Posidonia/Halophila* occurs on the western side of the bay.

Posidonia areas in Port Hacking that aren't affected by moorings:

South West Arm – some good quality *Posidonia* beds.

Costens Point – massive *Posidonia* bed.

Dark Bay, Carruthers Bay and Gogerleys Point – some *Posidonia* strips.

The Basin – tiny bits of *Posidonia*.

### Botany Bay

There does not appear to be any *Posidonia* areas occurring in mooring sites. While Botany Bay has lost 58% (an area of 2.5km<sup>2</sup>) of *Posidonia* cover between 1942 and 1986, this has been due to dredging, major storm events, eutrophication and sea urchin grazing (Larkum & West 1990). *Z. capricorni* has replaced much of the *P. australis* and covers an estimated of 3.09 km<sup>2</sup>.

Extensive *Posidonia* beds occur along Kurnell and in the Towra Point Aquatic reserve (Quibray Bay, Towra Point, Weeny Bay and Elephants Trunk). Seagrass in the reserve is protected in a Sanctuary Zone. A number of courtesy SFMs occur here.

### Summary

Manly Cove, Watson's Bay and Vaucluse Bay should be considered the highest priority sites in the Sydney Metro CMA area. The other sites listed for the area east of the Harbour Bridge and Middle Harbour may also warrant attention. In Port Hacking there is a relatively high density of moorings in Gunnamatta Bay and Burraneer Bay and *Posidonia* beds have been significantly reduced (not necessarily by moorings). Other areas in Port Hacking may also warrant attention, however there are some relatively large areas of *Posidonia* in Port Hacking that occur in areas without moorings (particularly Costens Point).

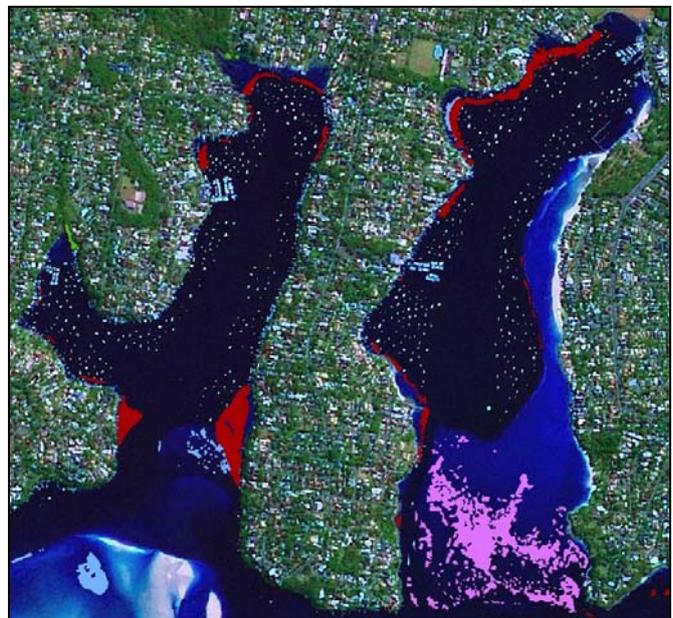
**Figure 9: Seagrass distribution in Manly Cove**



1:3,867

West (2007)

**Figure 10: Seagrass distribution in Burraneer Bay and Gunnamatta Bay (Port Hacking)**

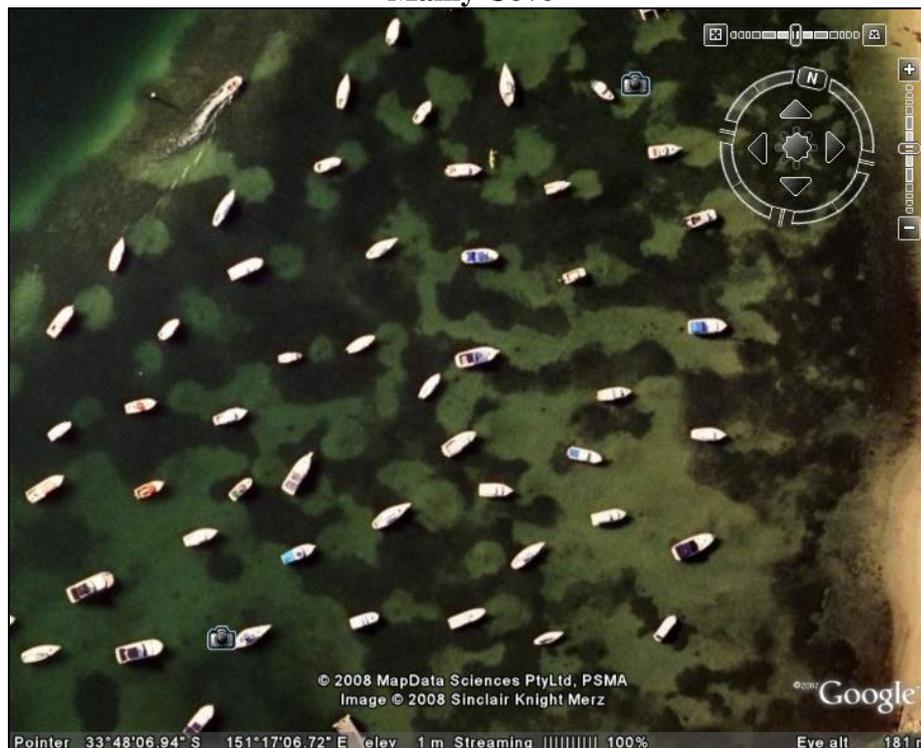


1:11,002

West (2007)

*Posidonia*
 *Posidonia/Zostera/Halophila*
 *Zostera/Halophila*
 *Zostera*

**Figure 11: Circular scours (in *Posidonia/Zostera/Halophila* bed) caused by moorings in Manly Cove**



#### 5.4. SOUTHERN RIVERS CMA AREA

##### Bomaderry

###### JERVIS BAY

- 23 moorings, 0 waiting list.
- Large *Posidonia/Halophila* patch on the west side of Hare Bay. All the moorings in Jervis Bay occur right in this area.
- MPA in Jervis Bay has replaced 3 courtesy moorings in the Jervis Bay Marine Park and there are plans to install more (see section 4 of this report).
- There are other areas in Jervis Bay that aren't affected by moorings: a massive *Posidonia* bed on the north-east area of Hare bay (in marine park sanctuary zone, no anchoring allowed here) and *Posidonia/Zostera/Halophila* patch mid-north area of Hare Bay; *Posidonia* patch at Barfleure Beach; long strip of *Posidonia* at Darling Road (south of bay); patch of *Posidonia/Zostera/Halophila* at Murrays Beach (south of bay); patch of *Posidonia/Halophila* west of Bowen Island (south of bay).

###### *Posidonia* areas in Bomaderry that aren't affected by moorings:

St Georges Basin – Strips of *Posidonia* all around the Basin (particularly long strip on east side). While there are 68 private moorings in the Basin they do not appear to occur in any *Posidonia* areas.

Sussex Inlet – Large continuous beds of *Posidonia*. While there are 87 private moorings in Sussex Inlet they do appear to be impacting on the beds. From looking at Google Earth™ images they look like they are moored to jetties.

##### Batehaven

No areas of *Posidonia* in Batehaven are affected by moorings.

Corrigans Beach (Batemans Bay) – patches of *Posidonia*, *Posidonia/Zostera/Halophila* and *Posidonia/Halophila*.

## Narooma

### FORSTERS BAY SOUTH

- 22 moorings, 0 on waiting list.
- A small number of moorings appear to occur in *Posidonia* bed (approx. 10).
- *Posidonia* is continuous and stretches around the whole Bay.

#### Posidonia areas in Narooma that aren't affected by moorings:

Wagonga Inlet and Wagonga Inlet East – large amount of continuous *Posidonia*, stretching around most of the inlet. There does not appear to be many (or any) moorings in these areas. There are 27 private moorings in Wagonga Inlet.

Bermagui River – patches of *Posidonia/Halophila*, and long continuous bed of *Posidonia* near mouth of River.

## Eden

### 3. MERIMBULA EAST

- 57 moorings, 0 on waiting list.
- There is a large amount of *Posidonia* in this area, but it is hard to tell whether the boats are actually moored in the beds.

