SPONGES AND ASCIDIANS OF THE SOUTHERN BASIN OF WALLIS LAKE, NEW SOUTH WALES

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Perth

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Executive Summary

Previous studies have suggested that the seagrass and macroalgal meadows in the southern basin of Wallis Lake contain a relatively diverse assemblage of sponges compared to other coastal lakes and lagoons in New South Wales. Further, many of the sponges previously found in Wallis Lake are likely to be undescribed and new to science. Assemblages of sponges, ascidians and other conspicuous invertebrates (sea hares, nudibranchs and octopus) were sampled in 2007 and again in 2009 to reassess the uniqueness of Wallis Lake compared to other New South Wales coastal lakes and lagoons.

The number of species of sponges found in 2007 (4) and 2009 (7) was consistent with previous studies and highlights the relatively large diversity in Wallis Lake compared to other New South Wales lakes and lagoons. Importantly, in 2009, abundances of some species (e.g. *Suberites* sp.) were reduced compared to previous years and individuals were typically small and many individuals were showing signs of stress.

The most likely key threat to the ongoing survival of these species is deterioration of water quality through increased sediment loading which is likely to have both direct effects on the physiology and feeding efficiency of filter feeding sponges and indirect effects by reducing or changing the distribution of seagrass and algal meadows on which the sponges are closely associated.
1. INTRODUCTION

Wallis Lake is one of the largest coastal lakes in New South Wales with an area of over 90km² and contains extensive seagrass and macroalgal meadows. Until recently, sponges and ascidians have rarely been studied in New South Wales coastal lakes and lagoons (Barnes et al. 2006; Barnes 2009). These recent studies, however, suggest there are at least 20 species of sponges, the majority of which are likely to be undescribed and new to science (Barnes 2009). In contrast, ascidians in lakes are typically well known species with broad geographic distributions (Barnes 2009). In 2002, Wallis Lake was found to have the largest diversity with 10 species of sponge out of 20 New South Wales coastal lakes and lagoons (Barnes 2009). The majority of lakes, particularly smaller and temporally closed systems, are typically devoid of sponges and ascidians. Because most of the sponges found could not be named to species and are likely to be new to science it is very difficult to determine their broader range of distribution: for example, whether they also occur on the open coast or in larger estuarine systems. Preliminary evidence, however, suggests many of these sponges may be restricted in range to coastal lakes and lagoons and probably occur in only a very small subset of those in New South Wales (Barnes 2009). For example, four of the ten species of sponge found in Wallis Lake have only ever been recorded from Wallis Lake and most other species have only been recorded from a handful of other lakes.

While little is known of the biology and ecology of these sponges, they may be under threat from a range of natural and anthropogenic sources of environmental disturbance for a number of reasons. 1) Preliminary evidence suggests the distributions of many of the sponges may be restricted to a small number of lakes (Barnes 2009), 2) many species may be restricted to particular habitats (e.g. macroalgal or seagrass meadows) within those lakes (Barnes 2009). Small and isolated geographical ranges make species particularly vulnerable to extinction from catastrophic events because it is unlikely if a population is made locally extinct, new populations will be able to recolonise rapidly, if at all, from other lakes separated by many kilometres of open ocean, narrow inlet channels, periodic entrance openings and the vagaries of tides and currents. Recolonisation by sponges from other lakes may be further exacerbated by many sponge species having larvae that remain in the water column for relatively short periods of time and do not disperse long distances from the parent (Maldonado 2006). These concepts are supported by the evidence that smaller lakes and lagoons which experience rapid and large changes in water chemistry (e.g. salinity) due to heavy rainfall or the opening of sand bars and influx of salty seawater, do not support populations of sponges (Barnes 2009).

This study aimed to assess the current diversity of sponges, ascidians and other conspicuous invertebrates (sea hares, nudibranchs and octopus) and whether these assemblages make it a unique system in New South Wales.

2. METHODS

2.1. Field sampling

Sponges, ascidians and other conspicuous invertebrates (e.g. nudibranchs, sea hares and octopus) were sampled in the southern basin of Wallis Lake in November 2007 and December 2009 (Figures 1 and 2). Different sites were sampled in each year (see figures 1 and 2) with the exception of those near to Earps and Booti Islands. Twenty one sites were sampled in 2007 south of Earps Island. In
2009, sampling was expanded to include Sites north of Earps Island. Twenty five sites were sampled in 2009. Sites were chosen and spaced to provide a good representation of the habitats and invertebrate assemblages in the southern portion of Wallis Lake. Sites were approximately 60 metres in diameter.

Assemblages of invertebrates and benthic habitats were sampled in each site using two methods:

1. Transects were used to quantify the relatively abundant species of sponges and ascidians. Individual sponges, solitary and colonial ascidians, nudibranchs and seahares were counted by a snorkeller in six replicate 10 x 2 m transects haphazardly placed in each site. In addition to counting invertebrates, the percentage cover of different types of aquatic vegetation (seagrasses and macroalgae) were estimated in each transect to provide a qualitative description of the habitats in each site.

