FINAL REPORT

Poole Park Lakes: Research and monitoring

DATE:	March 2016
VERSION:	Final v1.0
BUG REFERENCE:	BUG2710
PROJECT MANAGER:	Adrian C. Pinder
REPORT AUTHOR(s):	Dr Andy Harrison, Adrian Pinder, Dr Roger Herbert, Wayne O'Brien, Dr Josie Pegg, Dr Daniel Franklin

BU Global Environmental Solutions (BUG)
Bournemouth University
Department of Life and Environmental Sciences
Faculty of Science and Technology
Christchurch House, Fern Barrow
Poole, Dorset, BH12 5BB
www.bournemouth.ac.uk/bug

Client:
Borough of Poole
1 New Fields Business Park
Stinsford Road
Poole
Dorset
BH17 0NF

TITLE: **Poole Park Lakes: Research and monitoring**

CLIENT: **Borough of Poole**

BUG REF: **BUG2710**

This document has been issued and amended as follows:

VERSION	DATE	DESCRIPTION	CHECKED BY LEAD AUTHOR	APPROVED BY
Draft v0.1	19/02/2016	Draft for client review		
Final v1.0	03/03/2016	Final version		

This report should be cited as:

Harrison A., Pinder A., Herbert R., O'Brien W., Pegg J. and Franklin D. (2016) Poole Park Lakes: Research and monitoring. BU Global Environmental Solutions (BUG) report to Borough of Poole. 96 pp.

EXECUTIVE SUMMARY

Poole Park was officially opened in 1890 and celebrated its 125 year anniversary in 2015; it is regarded as a focal point for recreational activity and outdoor space within the Borough of Poole (BoP) and is widely enjoyed by a variety of stakeholders. Central to the amenity and recreational value of Poole Park are the three water bodies; two small freshwater lakes and the larger 'boating lake' (referred to throughout this report as the Lagoon). All three lakes represent highly degraded ecosystems, characterised by poor water quality, algal blooms and problem swarms of non-biting chironomid midges.

Previous monitoring of the water bodies has been restricted to a limited number of small scale 'snapshot' investigations, mainly focussing on the Lagoon. As a result, previous management regimes have been severely constrained by a lack of robust evidence.

The findings of the current study corroborate previous short-term investigations and anecdotal information; albeit, providing a much more robust and holistic dataset. Results from the water quality and sediment quality, ecology and hydrology investigations are provided in Sections 4, 5 and 6, respectively.

The impounded nature of the Lagoon, along with limited opportunity for tidal exchange with Poole Harbour, have been identified as key factors constraining the ecological function of the Lagoon. The two main effects of prolonged impoundment are that a) salinity is gradually reduced due to rainfall and surface water inputs, and b) due to elevated nutrient loadings, phytoplankton and algae can capitalise on extended residence times and proliferate to nuisance levels. These are considered to be two of the most important contributory factors to the ecological issues affecting the Lagoon.

Sections 8 and 9 provide a detailed interpretative discussion of the environmental and hydrological monitoring results, and highlight the key management issues that need to be addressed. In particular, the sustainable management of these water bodies must rely on addressing the root causes of problems rather than the reactive application of 'sticky plaster' solutions.

Based on the data and interpretation presented within this report, it is important for BoP managers to accept and work within the limits of ecological potential the lakes offer. The current study reinforces the need for a fundamental shift in thinking with regard to the amenity value of the lakes and the management of on-going ecological issues. Specifically, it would be unrealistic to believe that the Lagoon could be maintained as a low nutrient, weed free water body. Rather, recognising and promoting the water body as a saline lagoon with the potential to attract unique wildlife, including invertebrates, fish and birds will be key to managing public expectations and allow BoP to set realistic and sustainable management targets with tangible outcomes for stakeholders.

Achieving these goals whilst balancing the sensitivities associated with 'change', however, will require a coherent management strategy, incorporating a maintained range of synergistic management actions.

With regard to the Lagoon; to realise the ecological potential offered by this unique system, such management actions include, but are not limited to:

- Increase and maintain the flushing frequency between the Lagoon and Poole Harbour.