#### Posidonia areas in Eden that aren't affected by moorings:

Merimbula West – large amount of *Posidonia* here and there does not appear to be any (or many) boats moored in beds (although there are 8 moorings in Merimbula West).

Pambula River – continuous beds of *Posidonia* and *Posidonia/Zostera/Halophila*.

## Summary

The Southern Rivers should be considered a lower priority CMA area. There are 3 sites that may warrant attention however (Jervis Bay, Forsters Bay South and Merimbula East). While the MPA are gradually replacing courtesy moorings in Jervis Bay there are a significant number of private moorings in Hare Bay (which is in Jervis Bay) that impact on *Posidonia/Halophila*.

## 5.5. NORTHERN RIVERS CMA AREA

*Posidonia* does not occur in the Northern Rivers CMA area. Therefore this would be considered the lowest priority CMA area. Priority sites have not been listed here, however if funds permit there may be cause to allocate resources to important *Zostera* areas.

## Overall summary

The highest priority CMA areas are Hunter / Central Rivers, Sydney Metropolitan and Hawkesbury Nepean. There are several priority sites in the Sydney Metro and Hawkesbury Nepean areas. While there are a relatively small number of priority sites in the Hunter / Central Rivers CMA area, Belmont Bay (Lake Macquarie) should be considered one of the highest priority sites in NSW.

## **6. NSW STAKEHOLDERS**

### **6. 1. CATCHMENT MANAGEMENT AUTHORITIES**

- Hunter/Central Rivers CMA – committing \$65,000 to set up demonstration site/s to trial Des’s SFM design (see section 3 of this report).
- Sydney Metro CMA – keen for an incentive program or demonstration site/s.
- Hawkesbury Nepean CMA – keen for an incentive program or demonstration site/s in Pittwater.
- Southern Rivers CMA – funded an SFM trial at Jervis Bay Marine Park (see section 4 of this report).

### **6. 2. NSW MARITIME**

- Have been involved in several trials.
- According to the Waterways Authority (no date) NSW Maritime is seriously challenged by the need to meet the demand from the boating public for mooring sites, whilst fulfilling its responsibilities in relation to managing impacts that moorings have on the seabed.
- At this stage Maritime are not willing to introduce regulations to require SFMs in seagrass areas due to the higher cost they would impose on mooring licensees.

### **6. 3. MARINE PARKS AUTHORITY**

- About to replace 20 courtesy moorings in the Port Stephens – Great Lakes Marine Park with Des Maslen’s Seagrass Friendly System (see section 4 of this report).
- All (45) navigational markers in the PSGM Marine Park are on Des Maslen’s lightweight SFMs as ‘best practice’. These are lightweight versions of the design that holds boats and can hold up to 2 tonnes in weight (D. Maslen *pers. comm.* Dec 2008).
- MPA in Jervis Bay has replaced 4 courtesy moorings with Jeyco SFMs and plan to replace 3 more (see section 3 of this report).

### **6. 4. DEPARTMENT OF PRIMARY INDUSTRIES (FISHERIES) NSW**

- Have been involved in trials in the past.
- The Aquatic Habitat Rehabilitation Program is currently looking at the feasibility of SFMs.

### **6. 5. NSW BOAT OWNERS ASSOCIATION**

Notes from discussions at the BOA Committee meeting, 5<sup>th</sup> February 2008:

- Agree that the issue of mooring damage to seagrass is a problem.
- Not convinced that SFMs hold boats in all weather conditions. They need to be convinced that Des Maslen’s design will work.
- Want to be involved in discussions and decisions on what direction the issue should take.
- Feel that it is very important to assess the issue on an area by area basis, rather than applying the same plan to the whole state. This is mainly because environmental factors vary between areas and create different issues in terms of what is needed to hold boats. SFM designs might work in some areas and not in other areas. Thus they suggest that prioritisation should not only be based on seagrass species.
- Need to be convinced of the ecological benefit of SFMs.
- Are sending a letter to Joe Tripodi (Minister for Ports and Waterways) and Ian Macdonald to ask that they convene a stakeholder group to discuss what should be done. User groups, BOA, DPI, Maritime, CMAs etc. should be included in discussions.

- According to a BOA Committee member, “about 98%” of boat owners would be against paying more for a mooring.
- Are concerned that other potentially greater problems like *Caluierpa* will be ignored if too much attention is put on moorings (note: continuing research by DPI is beginning to indicate that *Caluierpa* has not affected seagrass distribution in NSW).

## 6. 6. LOCAL USER GROUPS

- These groups represent boaters in local areas and are made up of vessel operators, boat owners and mooring licensees. They act primarily as a means of communication between boaters and NSW Maritime.
- May be useful to consult with on any future programs/trials.
- Contact the BOA or NSW Maritime to obtain details on local groups.

## 8. CONCLUSION AND RECOMMENDATIONS

Seagrass extent has declined significantly in NSW and conservation of remaining beds (particularly *Posidonia*) should be considered a priority. While moorings are certainly not considered to cause the greatest impact on seagrass, research and documented anecdotal information indicates that they do have a significant impact on beds that would otherwise be intact.

There are a number of challenges to face when approaching this issue. SFMs are relatively expensive. Even Des Maslen’s cheaper design (Seagrass Friendly Mooring Systems) is approximately double the cost of a traditional block and chain mooring. NSW Maritime is currently stating that they will not introduce regulations to require SFMs in seagrass areas unless the cost is significantly closer to that of a traditional mooring. Support from boat owners in NSW is currently limited. The BOA has been clear in stating that boat owners would oppose paying more for a mooring. They also need to be convinced that SFMs would be safe in all weather conditions and that they have warranted ecological benefit.

Liability is an important issue to consider. To date, trials of SFMs have shown mostly positive results in terms of holding capacity. Des Maslen’s SFM will soon be installed by the MPA in the PSGL Marine Park and by the Hunter Central Rivers CMA in the CMA area. This will provide an opportunity to further test the design’s holding capacity. An ideal exercise would be to test this design against a range of environmental factors in order to gain confidence in its safety.

In addition to these challenges is the questionable ability of seagrass in some areas to recover. *Posidonia* takes a very long time to recover and may not be able to recover in some areas if environmental conditions do not permit. Any research and monitoring on ecological benefit would need to acknowledge this. Transplanting is very expensive and has had mixed results (S. Carter, *pers. comm.* Dec 2007).

A number of case studies have provided an example of how the issue may be addressed. For instance, Gippsland Ports, Victoria and the Rottneest Island Authority are successfully phasing in or have introduced requirements for SFMS. In both cases the impetus for this has not only been for environmental reasons but also space availability. Gippsland Ports has avoided too much opposition from the boating community by introducing new requirements very gradually, first for new licensees only and then eventually for all current mooring licensees. At Rottneest Island the issue of liability is resolved through a mooring certification process that holds the mooring contractor responsible for meeting design safety criteria and the licensee responsible for maintaining an appropriate service frequency. To date there has been no liability incidents for either agency.

Improved communication with boat owners is needed. The boating community has largely been left out of discussions on past SFM trials in NSW. They are currently sceptical of the ability of current SFM designs to hold boats in all conditions and are unconvinced that there is an environmental need for them. In any instance community education on the impact of moorings on seagrass is vital.

Along with community education, research and monitoring would need to form a major component of any project. There is currently no documented evidence of the long term ecological benefit of SFMs and there is limited information on the extent of seagrass damage caused by moorings in NSW.

Feasibility in terms of costing may be achieved by prioritisation of sites. Trials should consider these areas first and if necessary key areas only may be regulated to require SFMs. This study has found that the Hunter Central Rivers, Sydney Metro and Hawkesbury Nepean are the highest priority CMA areas in NSW due to the concentration of moorings in relation to *Posidonia* distribution. Des Maslen's Seagrass Friendly Systems mooring is considered the most feasible design as it is significantly cheaper than all other SFM types.