2. Timed searches were used to determine the presence or absence of species of invertebrates. Because many species of sponge and ascidian are very uncommon and sparsely distributed in NSW coastal lakes (Barnes et al. 2006), and are therefore unlikely to be found in relatively small transects, timed searches in which a snorkeller swam haphazardly for five minutes within a site allowed more area to be searched than within transects and hence greatly increased the probability of finding the less common species. Four replicate five minute timed searches were done at each site (See Barnes et al. 2006; Barnes 2009 for optimisation of sampling design).

In 2007, timed searches were done first at each site. Transects were only done in those sites where sponges and or ascidians were common enough to acquire meaningful estimates of abundances. For example, if none or only one sponge or ascidian was found in the timed searches, transects were not done. In 2009, timed searches and transects were done in all 25 sites.
Figure 1: The 21 Sites sampled in Wallis Lake in November 2007

Figure 2: The 25 Sites sampled in Wallis Lake in December 2009
2.2. Comparison of assemblages of invertebrates in Wallis Lake with other New South Wales lakes and lagoons

Studies on sponges and ascidians in New South Wales lakes and lagoons are rare. The only published study before 2006 directly relating to sponges in New South Wales coastal lakes and lagoons is a nineteenth century inventory which reported up to eight species from 'The Illawarra' (von Lendenfeld 1888). In more recent times, although there appear to have been no studies specifically relating to sponges, they have been reported occasionally in studies focussing on other taxonomic groups (e.g. Hutchings et al. 1978; Robinson et al. 1982; Day & Hutchings 1984). None of these studies, however, reported scientific names. To the best of my knowledge, the only published studies reporting species names for sponges in New South Wales lakes and lagoons are Barnes et al. (2006) and Barnes (2009). Therefore, data from Barnes (2009) have been used, with permission, for comparison of Wallis Lake with other New South Wales lakes and lagoons.

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1 It is assumed when von Lendenfeld used the term, ‘The Illawarra’ in 1888 he was referring to what is now known as Lake Illawarra.
3. RESULTS

3.1. November 2007

3.1.1. Summary of results from 2007

In November 2007, four species of sponge (*Aplysilla* c.f. *sulphurea*, *Chondrilla* c.f. *australiensis*, *Mycale* sp., *Suberites* sp.), two species of ascidian (*Styela plicata*, *Eudostoma laysani*), one species of sea hare (*Aplysia* sp.) and one species of nudibranch (*Hypselodoris obscura*) were recorded in the southern basin of Wallis Lake (Table 1). *Styela plicata* is considered an introduced species in Australian waters. Three general regions were able to be categorised based on the type and density of seagrasses and macroalgae present. These were:

1. Habitat dominated by the charophyte, *Lamprothamnion* in the southernmost portion of the Lake, including Pacific Palms, Charlotte Bay and the southern portion of the bay west of Deepwater Point (Sites 1,2,3,7,12, 13,14). Typically Sites were no deeper than 1.5 metres. The sponges, *Suberites* sp., *Aplysilla* c.f. *sulphurea* and *Mycale* sp., and the ascidians, *Styela plicata* and *Eudostoma laysani* were found in this region. Previous studies from 2001-2004 (Barnes, unpublished data), have found these areas and *Lamprothamnion* meadows to have consistently contained the largest diversity and abundances of sponges in Wallis Lake.

2. A central region this area generally consisted of a mosaic of patches of *Zostera* with lots of bare sediment in the central portion (Sites 15, 20 and 21). No sponges nor ascidians were found. Typically the water was murkier with less visibility than other in other habitats.

3. The northern portion to Earps Island was dominated by meadows of *Zostera* which were tall, dense and healthy in appearance, with patches of *Ruppia*, red algae and filamentous green algae. The sponges, *Mycale* sp. and *Aplysilla* c.f. *sulphurea* were very abundant in some of the sites, typically found attached to the leaves of the seagrasses (Sites 6, 18 and 19).

With the exception of small rocky regions around the Earps and Booto Islands, the substrata at all sites consisted of soft sandy or muddy sediment.
Table 1: Summary of invertebrates found at each Site in November 2007

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<tr>
<th>Site</th>
<th>Sponges</th>
<th>Ascidians</th>
<th>Molluscs</th>
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<tr>
<td></td>
<td>Aplysilla cf. sulphurea</td>
<td>Chondrilla cf. australiensis</td>
<td>Mycale sp.</td>
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3.2. Summaries of each Site sampled in November 2007

Site 1. (Methods used: Timed searches and transects)

The lake floor was dominated by Lamprothamnion, with sparse Zostera and Halophila and small patches of red algae. Suberites sp. was the most common sponge with on average 2.2 individuals per transect (i.e. 1.1 per 10m²). Historically, Suberites sp. has been relatively common in this area (P. Barnes, unpublished data). Two Aplysilla cf. sulphurea and one Chondrilla cf. australiensis were also found, The C. australiensis, however was found on a beer can and this species had not been recorded at this site before over 10 sampling occasions (P. Barnes, unpublished data). C. cf. australiensis is typically common on rocky substrata around Earps and Booti Islands. The ascidian, Styela plicata, was also found but in relatively small abundances.

