Pond design

MILLION PONDS PROJECT

A 50-YEAR PROJECT TO CREATE A NETWORK OF CLEAN WATER PONDS FOR FRESHWATER WILDLIFE

1. Introduction and principles

Any pond design works if you have clean water. Even vertically-sided tanks will develop rich wildlife communities. But with good design it's easy to create better opportunities for wildlife, making ponds richer and longer-lived.

To maximise the wildlife value of a pond site:

- Create pond complexes or multiple pools rather than a single waterbody.
- Within complexes, include both permanent and seasonal ponds. Ponds don't need to hold water all year round: temporary ponds are important wildlife habitats.
- Make sure that almost all pond slopes are shallow, less than 1:5 (12°) and preferably less than 1:20 (3°).
- Make broad, almost flat, undulating wetland areas around and between ponds.
- Create underwater bars and shoals to benefit aquatic plants.
- Design according to your landscape. If ponds are grazed, even tiny micro-pools can persist in the long term. If the pond surrounds are not grazed, dig at least some larger ponds (at least 20 m diameter) to avoid complete over-shading by trees.
- Use design to minimise future problems for your ponds: think about how the pond will be used by people and animals.

2. Create pond complexes

Creating a single clean water pond is good. Creating a pond complex with many different ponds is even better (Figure 1).

The simplest way to increase site richness is to dig a series of ponds with different maximum depths. Ideally some pools should dry up every year, others dry occasionally in drought years, and some should be permanent.

It is possible to make pond complexes at all but the smallest sites. Individual pools can be tiny, just a few meters across. But it's best to keep shallow and deep water pools separate (except, perhaps in winter high water conditions) to maintain different communities in different ponds.

What's in this factsheet?

What is a pond?

Ponds are permanent or seasonal waterbodies between 1 m^2 and 2 hectares in surface area (about 2.5 football pitches).

This definition includes temporary ponds that dry up during the year, as well as tiny pools and very shallow ponds like 'wader scrapes'.

Creating varied sites has long term benefits for wildlife:

- The mosaic of permanent, semi-permanent and seasonal ponds will encourage a far greater variety of plants, invertebrates, amphibians and mammals to use the site.
- It creates a protective network whatever the climate that year or however the ponds mature. If one pool becomes unsuitable, plants and animals can move to another.
- It provides a safety net so that if unwanted species (like invasive plants or ornamental fish) or pollutants get into one pond, others remain problem free.