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## APPENDIX 1. LOCATION OF *POSIDONIA* PRIORITY AREAS

### 1. Hunter / Central Rivers CMA



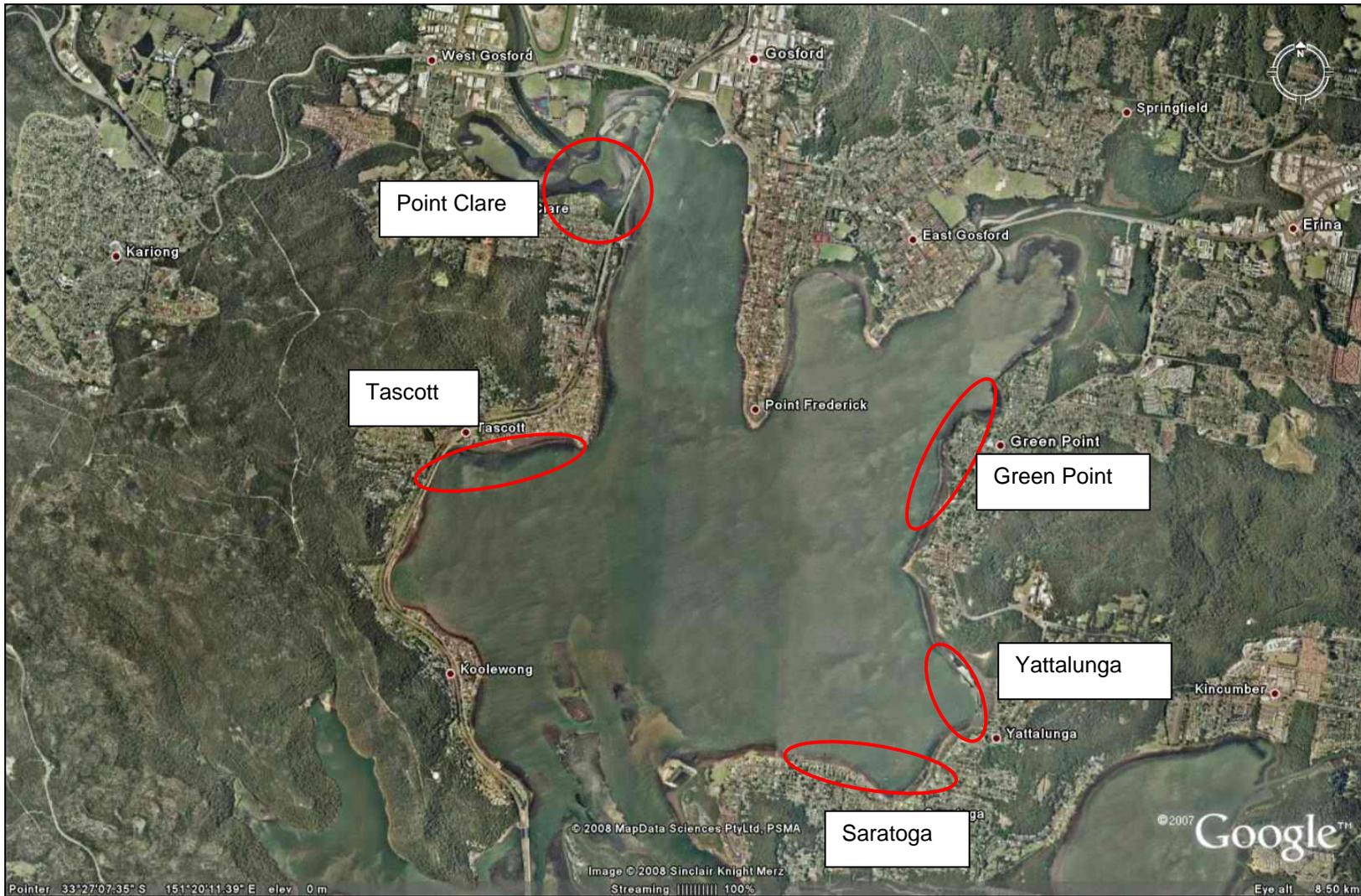
#### 1.1 Lake Macquarie Area



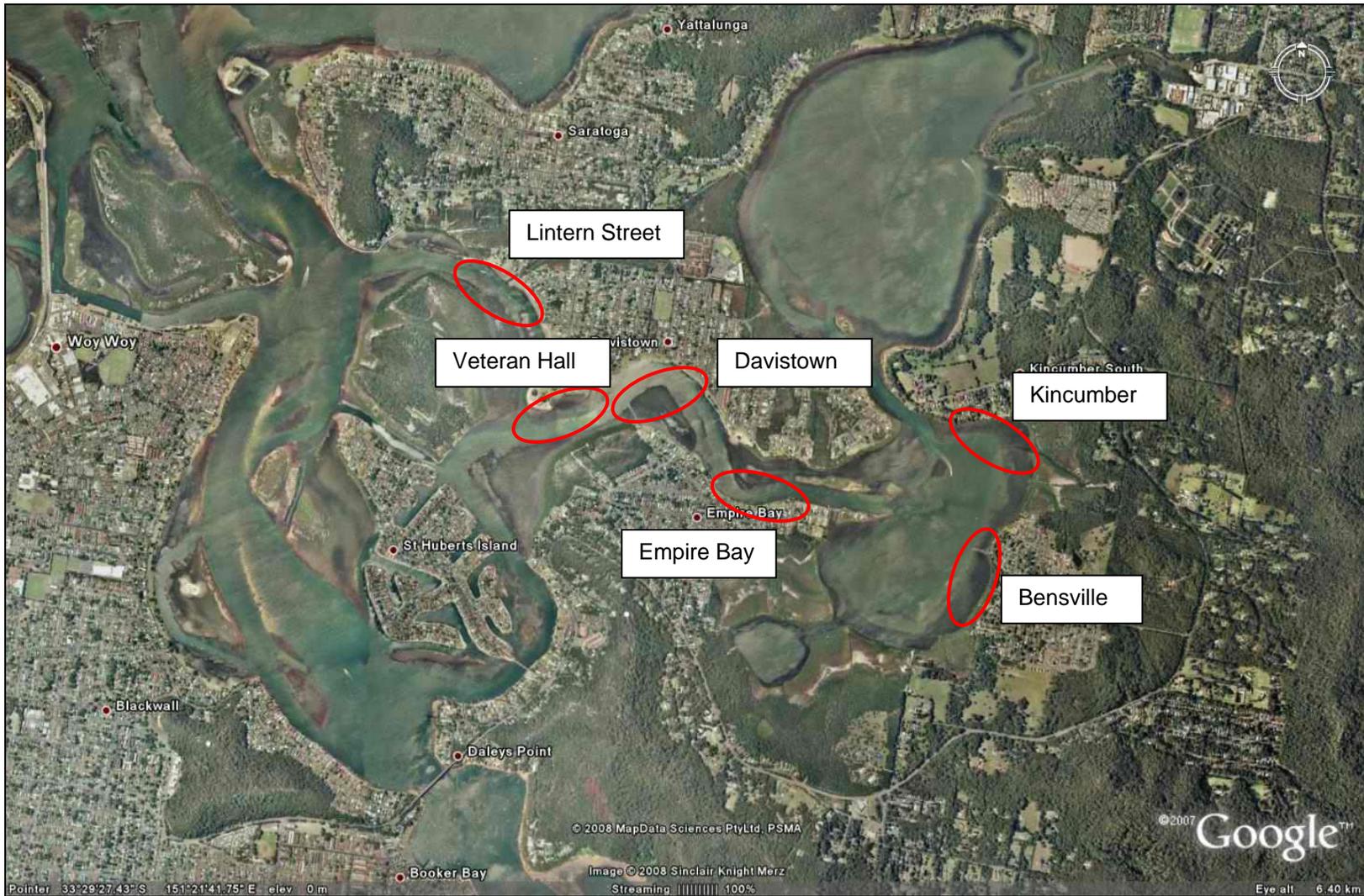
## 1.2 Port Stephens Area



### 1.3 Brisbane Water Area

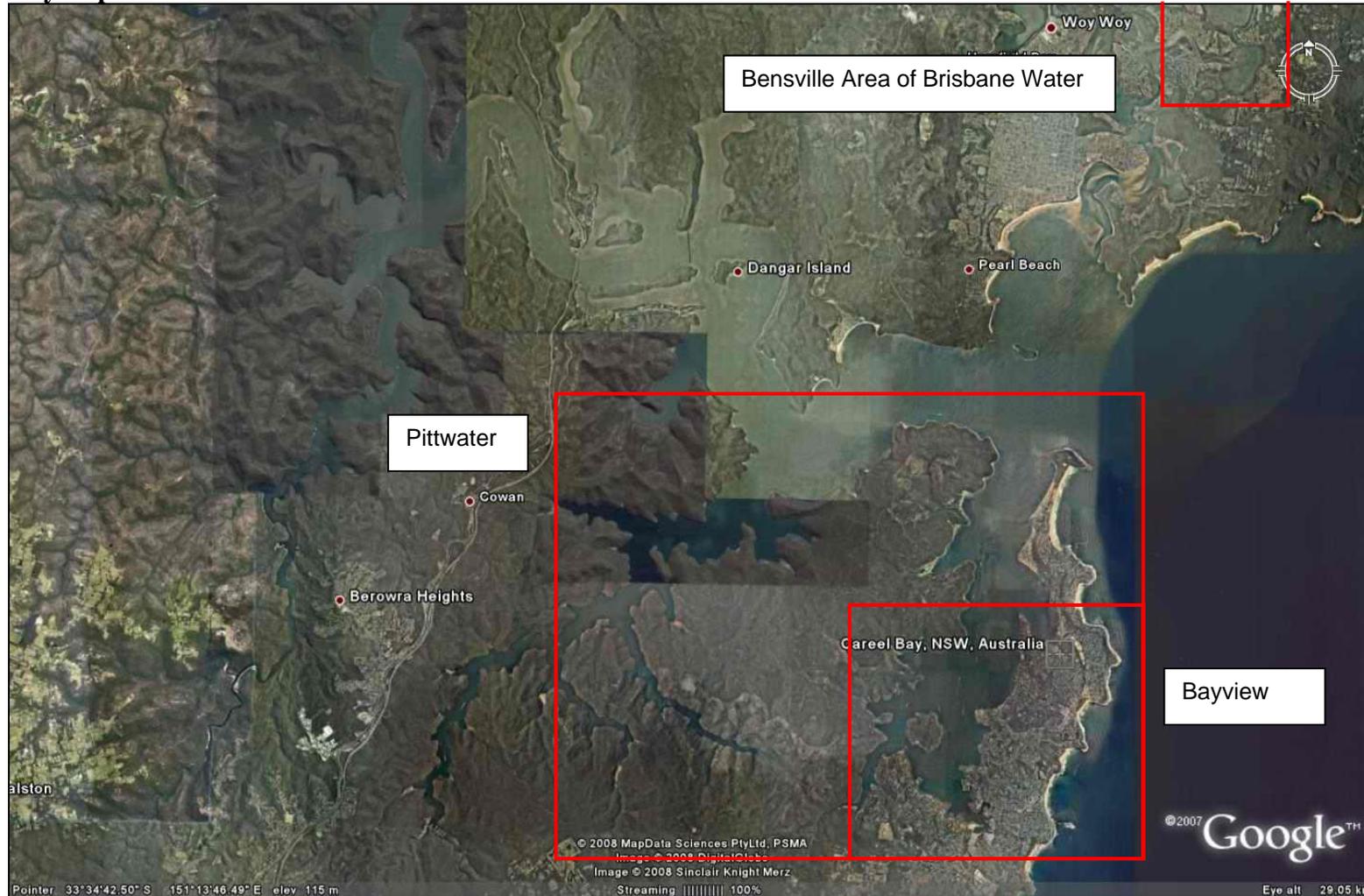