Site 2. (Methods used: Timed searches and transects)

The lake floor was dominated by Lamprothamnion (> 90% cover), with sparse Zostera, Halophila and Ruppia, small patches of bare sediment, red algae and filamentous green algae. Suberites sp., Aplysilla cf. sulphurea and Mycale sp. were found in timed searches only. Styela plicata was found but uncommon.
Site 3. (Methods used: Timed searches)

*Lamprothamnion* was less dense (approx. 50% cover) than in Sites 1 and 2 with more bare sediment (approx. 40%) and patchy *Zostera*, *Halophila*, *Ruppia* and filamentous green algae. No sponges were recorded, but *Styela plicata* was abundant.

Site 4. (Methods used: Timed searches)

Relatively dense cover of *Lamprothamnion* (approximately 75%). Approximately 40-50% cover of red algae on top of *Lamprothamnion*. Sparse and patchy *Zostera*, *Halophila* and small patches of bare sediment. *Suberites* sp. and *Aplysilla* cf. *sulphurea* were found but were not abundant.

Site 5. (Methods used: Timed searches)

This site encompassed the rocky reef on the western side of Booti Island. *Chondrilla* cf. *australiensis* was abundant and covering many of the rocks. Macroalgae were abundant on rocks and included *Cystoseira trinodus*, *Dictyota* cf. *dichotoma*, *Sargassum* sp., *Microdictyon umbilicatum*, *Hormosira banksii* and *Codium lucasi*. Patches of *Zostera* and *Halophila* were observed on the soft sediment between the rocks.

Site 6. (Methods used: Timed searches and transects)

The lake floor habitat consisted of dense beds of *Zostera* (approximately 75% cover) with relatively tall leaves (approximately 1m long), patchy *Ruppia* (approximately 20% cover) and red algae (approximately 10% cover). *Aplysilla* cf. *sulphurea* was very abundant (on average 32 individuals per transect). Individuals were relatively small and typically no larger than a tennis ball. Compared to other studies (Barnes 2009) these were the largest abundances recorded for this species in Wallis or any NSW coastal lake previously surveyed.

Site 7. (Methods used: Timed searches and transects)

The habitat was dominated by *Lamprothamnion*, with sparse *Zostera*, *Halophila* and *Ruppia*, small patches of bare sediment and red algae. *Suberites* sp. was relatively common (1.9 individuals per transect). The ascidians, *Styela plicata* and *Eudostoma laysani* were found but uncommon. Several nudibranchs, *Hypselodoris obscura*, were found.

Site 8. (Methods used: Timed searches)

The lake floor was mostly bare sediment (50%) and red algae (50%) with small and sparse patches of *Zostera* and *Halophila*. No sponges or ascidians were found.

Site 9. (Methods used: Timed searches)

This Site encompassed the rocky reef on the western side of Earps Island. *Chondrilla* cf. *australiensis* were found on the rocks, but were less abundant than at Booti Island. Macroalgae were abundant including *Microdictyon umbilicatum*, *Codium lucasi*, *Hormosira banksii*, *Cystoseira trinodus* and filamentous green algae. One sea hare (*Aplysia* sp.) was observed.

Site 10. (Methods used: Timed searches)
The lake floor habitat included large patches of dense *Zostera* interspersed with dense *Microdictyon umbilicatum*, patches of *Dictyota* and bare sediment. *Styela plicata* was present but not abundant.

**Site 11. (Methods used: Transects and timed searches)**

The lake floor habitat consisted of approximately 50% bare sediment and 30% red algae, with small patches of *Zostera* and *Halophila*. No sponges or ascidians were found. Historically vegetation at this site has changed from time to time. When *Lamprothamnion* is abundant in this area there are usually sponges and ascidians (Barnes, unpublished data).

**Site 12. (Methods used: Transects and timed searches)**

This site is in Charlottes Bay near the entrance to Wallis creek. The site was dominated by very dense, green, healthy looking *Lamprothamnion* (90%), with sparse *Zostera*, *Halophila* and *Ruppia*, small patches of bare sediment, red algae and filamentous green algae. *Suberites* sp. and *Aplysilla cf. sulphurea* were found, but were not common.