- Divert the large drain input on the north-eastern shore (referred to as 'L2' in this report) directly to Poole Harbour.
- Increased water depth and re-profiling of bed sediment; facilitated by creation of submerged reedbed islands, accessible via boardwalks.
- Remove barley straw bales.

For the freshwater lakes, the following should be considered:

- Carp removal from the large freshwater lake (referred to as 'FW1' in this report).
- Dredging of nutrient rich, anoxic sediment from both freshwater lakes.
- Reduction in wildfowl numbers, particularly geese, through a humane management plan.
- Investigate drainage issues; potential to divert drains into 'L2' and straight to Poole Harbour.

A future vision for Poole Park?

Given the long-standing and on-going ecological issues surrounding the Poole Park Lakes, in particular the Lagoon, a concerted effort will be required to realise the full potential of the ecosystem services offered by the water bodies and the surrounding area. Recognising, enhancing and managing the water body as a saline lagoon with unique habitats and species, whilst maintaining (and enhancing) the opportunity for water sports activities, would provide a whole range of ecological and societal benefits.

Section 9.3 discusses a potential 'future vision for Poole Park', including a schematic representation of one possible plan for the Lagoon, utilising the unique features of the water body to provide a shared resource offering both enhanced ecological benefits and high amenity value. This includes re-profiling the bed by the creation of new 'submerged' reed islands from dredged sediment. It is anticipated that these islands would be accessible via boardwalks to allow the public to engage more with the main lake and, combined with interpretation boards, highlight the unique lagoonal ecosystem, habitats and species present.

Reed beds (on the islands and shoreline), gravel shoals and varying depths in inaccessible areas would all provide habitat for invertebrates and wading birds, which could be observed from a bird watching hide.

Currently, water sports are mainly focussed on the western end of the lake; increased depths, better water quality and removal of the barley straw bales would all provide enhanced opportunities for a variety of activities on the lake in this watersports area.

Enhancing the accessibility of the Lagoon through the creation of submerged islands and boardwalks may also shift the focus from bird feeding in the freshwater lakes, which contributes to the degraded water quality and nuisance geese in these areas. For example, creation of a deeper 'crabbing' zone on one of the islands / boardwalks would provide additional activities for young families to enjoy.

Enhancing the overall ecological and amenity value of the Lagoon would provide significant tangible benefits. In addition to helping alleviate the on-going ecological issues; physical activity, mental health and societal benefits would be realised through promoting public engagement with green outdoor spaces.

9. THE FUTURE OF POOLE PARK

With specific reference to the Lagoon, the water bodies of Poole Park constitute key focal features of the park; aquatic-based problems (e.g. chironomid swarms and algal decay), therefore, have the potential to directly impact on the amenity value, business potential and wellbeing of local residents.

Enjoyed across the full demographic of society (local and tourists), the Lagoon has enormous potential to provide a range of currently untapped ecosystem services, which would benefit the public by facilitating and encouraging their engagement with outdoor space and nature.

For the three water bodies to achieve or move towards their functional potential, the 2015 monitoring programme has identified a range of issues which require remedial management action.

9.1 Managing the Lagoon – past, present and future

With previous monitoring of the lakes being restricted to a limited number of small scale 'snapshot' investigations, past management of the lakes has been severely constrained by a lack of robust evidence. Despite previous attempts to control algal production with the annual application of blue dye, rafts of barley straw bales and drying of the lake bed during winter, the efficacy of these measures has never been qualified (although appears to be negligible).

Moving forwards, the sustainable management of these water bodies must rely on addressing the root causes of problems rather than the reactive application of 'sticky plaster' solutions.

Based on the data and interpretation presented within this report, it is important for BoP managers to accept and work within the limits of ecological potential the lakes offer. Specifically, it would be unrealistic to believe that the Lagoon could be maintained as a low nutrient, weed free water body. Recognising and promoting the water body as a saline lagoon with the potential to attract unique wildlife, including invertebrates, fish and birds will be key to managing public expectations and allow BoP to set realistic and sustainable management targets with tangible outcomes for stakeholders.

Achieving these goals whilst balancing the sensitivities associated with 'change', however, will require a coherent management strategy, incorporating a maintained range of synergistic management actions, as outlined in the following sections.