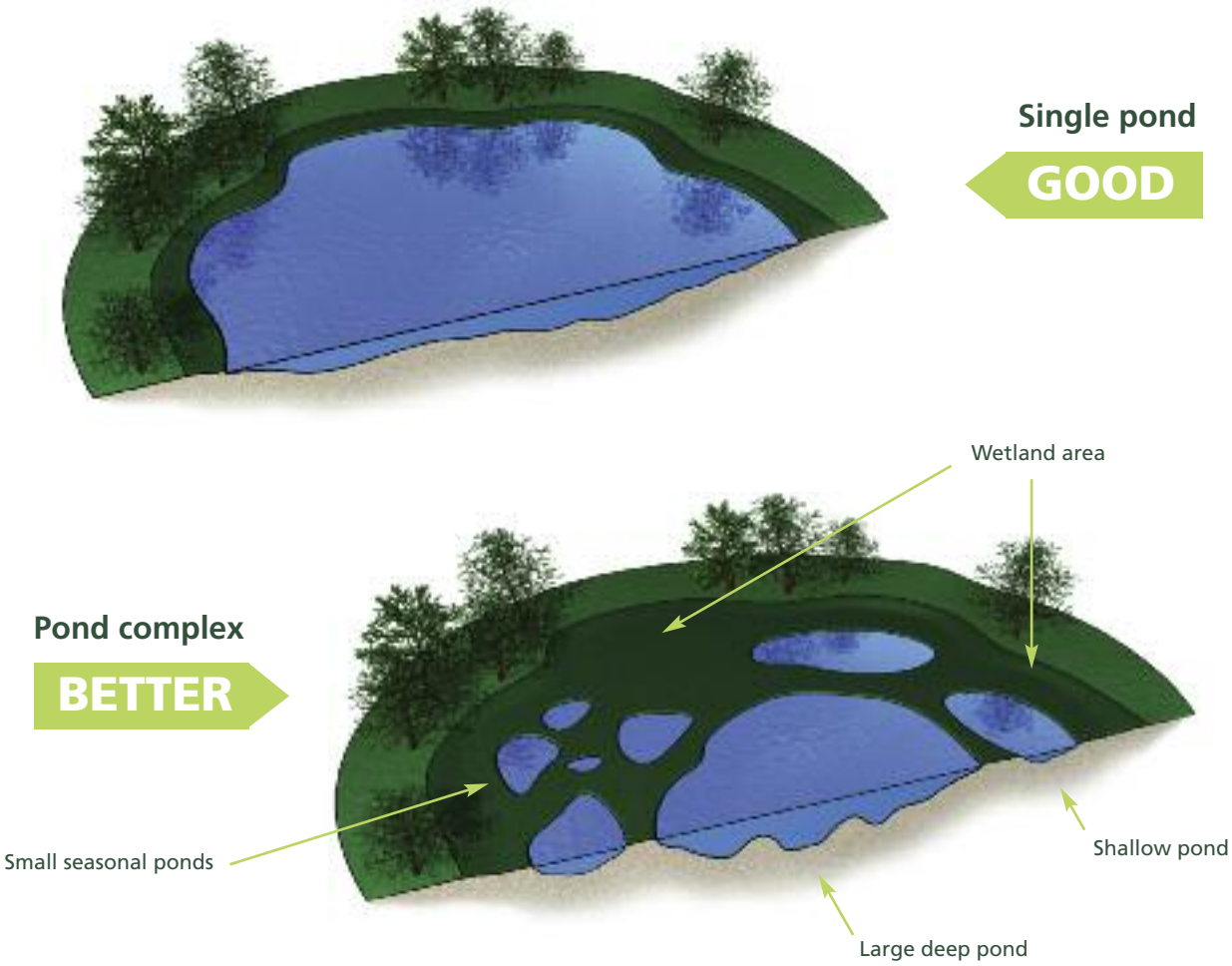


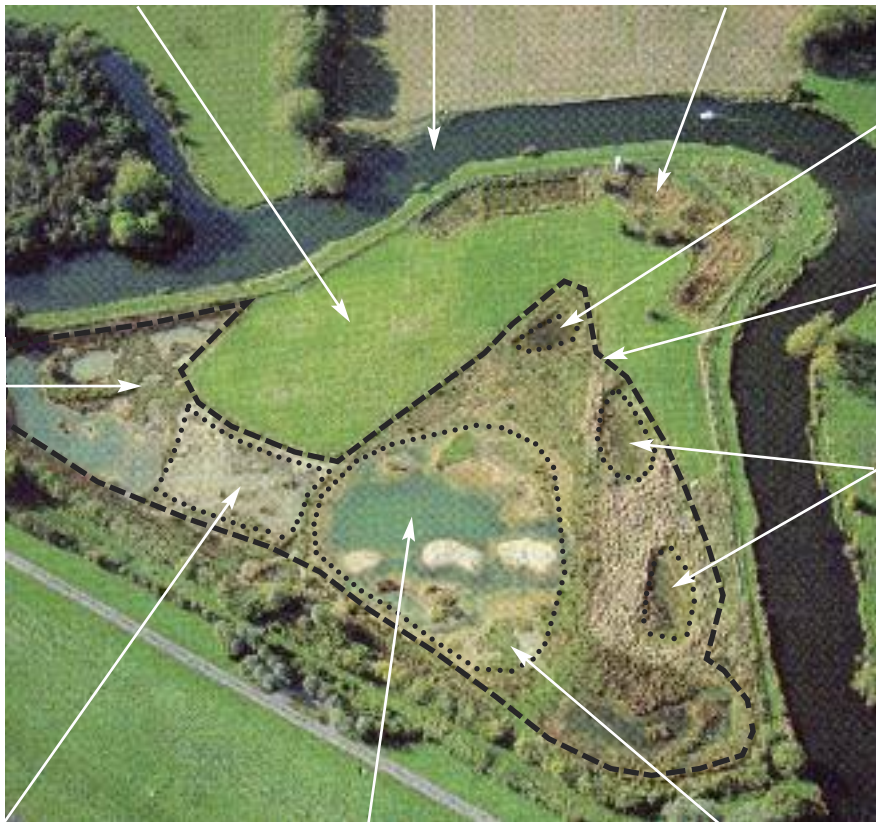
Figure 1. Create complexes of ponds with different depths and surface area. This will increase the range of wildlife attracted to the site, and provide habitats in all climate conditions.