**1.3a. Gosford Area of Brisbane Water.**



**1.3b. Bensville Area of Brisbane Water.**

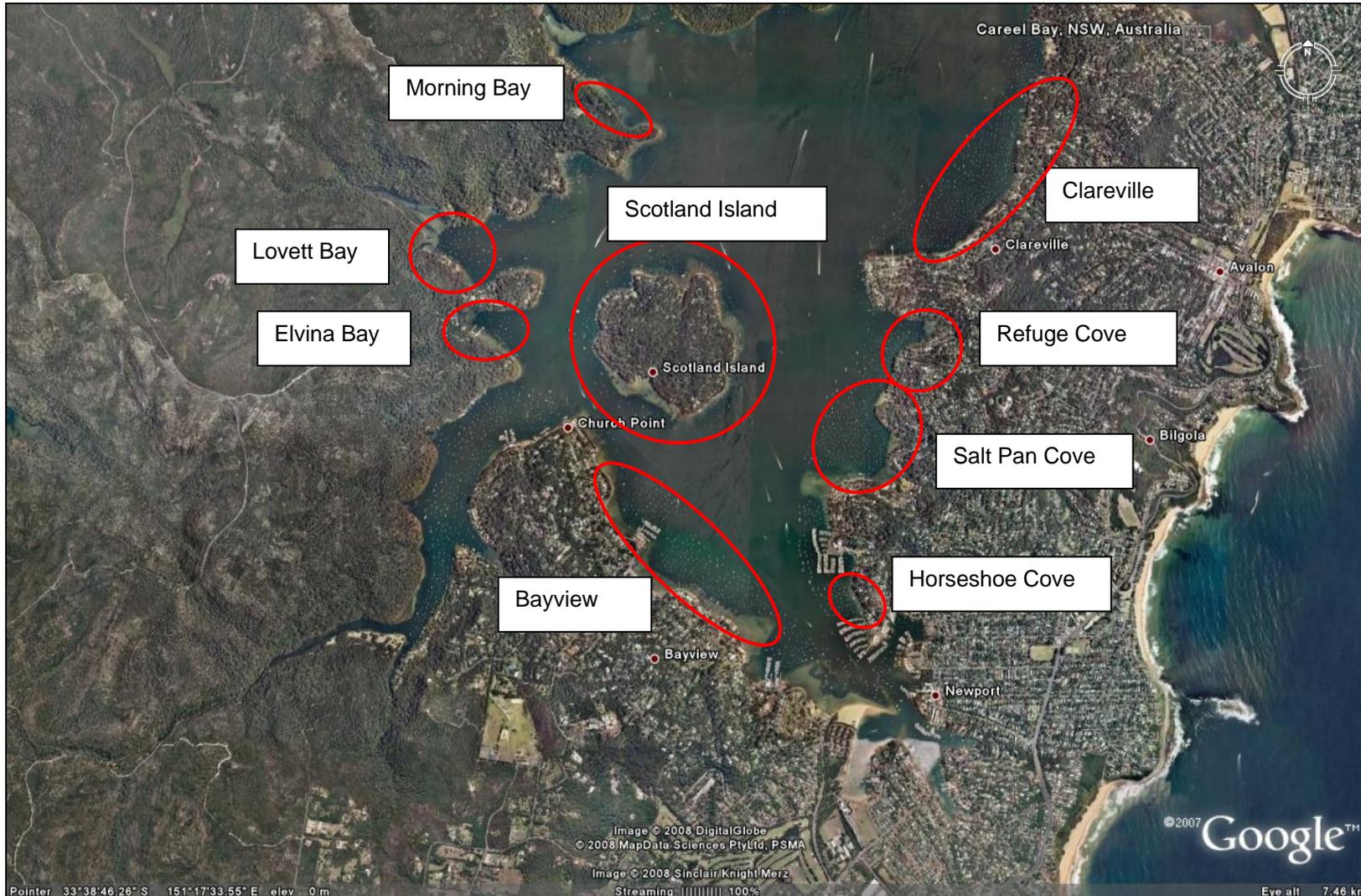
## 2. Hawkesbury Nepean CMA



### 2.1 Hawkesbury River, Broken Bay and Pittwater area

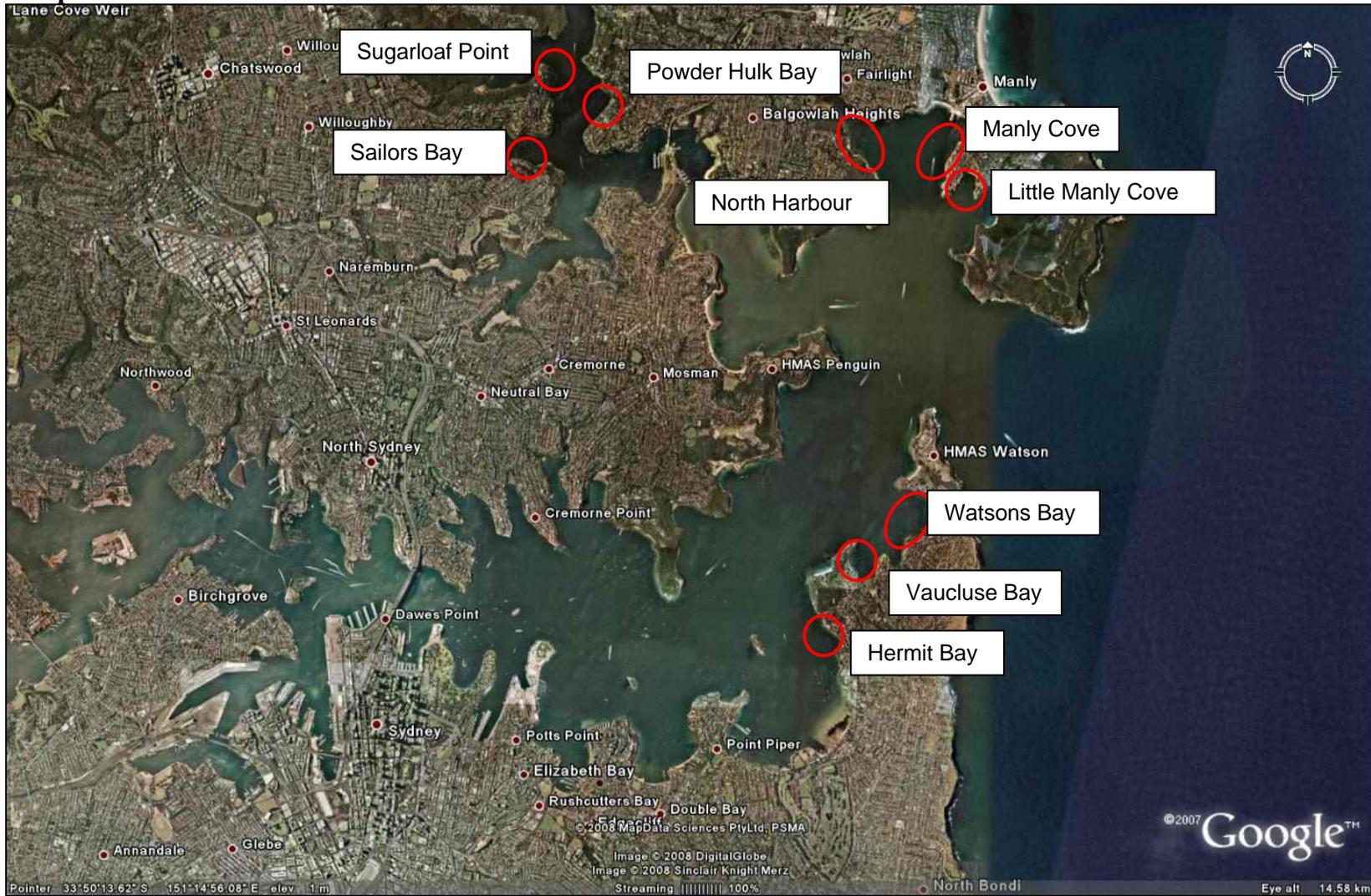


## 2.2 Pittwater Area of Hawkesbury Nepean, Broken Bay.



**2.3 Bayview area of Hawkesbury Nepean, Broken Bay.