9.1.1 Increase and maintain flushing frequency

Based on the evidence collected, increasing the frequency of flushing with Poole Harbour has been predicted to maintain higher water quality, assist in limiting the proliferation of phytoplankton blooms, limit the risk of chironomid swarms and enhance aquatic biodiversity within the Lagoon.

To increase the diversity and number of specialist lagoonal species present, the management of salinity is priority. Most specialist lagoonal species are closely related to marine species; therefore, most have a preference for salinities approaching that of the open sea i.e. 35 ppt. Although many are tolerant of periodic reductions in salinity, the input of freshwater is not necessary for saline lagoons; however, a freshwater gradient or patchiness in salinity can increase the diversity of habitats. Variation in salinity outside the range 15-40 ppt is likely to be tolerable to these specialist species for a few days; however, without remedial action, when levels fall below 10 ppt, the

invertebrate community is likely to become rapidly dominated by high densities of nuisance pest species (e.g. chironomids).

Using a combination of hydrology data (Section 6) and modelled salinity response (Section 8.8), maintaining salinity within the optimal range would require the monthly exchange of 75 percent of the lake total volume. Based on tides and flow exchange rates, opportunities for water exchange would be limited to the largest tidal ranges in the harbour, with both drain down and recharge taking approximately 7 hours. In terms of visualising disruption to current recreational activities and aquatic wildlife, under this management scenario, minimum water levels would be temporarily reduced by approximately 60 cm (to a reading of 0 mAOD) on the gauge board adjacent to The Kitchen restaurant. Given the length of time required to exchange 75 percent of the lake volume, it is likely that this scenario would require two tidal cycles to complete

Whilst the above management strategy would be expected to realise benefits across both water quality and ecology, reducing the volume of freshwater input to the Lagoon has the potential to dramatically reduce salinity dilution rates and thus reduce monthly tidal exchange requirements to 50 percent (or less) of the lake volume. A 50 percent volume exchange has been modelled to take approximately 4.5 hours for both the drain-down and recharge, with water levels on The Kitchen gauge board not dropping below 20 cm. With the continuous and highest proportional volume of freshwater to the lake being delivered from L2, the benefits of rerouting this drain are presented in Section 9.1.2.

It is important to note that leaving the lake drained for more than a single tide (e.g. as previously actioned to facilitate maintenance works) would have a deleterious impact on the ecological community of the lake. To promote the establishment and stability of a functional ecological community, such management practice should be avoided in future.

9.1.2 Divert L2 freshwater drain input

Despite the difficulties associated with gauging the highly variable flow of water entering the Lagoon from marginal drain inputs, observations of flow rates throughout the monitoring programme have confirmed L2 as the most significant source of freshwater to the Lagoon.

Not only does this have implications for diluting the salinity of the Lagoon, L2 periodically delivers licensed Combined Sewer Overflow discharge to the lake, along with a continuous delivery of high coliform and nutrient loadings.

Accordingly, the diversion of L2 to Poole Harbour would provide considerable benefits for the Lagoon and its management. Not only would this reduce the volume of monthly water exchange required to maintain desired salinity levels; removing the input of high nutrient, bacterial and ammonium loadings would also reduce localised health risks to the public (and pets) and translate to general improvements in water quality across the lake.

9.1.3 Island creation and increased water depth

The Lagoon is extremely shallow and, combined with prolonged periods of hot, calm weather, this can exacerbate the problems associated with algal blooms, filamentous algae and tasselweed. Although creation of an excessively deep lake is not considered desirable, increasing the water depth

by strategic removal of accumulated silt would provide multiple benefits to both water quality and ecological function.

The majority of UK lagoons are less than 2m deep and it is possible that depths exceeding this value may result in insufficient photosynthetic activity from benthic algae and macrophytes to maintain sufficient oxygen levels. In addition, plants also provide habitats for invertebrates.

Currently, there are five small islands in the Lagoon, created from dredged material from the lake bed. However, these islands are limited in terms of ecological function or amenity value. Increasing the lake depth by the creation of new 'submerged' islands from dredged lake bed sediments would provide multiple benefits to the lake ecology, as well as enhancing the amenity value of the lake to the public by making the islands accessible from the shore via boardwalks (see Section 9.3).