Pinkhill Meadow pond complex

The Pinkhill Meadow pond complex was created in 1990 and has some 40 ponds of varying sizes and depths on a five hectare site. It quickly became one of the richest pond sites in the UK.

Detailed monitoring of the site shows that individual ponds have changed in wildlife value, but 20 years on the site as a whole is still as rich as ever. The ponds monitored reached 'Priority Pond' status (see the *Pond HAP*) very quickly – after just three years, and this is still the case today, some 15 years later.

This creation scheme was a partnership between the Environment Agency, Thames Water and Pond Conservation.



3. Pond design and landscape type

The landscape type in which you put a pond will fundamentally affect how the pond develops. You can use design to make sure that ponds in any landscape are long-lived and maintain a varied range of habitats through their lifetime.

The most important landscape distinction is between ponds that are grazed by stock (cattle, sheep or horses), and those that are not (Figure 2).

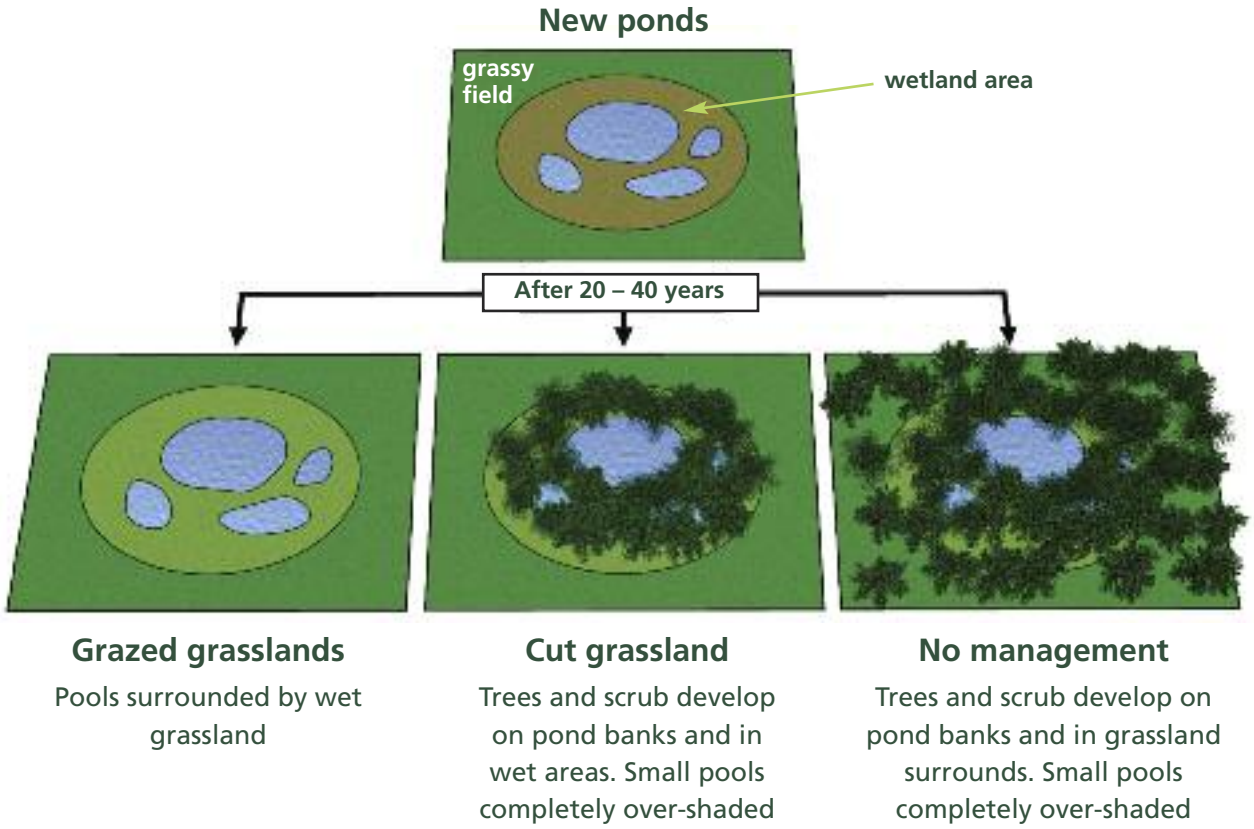


Figure 2. Ponds on grazed and un-grazed sites develop very differently over time.