**

### 3. Sydney Metropolitan CMA area

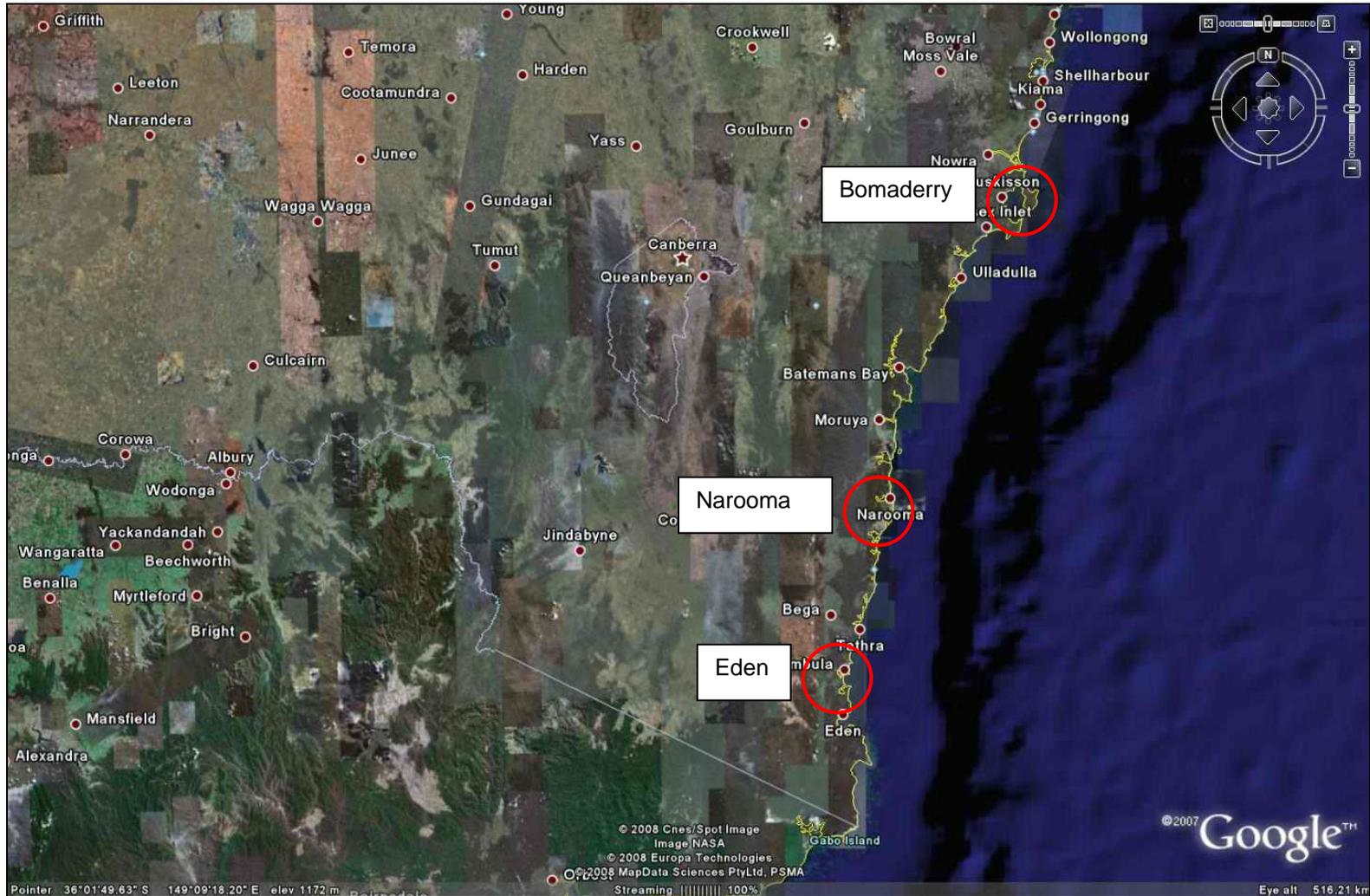


### 3.1 Sydney Harbour

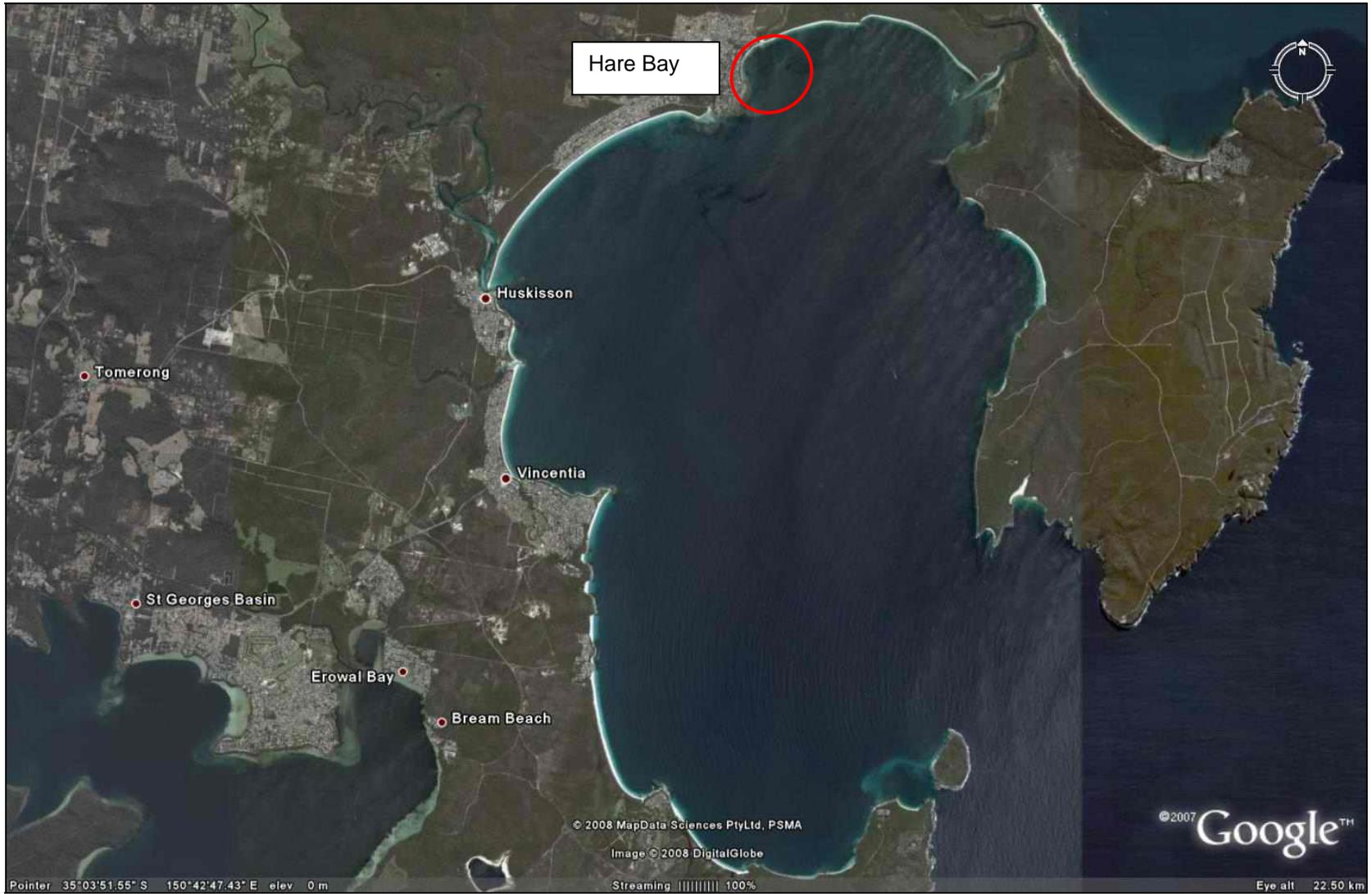


### 3.2 Port Hacking

#### 4. Southern Rivers CMA area



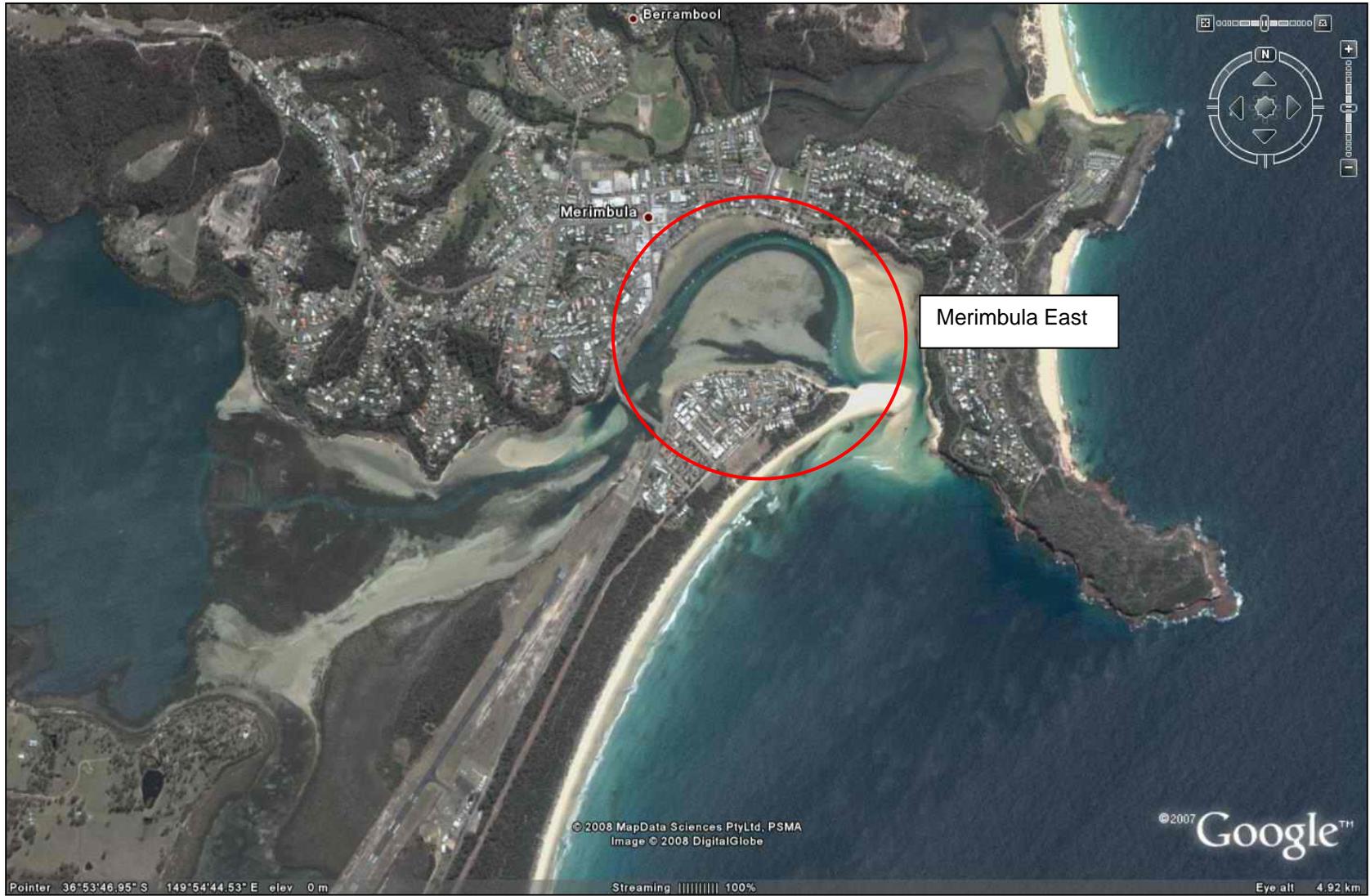
#### 4.1 Southern Rivers CMA area



#### 4.2 West side of Hare Bay



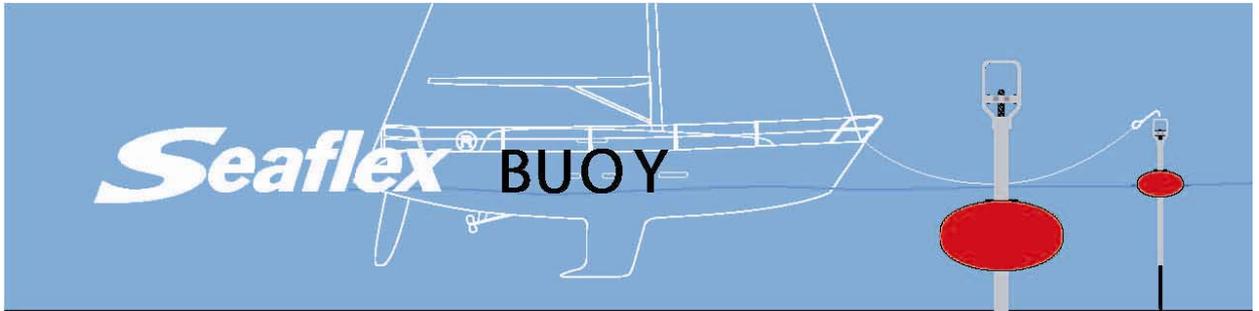
### 4.3 Narooma



#### 4.4 Eden

## APPENDIX 2. SFM DESIGN DRAWINGS AND PROMOTIONAL BROCHURES

### Seaflex® Buoy Promotional Brochure



# The Seaflex buoy tackles every strain

The Seaflex buoy is a ready-for-use mooring device that provides safe mooring in limited marina spaces. A boat moored to a Seaflex buoy demands less security distance and stays in position regardless of tide and wave movements.