To promote the establishment of reed beds to cover the islands, the new islands should be submerged approximately 30 cm below the lake full water level (depending on reed species); this would also help to discourage wildfowl roosting on the islands. The margins of the islands should comprise a shallow shelving depth profile, providing varying habitats for a range of species.

Creation of sufficiently large islands would enable the lagoon bed to be re-profiled, with a view to providing an increased diversity and quality of habitat. Depths should range between 0 and 2 m, with shallow shelving areas, beaches and gravel shoals to provide habitat for a range of key lagoonal invertebrate and bird species. NOTE: An investigation of groundwater levels should be conducted in advance of any excavation to determine any potential issues with groundwater intrusion.

In addition, creation of new islands in the north-eastern area of the Lagoon would also help to reduce the impact of wave action on the northern banks during periods of high winds from the prevailing south-westerly direction (Figure 9.1).

Figure 9.1 High south-westerly winds creation wave action on the north-east shore due to the large reach across the main body of the Lagoon.

9.1.4 Remove barley straw bales

The efficacy of barley straw in controlling algal blooms in water bodies is largely untested from an independent scientific perspective, with much of the literature relating to its effectiveness being anecdotal in nature and in relation to smaller water bodies.

From a UK perspective, the most comprehensive assessment of the use of barley straw for algae control was produced by CEH (2004). In a recent literature review of aquatic and riparian plant management (EA 2014), this CEH report is still cited as the most up to date literature on the use of barley straw for algal control, with no more recent scientific assessments of its efficacy being presented.

With regard to the Lagoon; the highly variable nature of the nutrient status and water chemistry (particularly salinity), largely augmented through flushing events with Poole Harbour, would likely have a confounding effect on the efficacy of barley straw in limiting algal production. Furthermore, given the often highly turbid nature of the water column, the amount of barley straw required for effective treatment may need to be increased beyond the normal recommended dose by at least a factor of two (CEH 2004). In addition, the current spatial distribution of bales within the lake is not considered sufficient to provide any effective algal control.

Given the continued recent problems with dense algal blooms in the lake, the efficacy of the existing barley straw bales could, and indeed should, be questioned. However, regardless of their effectiveness, attempting to control algal production by continued maintenance of barley straw bales within the lake is regarded as a 'sticky plaster' approach that does not address the fundamental underlying causes of the various lake management issues.

In addition, it could be argued that the floating structures used to contain the straw exist as an eyesore, a public health risk due to excessive bird faeces and obstructions to recreational water sports activities.

Given the high profile nature of the site, where recreational activities and aesthetic value are of paramount importance, the continued use of barley straw bales is not considered a viable long-term solution.

9.2 Managing the freshwater lakes

Water quality within the freshwater lakes has become severely degraded over time, which is mirrored by depauperate biodiversity and ecological function. While neither of the freshwater ponds present tangible problems to park users (chironomid swarms and decaying weed), the data presented within this report support consideration of the following management suggestions.

9.2.1 Carp removal in FW1

Due to high nutrient loadings, FW1 is prone to elevated levels of chlorophyll and periodic blooms of blue-green algae. In addition to a high density of wildfowl, high densities of large carp currently exacerbate water quality issues by disturbing bottom sediments, mobilising nutrients and preventing the establishment of a more balanced community of macrophytes.

With water quality frequently reaching threshold conditions to support fish, it is strongly advised that the carp population is severely cropped and translocated to an alternative waterbody. Due to

the size and condition of individual fish, the stock is likely to be of commercial interest to fish dealers and it is suggested that a single contractor is identified that can catch and relocate the fish in a single operation.

Not addressing this issue carries a risk for BoP, in that a comprehensive fish kill is not unlikely at some point in the future. Not only would this highlight the poor water quality in the lake, it would also cause distress to park users and require the recovery and disposal of a high biomass of decomposing carcasses.

9.2.2 Dredging

Both lakes have been subject to a high degree of silt accumulation, with water depths in FW2 not exceeding 30cm. Largely due to guano input from the high density of wildfowl, the sediment in both lakes provides a reservoir of nutrients to fuel algal production, is anoxic and would benefit from removal.