If ponds are grazed, even small-scale features such as tiny 20 cm deep grassy pools are worth creating and these features will usually be maintained in the long term. This gives enormous flexibility in pond design: all sizes, shapes and depths of pond and pool will work (Figure 3).

If ponds are not grazed, tiny pools are quickly filled by the roots and leaves of taller sedges and reeds. As ungrazed sites mature they will usually become wooded and small pools can quickly become heavily shaded and full of leaves. Even if sites are cut or mowed, a tree-lined fringe will usually grow up on the un-cut pond edges, overshading the pond.

There is nothing wrong with tree-shaded leaf-filled pools: they can support distinctive pond animal communities, and wet woodland is a priority habitat type. However, small leaf-filled ponds tend to be rather uniform. Where sites are not grazed, it is worthwhile including large (sometimes shallow) waterbodies and carefully planning pond edge and slopes to ensure wetland plants can grow at the margins (see website for lots of design examples).

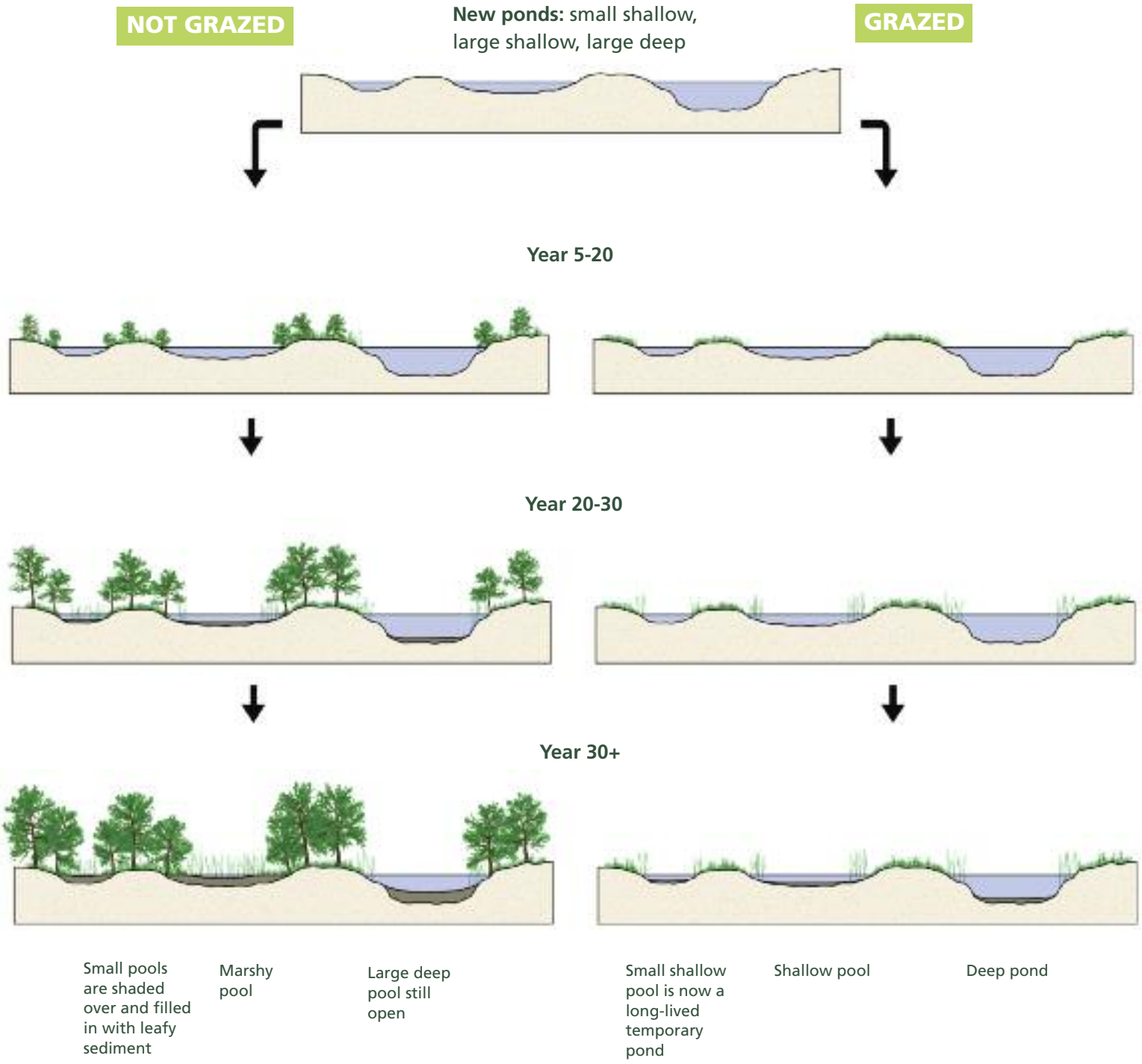


Figure 3. The fate of small, deep and shallow ponds under grazed and ungrazed management.

4. Designing different areas of the pond for wildlife

To design good wildlife ponds it helps to understand the different areas of a waterbody and how they are used by plants and animals (Figure 4).

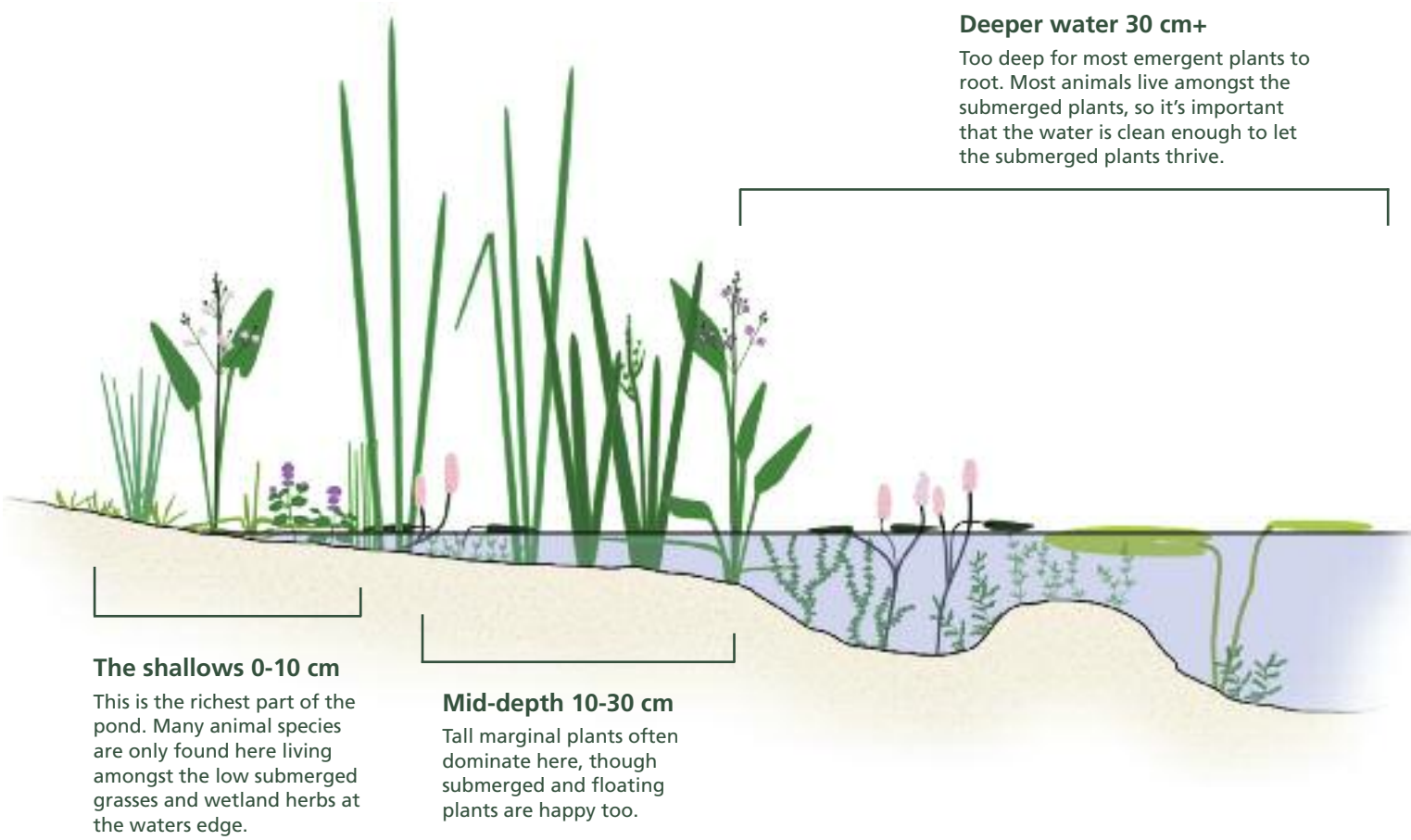


Figure 4. Where's the wildlife?