The Seaflex hawser is made of a homogeneous rubber core, armed with a specially braided cord. The unique construction gives a progressive resistance that dampens motion from the water and works as a secure shock absorber even in the harshest weather conditions.

#### INSPECTIONS

The rubber hawser will never be subject to damaging UV rays. Fittings and shackles in stainless steel fight corrosion and deterioration and an age resistant polyester rope has the capacity to handle immense amounts of strain and stress. A Seaflex buoy demands minimal maintenance and successfully reduces the need for inspection.

Light in handling - A Seaflex mooring buoy is easily handled by one person



#### THE ENVIRONMENTAL MOORING

Seaflex is 100% environmentally safe and avoids disturbing sensitive sea bed vegetation. The great flexibility of Seaflex is extended even further through its capacity to adapt to extensive water fluctuations.

Indicative Vessel/Seaflex size.

BOAT LENGTH	SEAFLEX	ROPE diameter	ANCHOR EYELET diameter	BOTTOM ANCHOR holding
8 m	2 015 BP	18 mm	16 mm	2000 kg
10 m	4 015 BP	24 mm	20 mm	3000 kg
14 m	4 020 BP	24 mm	20 mm	4000 kg
16 m	6 020 BP	32 mm	24 mm	6000 kg

Larger mooring specifications available on request

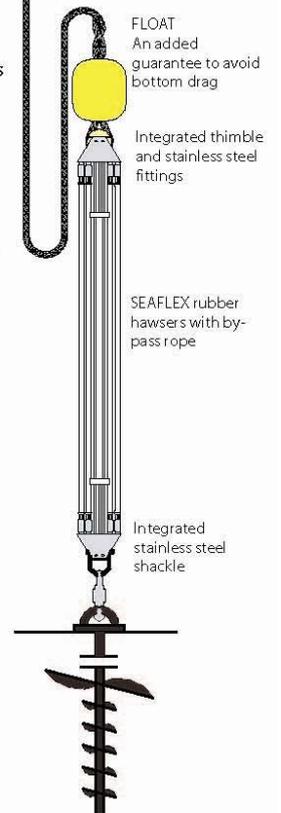
**CONTINUOUS POLYESTER ROPE**  
Together with Seaflex, the length of rope has to correspond to at least the water level at high tide

**FLOAT**  
An added guarantee to avoid bottom drag

Integrated thimble and stainless steel fittings

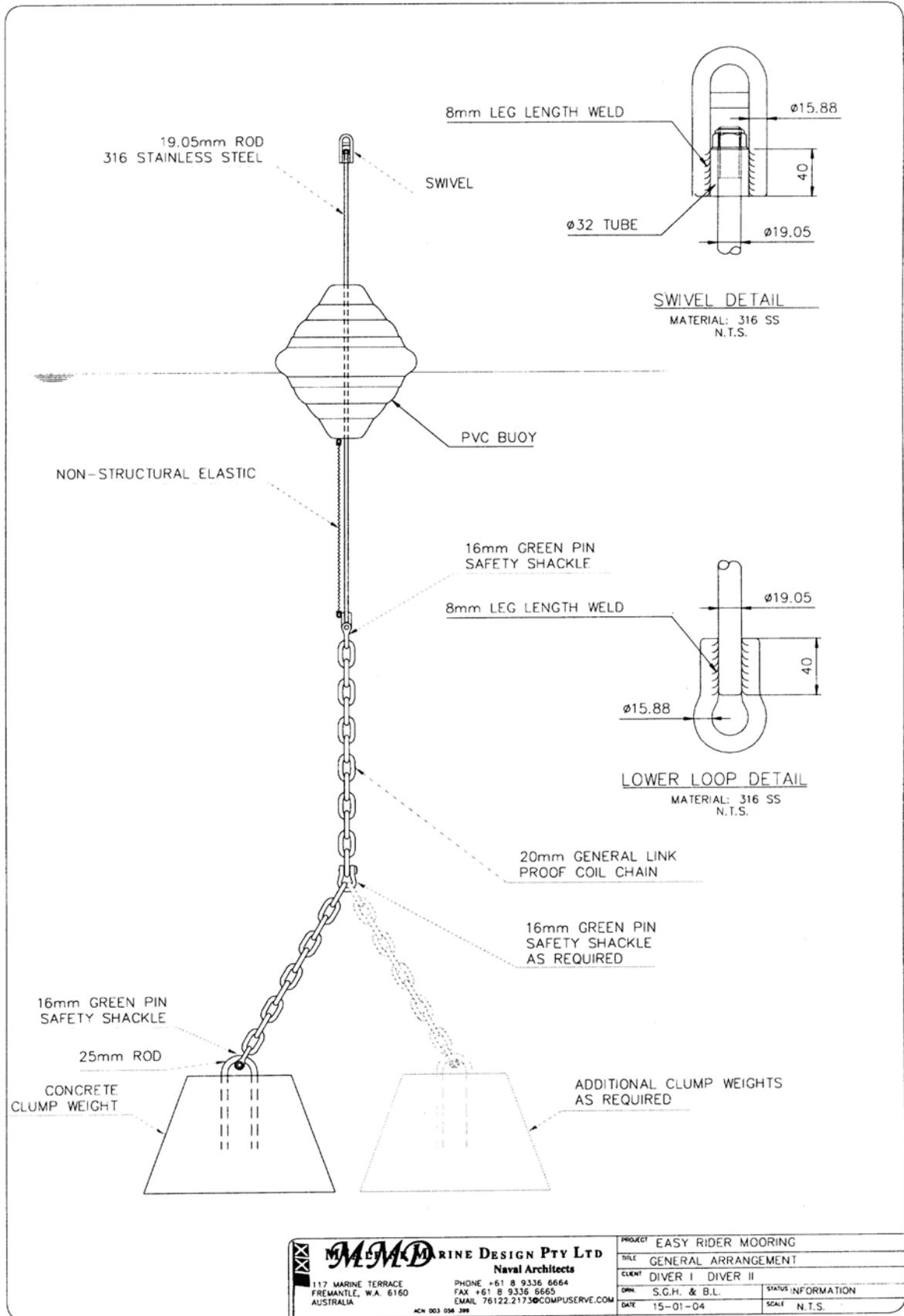
SEAFLEX rubber hawsers with bypass rope

Integrated stainless steel shackle



SEAFLEX AUSTRALIA 38 Fink Street, Williamstown, Vic. 3016  
Phone 03-93970118, 0417-525332, Fax 03-93970115, www.seaflex.net

# Technical drawing of Easy Rider® Sea Grass friendly mooring buoy.



Courtesy of McAlpine Marine Design Pty Ltd. Naval Architects.

# Port-a-Moor™

Portable Mooring System

A simple light-weight, portable and efficient 'mooring anchor' that won't damage the environment.



**SELF INSTALL AND REMOVE IN MINUTES**

## IDEAL TEMPORARY MOORINGS IN PEAK SEASON

**For Individual Boat Owners**  
- Model: 240.64.850

Suitable for smaller vessels to 6M, installed and removed by the owner in shallow water.  
Provides up to 2500lbs deadweight.