**Site 13. (Methods used: Transects and timed searches)**

Site 13 was very similar to Site 12. Site 13 was also in Charlottes Bay. The lake floor was dominated by dense, bright green healthy looking *Lamprothamnion* (90%), with sparse *Zostera*, *Halophila* and *Ruppia*, small patches of bare sediment, red algae and filamentous green algae. *Suberites* sp. and *Aplysilla cf. sulphurea* were found, but were not common.

**Site 14. (Methods used: Timed searches)**

This site appeared to include the western edge of the *Lamprothamnion* bed. The near shore (western) side of the site was dominated by bare sediment (90%) with sparse *Zostera* and *Ruppia*, and a few *Suberites* sp. In comparison, the eastern side was dominated by thick *Lamprothamnion* with small patches of *Zostera*, *Halophila*, *Ruppia* and bare sediment. *Suberites* sp. was found, but was not common.

**Site 15. (Methods used: Timed searches)**

The lake floor was mostly bare sediment with some small patches of *Zostera* and *Halophila* and small clumps of red algae. No sponges or ascidians were found.

**Site 16. (Methods used: Timed searches)**

Site 16 was dominated by dense, tall *Zostera*, with small clumps of *Dictyota*, red algae and filamentous green algae. *Aplysilla cf. sulphurea* and *Styela plicata* were present, but not abundant.

**Site 17. (Methods used: Timed searches)**

Site 17 was very similar to Site 16, dominated by dense, tall *Zostera*, with small clumps of *Dictyota*, red algae and filamentous green algae. *Aplysilla cf. sulphurea* and *Styela plicata* were present but not abundant.
Site 18. (Methods used: Timed searches and transects)

The lake floor was dominated by dense and tall Zostera (approximately 85% cover) with small patches of Ruppia and bare sediment, and very sparse Halophila. Mycale sp. (3.6 individuals per transect) and Aplysilla (7 individuals per transect) were relatively abundant compared to other sites. Styela plicata was also present, but not in large abundance.

Site 19. (Methods used: Timed searches and transects)

The lake floor had approximately 50% cover of tall very healthy looking Zostera with patches of red algae, filamentous green algae and wrack. Mycale (4.4 individuals per transect) and Aplysilla c.f. sulphurea (1.6 individuals per transect) were found and were relatively abundant compared to other sites. Styela plicata were also present.

Site 20. (Methods used: Timed searches and transects)

The lake floor was mostly bare sediment (approximately 80%) with patches of Zostera and very sparse Halophila. Zostera appeared less healthy in this site with visible heavy sedimentation and microalgal growth on the leaves. On the day of sampling visibility was much less in this site compared to most other sites. No sponges or ascidians were found.

Site 21. (Methods used: Timed searches and transects)

Site 21 was very similar to Site 20 with mostly bare sediment (approximately 80%) with patches of Zostera and very sparse Halophila. The Zostera appeared much less healthy with lots of sedimentation and microalgal growth on leaves. On the day of sampling visibility was much less in this site compared to most other sites. No sponges or no ascidians were found.

3.3. December 2009

3.3.1. Summary of results from 2009

In December 2009, seven species of sponge (Aplysilla c.f. sulphurea, Chondrilla c.f. australiensis, Dysidea sp., Mycale sp., Raspaillia sp., Suberites sp., Calcereous sponge), one species of ascidian (Styela plicata), one species of sea hare (Aplysia sp.) and one species of nudibranch (small white) were recorded in the southern basin of Wallis Lake (Table 2). Similar to the survey in 2007, the southernmost portion of the Lake, including Pacific Palms, Charlotte Bay and the southern portion of the bay west of Deepwater Point (Sites 22, 23, 24, 25, 41, 44), was characterised by beds of the charophyte, Lamprothamnion with patches of seagrass and other macroalgae. Typically sites were no deeper than 1.5 metres. On the days of sampling, water clarity was poor in this region and there appeared to be a heavy sediment/microalgal cover on the aquatic vegetation. The sponge, Suberites sp., was found in a number of Sites along the southern shoreline where Lamprothamnion was present, but in very low abundances, with most individuals relatively small (less than the volume of a golf ball) and showing signs of necrosis. An opportunistic investigation of the small jetty adjacent to Pacific Palms Recreation Club, found 6 relatively larger individual Suberites sp. which were healthy in appearance showing no signs of necrosis. These individuals were attached to the pylons in the top 50cm of the water column. Suberites sp. was not found on the rocky reefs near Earps and Booti.
Islands. Previous studies from 2001-2004 (Barnes, unpublished data), have found these areas and *Lamprothamnion* meadows have consistently contained the largest diversity and abundances of sponges in Wallis Lake.

The remainder of the Sites were not easy to categorise based on habitat as was possible in 2007. Rather, they contained varying covers of the seagrasses, *Zostera, Posidonia australis, Halophila* and *Ruppia*, red and green algae, but generally did not contain *Lamprothamnion*.