4.1 The drawdown zone

One of the many myths about ponds is that pond water levels need to be stable throughout the year. In most ponds, nothing could be further from the truth.

Typically, pond water levels drop by around half a meter or more during the summer months. This exposes a seasonal 'drawdown zone' – an area of mud and vegetation which is flooded in winter and spring, and progressively dries as water levels fall in summer. The ever-changing drawdown zone is one of the most important areas of a pond. It is an exceptionally rich habitat for plants and invertebrates, and often used by birds and small mammals as a feeding area.

Designing the drawdown zone

In traditional pond designs the drawdown area is rarely considered and, by default, is usually restricted to a narrow strip at the water's edge. Broadening the drawdown to create extensive summer marsh and mud habitats can considerably improve a pond's wildlife value (Figure 5).

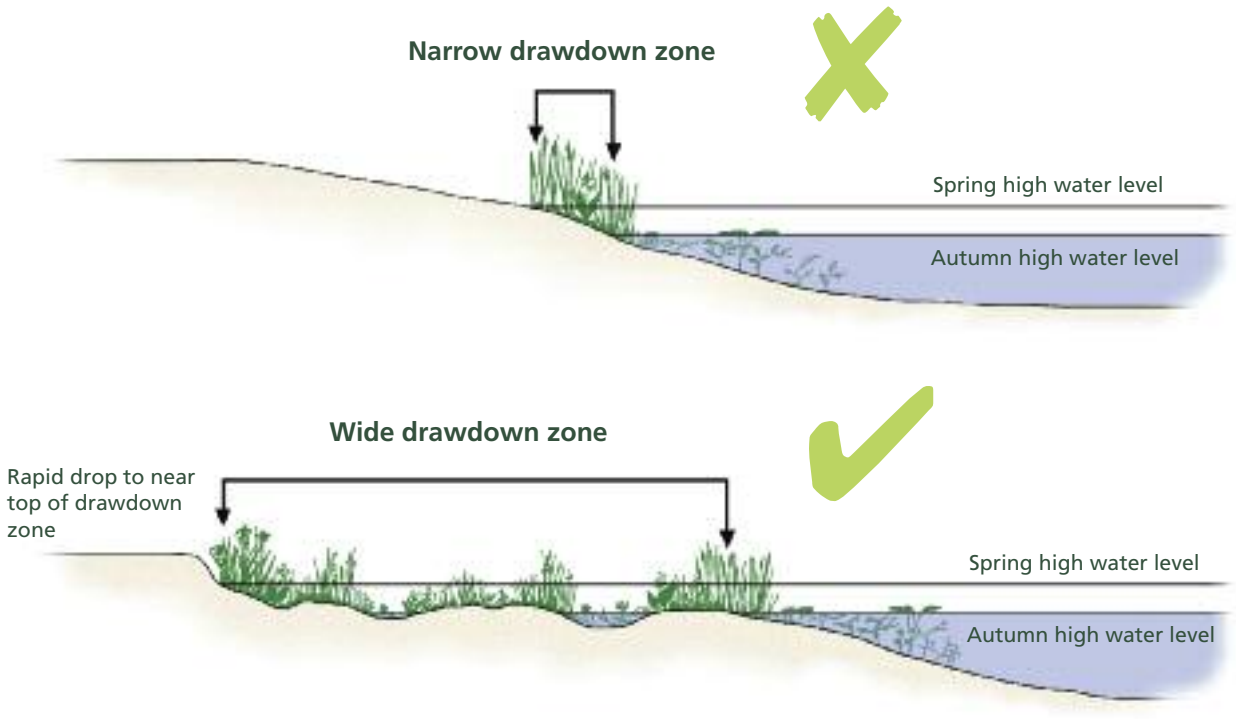


Figure 5. **Create broad undulating drawdown zones – they are one of the most valuable areas for wildlife.**

To design a good drawdown zone you need to roughly know the height of the winter and summer water levels (something that is not always easy before you dig a pond: see *Factsheet 10*). At sites where space is limited it can be useful to cut down steeply through the overburden (which will eventually form the pond's upper banks), then the slope below the top of the winter water level can be flattened off to create the drawdown zone (Figure 5).