**For Yacht Clubs, Marinas and Local Councils**  
- Model: 380.128.885

Suitable for larger vessels to 12M in deeper water.  
Best installed by mooring contractor.  
Provides up to 4500lbs deadweight.

**Designed, Owned & Made in Australia.**

Parks Victoria Approved Design



**NO MORE HEAVY DEADWEIGHTS!**

# Port-a-Moor™

Portable Mooring System



## PORT-A-MOOR

Package Contains:

- Base Plate
- Auger (Drills) X3
- Drive Key
- Dome Cover
- Pipe Caps
- Carry Bag
- Mooring Sling (optional)



**BASE PLATE**



**SCREW IN AUGER**



**CAPS PREVENT BUILD UP OF SILT IN PIPES**



**COVER PREVENTS ANY LINE ENTANGLEMENT AND WARNS OF FOOT HAZARD**

## PORT-A-MOOR™

### Features

- Suitable for sea and fresh water, lakes, rivers and waterways: sand, mud and gravel
- Does not drag around sea floor & destroy surrounding habitat & marine life
- Eliminates the need to locate fixed objects on shoreline and the associated hazards of long cables
- Lightweight and compact
- Easily installed & removed by boat operator or mooring contractor with one simple hand tool
- Holding force is 100% efficient: (solid objects 'lose' up to 50% weight efficiency due to buoyancy in water)
- Durable in harsh environments
- Maintenance free
- Two sizes available:
  - Smaller vessels/shallow water
  - Larger vessels/deep water



## PORT-A-MOOR™ MOORING SLING

- Replaces heavy mooring chains that damage the sea-bed
- No electrolysis – a chemical reaction that attacks other metals
- No rust - will outlast chain for many years
- Maintenance free, lightweight and easily transported
- Adjustable wave dampener
- Approved design and used by Parks Victoria Mooring Contractors

### Contact:

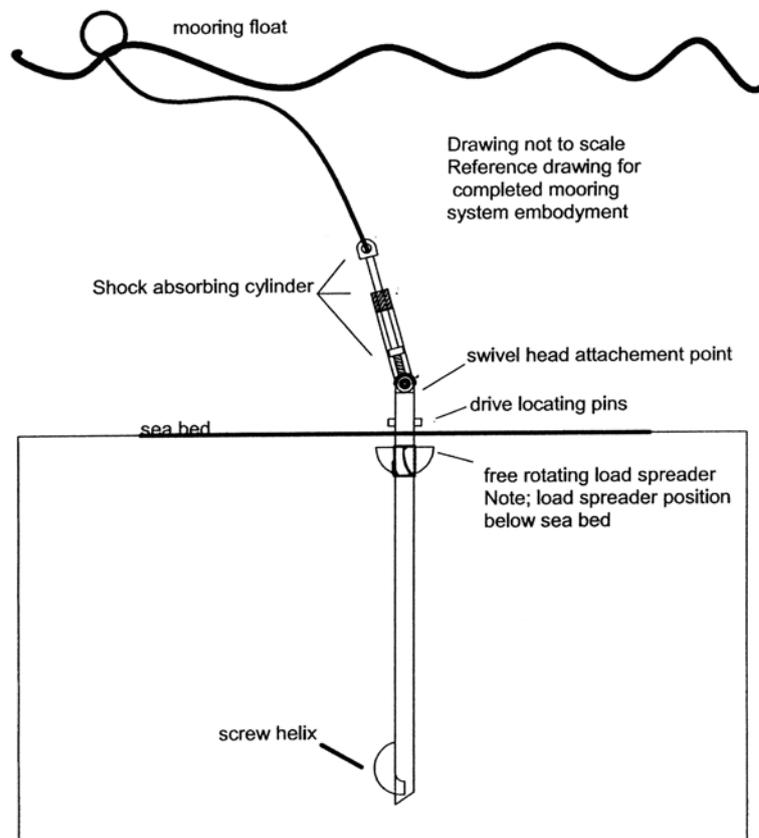
[info@portamoor.com.au](mailto:info@portamoor.com.au)  
[www.portamoor.com.au](http://www.portamoor.com.au)

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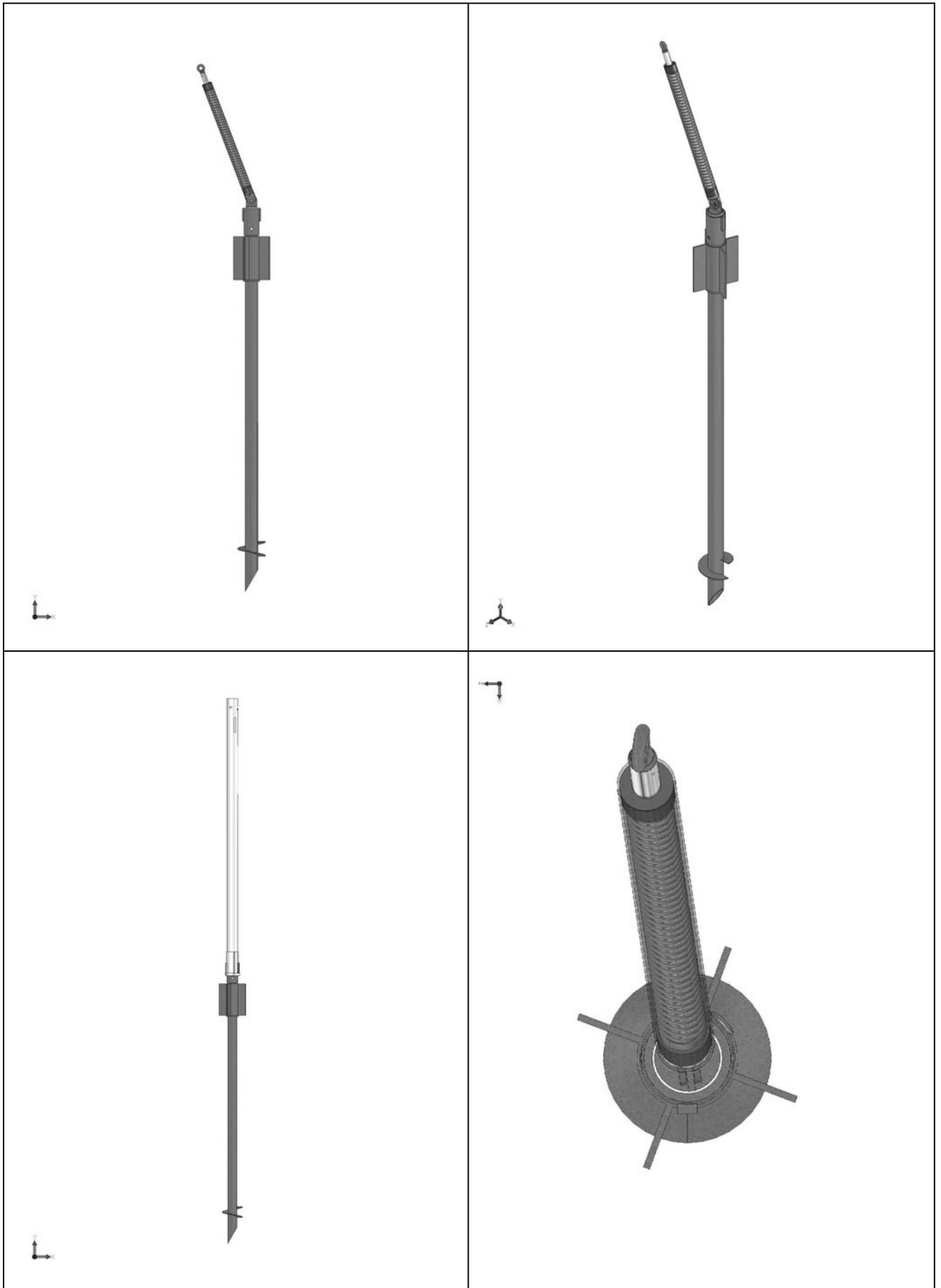
## Des Maslen's Seagrass Friendly Mooring buoy



Photo courtesy ABC website (<http://www.abc.net.au/tv/newinventors/txt/s1940114.htm>)



Drawing of Des Maslen's Seagrass Friendly Mooring buoy



Design specifics of Des Maslen's Seagrass Friendly Mooring system.