9.2.3 Aesthetics

In addition to providing an attractive feature, the installation of one or more decorative fountains on FW1 would assist in maintaining DO levels at a level more conducive to supporting aquatic fauna.

9.2.4 Reduction in wildfowl numbers

The main cause of poor water quality in both freshwater ponds is due to bird numbers. While a humane management programme (e.g. egg pricking) offers the most effective measure of managing this stressor, the discouragement of feeding wildfowl could be promoted through a combination of educational interpretation boards and preventing the sale of bird (and fish) food from the railway kiosk.

The success of such a scheme would, however, depend on the provision of alternative activities, and crabbing within the main lake may assist in this respect. At present, the islands in FW2 are utilised as roosting habitat, so the removal of the islands or the installation of deterrents (such as lighting) may be effective in discouraging birds from congregating on FW2 at night.

9.2.5 Drainage issues

The reduced temporal and spatial scale of water quality sampling in the freshwater lakes continues to constrain knowledge of how drain inputs impact on the water quality of FW1 and FW2. However, the physical drainage to the north of FW2 is clearly an issue, with the path often flooded during wet weather events.

Should the option to divert L2 to Poole Harbour be further investigated, it is strongly recommended that the feasibility of rerouting all drains currently entering the freshwater lakes into the L2 discharge is explored.

9.3 A future vision for Poole Park

Poole Park is a focal point for the local community and the opportunity for development of the area for public benefit raises fundamental questions as to how and for what purpose the lakes should be managed in the future.

Given the long-standing and on-going ecological issues surrounding the Poole Park Lakes, in particular the Lagoon, a concerted effort will be required to realise the full potential of the ecosystem services offered by the water bodies and the surrounding area.

As mentioned in Section 9.1, recognising and promoting the lake as a saline lagoon with the potential to attract unique wildlife, including invertebrates, fish and birds will be key to managing public expectations and allow BoP to set realistic and sustainable management targets. The current study, supported by years of previous smaller investigations, anecdotal information and negative public comments, reinforces the need for a fundamental shift in thinking with regard to the amenity value of the lake and the management of on-going ecological issues.

Currently, the Lagoon is a hugely under-utilised resource in Poole Park, largely focussed on recreational water sports for the benefit of a relatively small minority. Recognising, enhancing and managing the water body as a saline lagoon with unique habitats and species, whilst maintaining (and enhancing) the opportunity for water sports activities, would provide a whole range of ecological and societal benefits.

Figure 9.2 shows a schematic representation of one possible plan for the Lagoon, utilising the unique features of the water body to provide a shared resource offering both enhanced ecological benefits and high amenity value.

The creation of new 'submerged' reed islands that are accessible via boardwalks would allow the public to engage more with the main lake and, combined with interpretation boards highlighting the unique lagoonal ecosystem, would increase awareness of the unique habitats and species present.

Reed beds (on the islands and shoreline), gravel shoals and varying depths in inaccessible areas would all provide habitat for invertebrates and wading birds, which could be observed from a bird watching hide.

Currently, water sports are mainly focussed on the western end of the lake; increased depths, better water quality and removal of the barley straw bales would all provide enhanced opportunities for a variety of activities on the lake in this watersports area.

Enhancing the accessibility of the Lagoon through the creation of submerged islands and boardwalks may also shift the focus from bird feeding in the freshwater lakes, which contributes to the degraded water quality and nuisance geese in these areas. For example, creation of a deeper 'crabbing' zone on one of the islands would provide additional activities for young families to enjoy (Figure 9.3).

Enhancing the overall ecological and amenity value of the Lagoon would provide significant tangible benefits. In addition to helping alleviate the on-going ecological issues; physical activity, mental health and societal benefits would be realised through promoting public engagement with green outdoor spaces.