Where a number of pools are being created close together, a good option is to remove overburden across the whole area to near the upper drawdown level (Figure 6). This increases the amount of spoil that needs to be excavated (with cost implications), but creates rich and natural wetland areas between the ponds and makes it easy to create new pools or change the site later without generating much additional spoil.

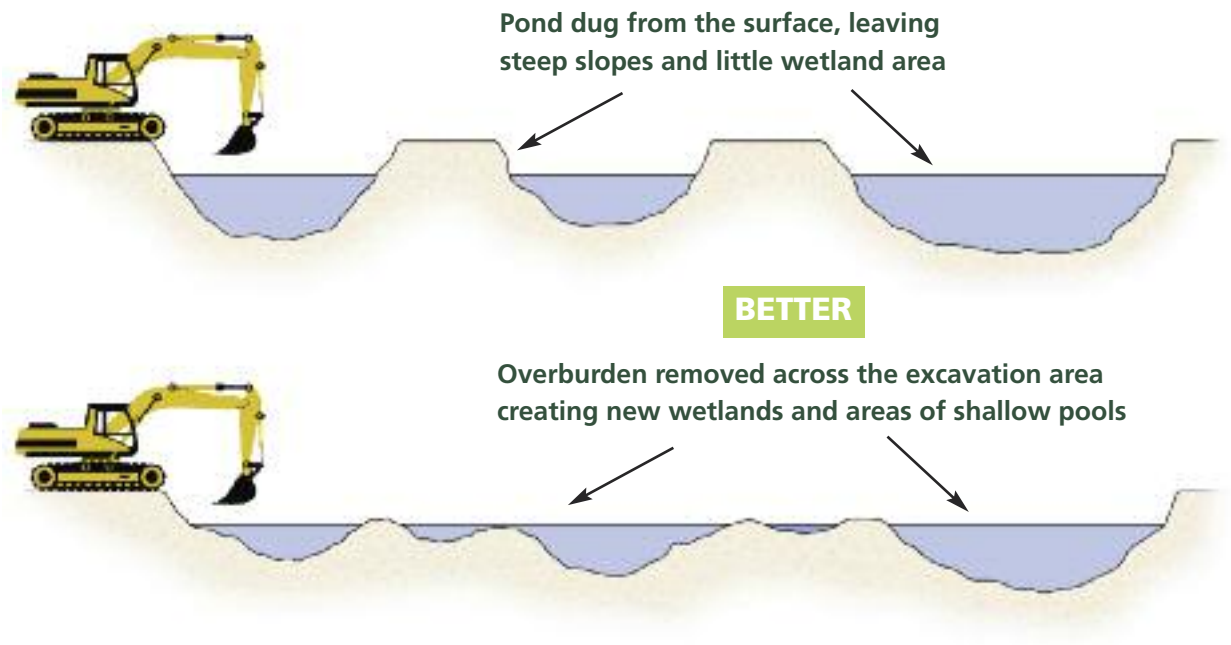


Figure 6. **Rather than excavating all the ponds from the surface, strip off overburden across the whole area and create new pools and wetland areas between.**

Undulating drawdown zones

Drawdown zones don't need to slope evenly down to deeper water: they can undulate, creating pools, spits and marshy areas around the pond edge. Designed well, these wet areas create a patchwork mosaic of small-scale habitats which can be exceptionally rich in plants and invertebrates (see Pinkhill Meadow box).

4.2 Shallow water

Many people know that the shallow areas of a pond are the best for wildlife, but think that 'shallow' means water 20 – 30 cm deep. Most pond animal species live in very shallow areas, right against the bank, often in water that's often only 1 – 10 cm deep. To improve ponds for wildlife, focus on these marginal areas.