With the exception of small rocky regions around the Earps and Booti Islands, the substrata at all sites consisted of sandy or muddy sediments.

Table 2: Summary of invertebrates found at each Site in December 2009

<table>
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<th>Site</th>
<th>Sponges</th>
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<th>Molluscs</th>
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<td>Aplysilla cf. sulphurea</td>
<td>Calcareous sponges</td>
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</table>

14
3.4. Summaries of each Site sampled in December 2009

Site 22. (Methods used: Timed searches and transects)

The lake floor was dominated by *Lamprothamnion*, with large patches of filamentous green algae (probably *Chaetomorpha* sp.) and bare sediment. *Suberites* sp. was found, but in relatively very small abundance compared to 2007 and other surveys of this area (Barnes 2009). In addition, the individuals found were relatively small (less than the size of a golf ball) and appeared to have more necrotic tissue than previous surveys in this area of Wallis Lake (Barnes, pers. obs). One *Aplysilla* c.f. *sulphurea* and one *Styela plicata* were also found.

Site 23. (Methods used: Timed searches and transects)

Habitat was dominated by *Lamprothamnion*, with patches of *Zostera, Halophila*, filamentous green algae (probably *Chaetomorpha* sp.) and patches of bare soft sediment. *Suberites* sp. was found, but similar to Site 22, there were relatively few individuals and those found were relatively small and showed signs of necrosis.

Site 24. (Methods used: Timed searches and transects)

The habitat was dominated by *Lamprothamnion* with patches of red algae and filamentous green algae with patches of *Lamprothamnion* and bare sediment. Only two, very small *Suberites* sp. were found.

Site 25. (Methods used: Timed searches and transects)

The Site was dominated by *Lamprothamnion* with patches of bare sediment. No sponges or ascidians were found.

Site 26. (Methods used: Timed searches and transects)

The Site was dominated by *Zostera* with patches red algae, bare sediment and sparse *Halophila*. No sponges or ascidians were found.

Site 27. (Methods used: Timed searches and transects)

The seafloor was dominated a mixture of patches of *Zostera* and bare sediment with sparse *Halophila* and *Ruppia*. *Styela plicata* were found, but in very low abundance.

Site 28. (Methods used: Timed searches and transects)

The seafloor was mostly unvegetated sediment with patches of red algae and sparse *Zostera Halophila* and filamentous green algae. No sponges or ascidians were found.

Site 29. (Methods used: Timed searches and transects)

This site was near Booti Island near to Site 5 sampled in 2007. The seafloor was mostly *Zostera* (approximately 50% cover) with masses of the brown alga *Dictyota* c.f. *dichotoma*, smaller patches
of bare sediment, filamentous green algae, red algae, *Ruppia* and sparse *Halophila*. Two *Mycale* sp. were found in transects. *Chondrilla* c.f. *australiensis* was common on the rocks in shallow water closer to the island.

**Site 30. (Methods used: Timed searches and transects)**

The seafloor was mostly vegetated with a mixture of *Zostera, Ruppia* and *Lamprothamnion* with smaller patches of *Dictyota* c.f. *dichotoma* and *Halophila*. *Mycale* sp. was present, but only represented by a few individuals. Small white nudibranchs were also observed.

**Site 31. (Methods used: Timed searches and transects)**

Similar to Site 30, the seafloor at Site 31 was vegetated with a mixture of *Zostera* and *Ruppia* with smaller patches of *Dictyota* c.f. *dichotoma* and *Halophila*. *Mycale* sp. was present, but only represented by a few individuals.

**Site 32. (Methods used: Timed searches and transects)**

Site 32 was dominated by *Zostera*, with large patches of bare sediment, smaller patches of *Dictyota* c.f. *dichotoma* and sparse *Halophila*. *Aplysilla* c.f. was recorded but uncommon.

**Site 33. (Methods used: Timed searches and transects)**

Site 33 was adjacent to Earps Island nearby Site 9 sampled in 2007. Macroalgae were abundant including *Microdictyon umbilicatum, Codium lucasi, Hormosira banksii* and *Cystoseira trinodus* in the shallow rocky area near the island. The sponge, *Chondrilla* c.f. *australiensis* was also common on the rocks. The sandy seafloor further from the island was dominated by *Zostera*, with large patches of bare sediment, smaller patches of *Dictyota* c.f. *dichotoma* and sparse *Halophila*. No sponges or ascidians were found among the seagrasses.

**Site 34. (Methods used: Timed searches and transects)**

The seafloor was dominated by *Zostera*, with sparse *Halophila* and *Ruppia* and patches of *Dictyota* c.f. *dichotoma*. One *Chondrilla* c.f. *australiensis* was found along with an *Aplysia*, small white nudibranchs and octopus holes.