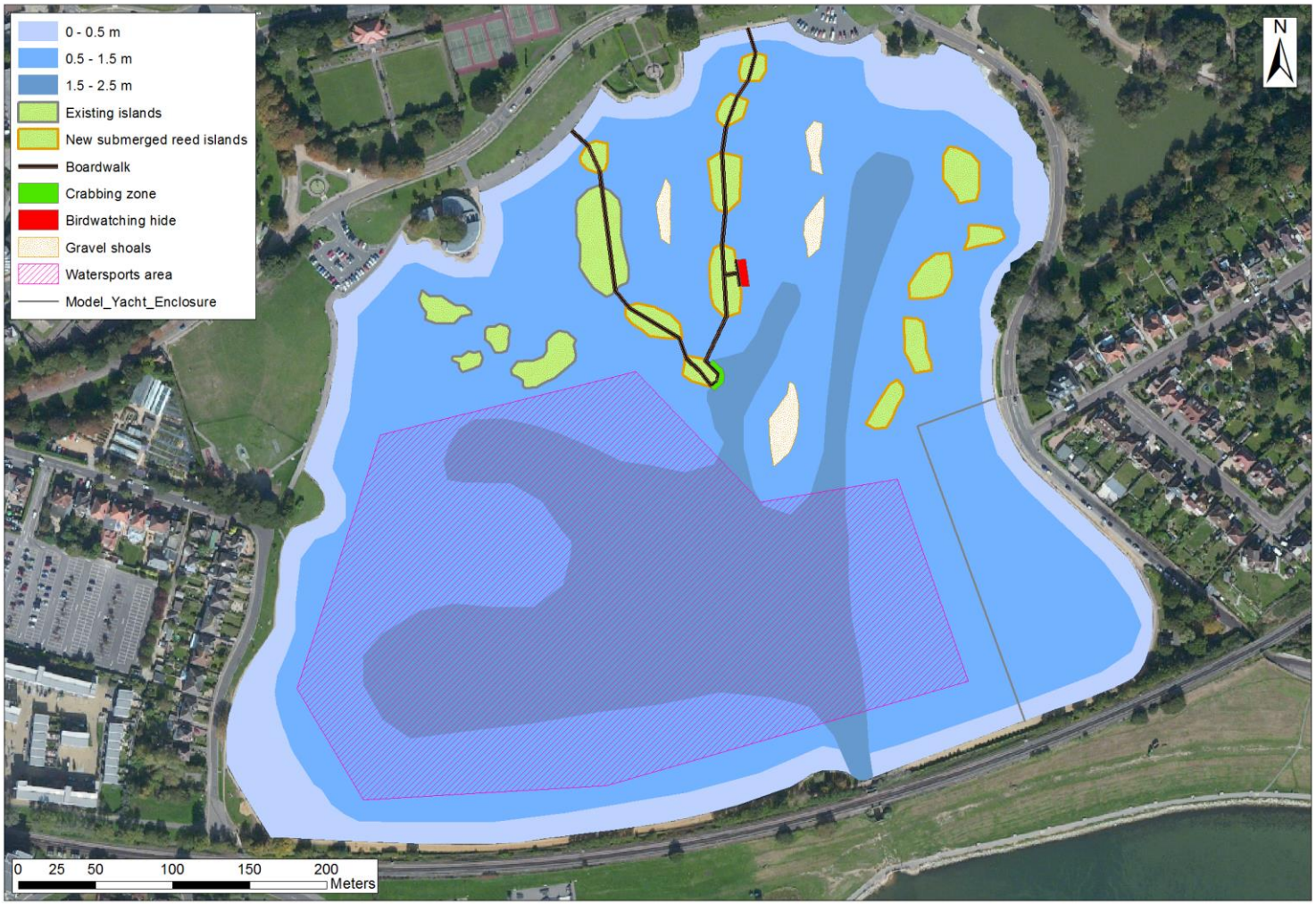

Figure 9.2 Schematic example of the Lagoon with new submerged reed islands, gravel shoals, boardwalk, birdwatching hide, crabbing area, designated water sports zone and model yacht enclosure.

Figure 9.3 Decked boardwalk at Radipole Lake in Weymouth – a children's crabbing area for the Lagoon in Poole Park?

Although considerably larger than the Lagoon and subject to a range of different environmental conditions, Figure 9.4 below shows a photo of Radipole Lake in Weymouth and illustrates the type of habitats that could be created in the Lagoon. In particular, gravel shoals and submerged reedbed islands with shallow depth profiles offer foraging habitat for wading birds, and provide refuge for a range of species.

Figure 9.4 Radipole Lake in Weymouth – an example for the Lagoon in Poole Park?