**Site 35. (Methods used: Timed searches and transects)**

Site 35 was the most northen Site sampled. The vegetation was different from the other sites in that it included patches of the seagrass *Posidonia australis*, mixed with patches of *Zostera*. This was the only Site in which the sponge *Raspailia* sp. was found. The sponge *Haliclona* sp. and the the ascidian *Styela plicata* were also found, but in small abunances.

**Site 36. (Methods used: Timed searches and transects)**

The seafloor was approximately 50% bare sediment with patches of *Zostera, Ruppia* and *Dictyota* c.f. *dichotoma*. No sponges or ascidians were found.

**Site 37. (Methods used: Timed searches and transects)**
The seafloor was dominated by *Ruppia* with patches of *Zostera* and filamentous green algae. *Mycale* sp. was found.

**Site 38. (Methods used: Timed searches and transects)**

The seafloor was dominated by *Ruppia* with patches of *Zostera*, *Halophila*, *Dictyota c.f. dichotoma* and filamentous green algae. *Aplysilla c.f. sulphurea* and small white nudibranchs were found.

**Site 39. (Methods used: Timed searches and transects)**

The seafloor was dominated by a dense meadow of *Zostera*, with small patches of *Halophila* and *Dictyota c.f. dichotoma*. *Aplysilla c.f. sulphurea*, *Mycale* sp. and a small white calcareous sponge were found, but represented by only a few individuals. The unidentified small white nudibranchs, *Aplysia* sp. and octopus holes were also found.

**Site 40. (Methods used: Timed searches and transects)**

The seafloor was dominated by a dense meadow of *Zostera*, with small patches of *Halophila*, *Dictyota c.f. dichotoma* and filamentous green algae. *Styela plicata* was present in small numbers as was the small white nudibranchs.

**Site 41. (Methods used: Timed searches and transects)**

The seafloor was mostly *Lamprothamnion* with patches of red algae, filamentous green algae and sparse *Zostera* and *Halophila*. No sponges or ascidians were found.

**Site 42. (Methods used: Timed searches and transects)**

The seafloor was mostly bare sediment with patches of red algae, filamentous green algae and sparse *Zostera* and *Halophila*. *Suberites* sp. and *Haliclona* sp. were found, but represented by very few individuals. Octopus holes were also found.

**Site 43. (Methods used: Timed searches and transects)**

The seafloor was mostly soft sediment covered with a brown microalgal layer, with small patches of *Zostera*, *Halophila*, red algae and filamentous green algae. *Suberites* sp. were found, but represented by very few individuals. Octopus holes were also found.

**Site 44. (Methods used: Timed searches and transects)**

The seafloor was dominated by patches of Lamprothamnion, bare sediment and mats of filamentous green algae with small patches of *Zostera*, *Halophila* and *Ruppia*. No sponges or ascidians were found.

**Site 45. (Methods used: Timed searches and transects)**

The seafloor was dominated by patches of *Zostera*, bare sediment and mats of red algae and sparse *Halophila*. No sponges or ascidians were found.
Site 46. (Methods used: Timed searches and transects)

The seafloor was dominated by patches of Zostera and filamentous green algae with small patches of Lamprothamnion and Ruppia and sparse Halophila. Aplysilla c.f. sulphurea was relatively abundant compared to other Sites in 2009 (on average 1.5 individuals per transect). Mycale sp. was found in all four timed searches and Styela plicata was also found.
Table 3: ‘Table 3.1’ from Barnes (2009) included with permission. Numbers refer to locations in which species were found in each of ten NSW coastal lakes. Includes data from timed searches and transects. Refer to Figure 3.1 in Barnes (2009) for positions of Locations in each lake.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Less modified</th>
<th>Extensively modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening-regime</td>
<td>Mostly closed</td>
<td>Mostly open</td>
</tr>
<tr>
<td>Size</td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td>Lake</td>
<td>Swan</td>
<td>Durras</td>
</tr>
<tr>
<td>Porifera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aplysilla cf. sulphurea</td>
<td>2 6 1</td>
<td></td>
</tr>
<tr>
<td>Aplysinella cf. rhax</td>
<td></td>
<td>1,2,4,5,6</td>
</tr>
<tr>
<td>Dysidea sp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halichondria sp. 1</td>
<td>1 3</td>
<td></td>
</tr>
<tr>
<td>Halichondria sp. 2</td>
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<td></td>
</tr>
<tr>
<td>Halichondria sp. 3</td>
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</tr>
<tr>
<td>Halichondria sp. 4</td>
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</tr>
<tr>
<td>Halichondria sp. 5</td>
<td>4,6</td>
<td></td>
</tr>
<tr>
<td>Haliclona sp. 1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Haliclona sp. 2</td>
<td>3,4</td>
<td></td>
</tr>
<tr>
<td>Hymeniacidon sp. 1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Hymeniacidon sp. 2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Mycale sp.</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Niphates sp.</td>
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<td></td>
</tr>
<tr>
<td>Raspailia sp.</td>
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<td></td>
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<tr>
<td>Suberites sp. 1</td>
<td>1,3,4,5,6</td>
<td></td>
</tr>
<tr>
<td>Suberites sp. 2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Tetilla sp.</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Total number of sponge species per lake

| Ascidiacea       |                      |                     |                      |                     |         |
| Botrylloides leachi |              | 6                    |                      |                     |         |
| Eudistoma laysani | 2,6               | 3                    | 1,2,3,4,5,6          |                     |         |
| Herdmania grandis |                      |                      | 4                    |                     |         |
| Microcosmus squamiger |            | 1,3                 |                      |                     |         |
| Pyura stolonifera | 1,2,3,4,5,6 |                     | 3                    | 1,2,3,4,5,6        | 5         |
| Styela plicata   | 3,4,6           | 2,3                  | 4                    | 1,2,3,4,5,6        | 1,4       |

Total number of ascidian species per lake

|                     | 0 1 2 3 2 3 1 |         |           |           |           |         |
4. DISCUSSION
The diversity and distributions of sponges and ascidians in Wallis Lake in 2007 and 2009 were very similar to previous years (compare with Table 3; Table 4). Similar to previous sampling in Wallis Lake, most species had very patchy distributions and some species were largely restricted to some areas of the the Lake; for example, *Suberites* sp. were only observed along the southern shoreline largely associated with beds of *Lamprothamnion*. However, in 2009 in stark contrast to previous years, the abundances, sizes and apparent health of the the sponges was very different compared to previous years. For example, abundances of *Suberites* sp. have been relatively stable from 2002 to 2007 (Figure 3), but in 2009, no individuals were found in transect searches and only a few individuals were found in timed searches. Further, those *Suberites* sp. found were typically very small, many with large areas of necrotic tissue.

![Figure 3: Mean (SE) number of Suberites sp. in Lamprothamnion meadows in the southern portion of Wallis Lake (n =12 transects). Data from January 2002 – February 2005 are included with permission from P. Barnes. Methods used from 2002 -2005 were identical to those used in the current survey.](image)

4.1. Uniqueness of Wallis Lake
In terms of diversity of ascidians, Wallis Lake cannot be considered unique. Of the two species found, *Styela plicata* is considered an introduced species in Australian waters and *Eudistoma laysani* is a cosmopolitan species. Additional species (*Pyura stolonifera, Micocosmus squamiger*) have been found in previous studies (Barnes 2009), but again these are cosmopolitan species with broad distributions.

It is difficult to provide a quantitative assessment of the uniqueness of Wallis Lake in terms of its molluscan fauna (nudibranchs, sea hares, octopus), because there appears to be no information on the distribution of these animals in other New South Wales Lakes and lagoons. It would appear, however, that nudibranchs and sea hares are typically rare or in most cases absent from other lakes and lagoons, while not uncommon in Wallis Lake (P. Barnes, pers. obs).
The uniqueness of Wallis Lake in terms of diversity of invertebrates lies with its sponge fauna. In a survey of 10 coastal lakes in 2002 (Barnes 2009), Wallis Lake with ten species had almost twice as many species as any other lake. Sponges and ascidians are absent from the majority of lakes and lagoons in New South Wales. Most species appear restricted in distribution to only one or a few lakes. For example, *Dysidea* sp., *Raspaillia* sp., a species of *Haliclona* and a species of *Halichondria* have only been recorded in Wallis Lake (Table 3; Barnes 2009). Of the twelve species so far reported from the southern basin of Wallis Lake only, *Chondrilla* c.f. *australiensis* and *Aplysilla* c.f. *sulphurea* could be tentatively identified to species. The remainder are likely to be undescribed and new to science.

### 4.2. Potential threats to sponges in Wallis Lake

In coastal environments, the distribution of sponges and ascidians may be affected by a variety of human impacts (Carballo *et al.* 1996; Carballo & Naranjo 2002) including sewage and silt deposition (Roberts *et al.* 1998; Roberts *et al.* 2006).

**Increased sediment loads**

While little is known of the tolerances of the species in Wallis Lake to impacts such as silt deposition, it is likely that increased sediment loads would adversely affect their physiology and interfere with the feeding efficiency of filter feeders such as sponges. Further, the *Suberites* sp. found in Wallis Lake contains cyanobacteria. Symbioses between sponges and cyanobacteria and other algae are common in shallow well lit waters and the photosynthesising symbionts often provide a large proportion of energy to the sponge cells. It is reasonable to hypothesise that long-term and dramatic reductions in light availability caused by increased sediment loads may adversely affect species with symbionts such as *Suberites* sp. This must, however, be balanced by the results of a study in nearby, Smiths Lake, that found no negative effects on *Suberites* sp. after 1 month of shading (Barnes 2009). It is also important to note that while those *Suberites* sp., found on or near the seafloor were typically small and appeared to be stressed, the individuals found on the jetty at Pacific Palms were larger and healthier in appearance. These individuals were closer to the surface, where they would receive more sunlight and presumably be at less risk from deposition of sediment.

**Loss of habitat (algal and seagrass meadows)**

Many species of sponges in Wallis Lake and other New South Wales coastal lakes show strong associations with the types of aquatic vegetation present (Barnes 2009). For example, the *Lamprothamnion* meadows in the southern portion of the lake typically support the most diverse and abundant populations of sponges; some species of the sponge *Halichondria* in Wallis Lake have only been recorded on the brown alga, *Cystoseira trinodus* (Barnes 2009). *Mycale* sp. typically grows on the leaves of seagrasses or commonly on macroalgae (particularly *Lamprothamnion*). One of the few other lakes where *Mycale* sp. could be considered abundant is Lake Conjola on the New South Wales south coast. However, in Lake Conjola, *Mycale* sp. grows predominantly on the alga *Caulerpa taxifolia* which is considered an introduced pest and has been the target of an intensive irradiation programme. Substantial losses or changes in the distribution of seagrasses and macroalgae have due to human impacts are common in Australia and around the world (Waycott *et al.* 2009). Two of the key causes of seagrass loss have been increased nutrient loads from urban, industrial and agricultural run-off (e.g. use of fertilisers) causing algal blooms and increased sediment loads both
reducing light reaching the seagrasses. It is likely that if large areas of seagrass or meadows of *Lamprothamnion* are lost from Wallis Lake, there will be a concurrent loss of sponge species.

5. **RECOMMENDATIONS**

It is difficult to determine if the decline in abundances of some species in 2009 is a result of human induced changes in the system or simply part of the natural temporal variation in abundances. Even if the declines are natural, small numbers of individuals may render populations more susceptible to extinction from unforeseen or planned human disturbances (e.g. increased nutrient loads leading to loss of aquatic vegetation; large inputs of sediment from construction, roadworks, landclearing, etc.). It is, therefore, recommended that for precautionary reasons to protect the most diverse sponge fauna in New South Wales coastal lakes which includes several species yet to be named, that every effort be made to prevent the deterioration of water quality in the lake and prevent the loss of valuable seagrass and macroalgal habitats, in particular the large beds of *Lamprothamnion* in the southern portion of the lake.

6. **CITED LITERATURE**


Table 4: Table 5.4 from Barnes (2009). Distributions of sponges and ascidians found in the seagrass meadows of Lake Macquarie compared to Wallis Lake, Smiths Lake, Brisbane Water, Pittwater, Port Hacking and Lake Conjola in January-April 2004. Condition as classified by Healthy Rivers Commission (2002). Numbers in () indicate total number of sites where those species were found. ‘Outlets’ refer to points of hot water discharge from two power stations.

<table>
<thead>
<tr>
<th>Estuary</th>
<th>Lake Macquarie</th>
<th>Wallis Lake</th>
<th>Smiths Lake</th>
<th>Brisbane Water</th>
<th>Pittwater</th>
<th>Port Hacking</th>
<th>Lake Conjola</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Condition</strong></td>
<td>Severely affected</td>
<td>Moderately affected</td>
<td>Slightly affected</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>Slightly affected</td>
</tr>
<tr>
<td><strong>Sites sampled</strong></td>
<td>29</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>17</td>
<td>17</td>
<td>24</td>
</tr>
</tbody>
</table>

**Sponges found in Lake Macquarie**

- *Haliclona* spp.: Uncommon (1) Uncommon (2) On mussel reefs, but uncommon (2)
- *Mycale* sp.: Abundant in patches near outlets and on *Posidonia australis* near Swansea (7) Very patchy, growing on *Lamprothamnion* sp. (4)
- *Phorospongia* sp.: Very uncommon, two individuals found (1)
- *Suberites* sp.: Found near outlets, but otherwise uncommon (4) Patchily distributed amongst the alga, *Lamprothamnion* sp. and patchy *Zostera capricorni* (6)

**Total number of species of sponges**: 4 6 2 5 2 1 2

**Ascidians found in Lake Macquarie**

- *Botrylloides leachi*: Abundant on *Z. capricorni* near Swansea Channel (3)
- *Polyclinum nudum*: Abundant near Vales Point outlet (2)
- *Styela plicata*: Uncommon (5) Widespread, abundant in patches (8)
- *Symplegma oceania*: Abundant on *Z. capricorni* near Swansea Channel (2)

**Total number of species of ascidians**: 4 3 1 2 0 1 2