Designing shallow water

To create such shallow areas, ponds need to slope very gently at the edge, at less than 1:5 (12°) and preferably less than 1:20 (3°) (Figure 7). Typical pond margins of 20-30° are usually too steep. With a 20° slope the critical wildlife-rich area (water less than 10 cm deep) is only a band around 35 cm wide – slightly more than the length of your shoe (Figure 8).

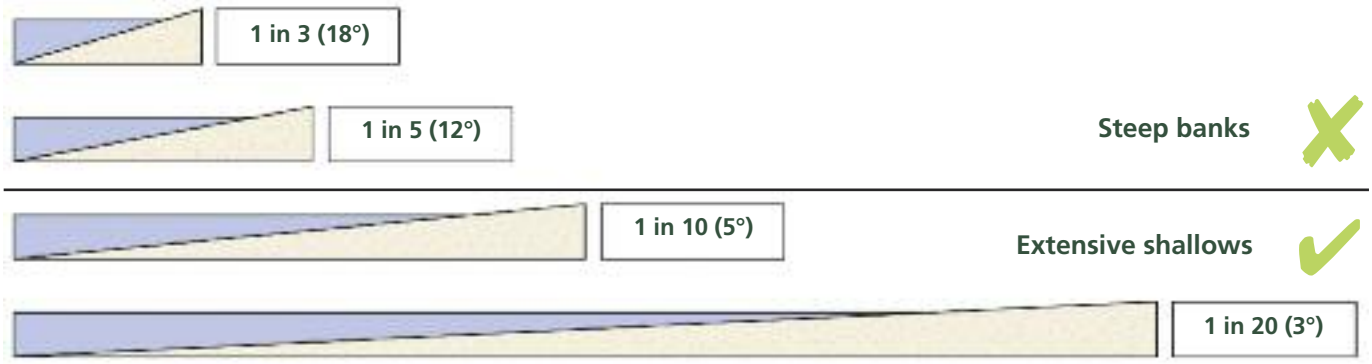


Figure 7. Bank angles. Slopes less than 1:10 are preferable for water's edge areas (though the terrestrial bank above can be much steeper). The aim is to create broad areas of very shallow water. Even with a 1:10 slope the shallow water zone (<10 cm deep) is only 1 m wide. Three strides from the bank, and the water is over the top of Wellington boots – too deep for many pond animals to be comfortable.

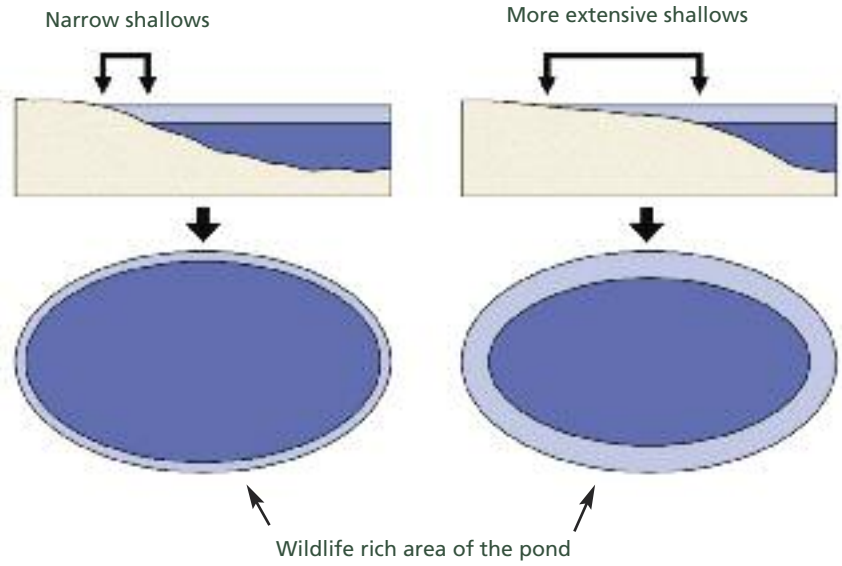


Figure 8. Design extensive shallows to improve the pond for wildlife.

To create deeper ponds (with depth over 0.5 m) and broad areas of shallow water – you need larger ponds. For a small pond (less than 10 m x 10 m) with an average summer drawdown of 0.5 m in height, even with quite a steep 10° (roughly 1:6) slope, the maximum summer water depth in the middle would be 50 cm, and the average depth 25 cm.

If necessary go for an asymmetric shape with some very shallow water, and a steeper far bank to gain water depth (Figure 9).

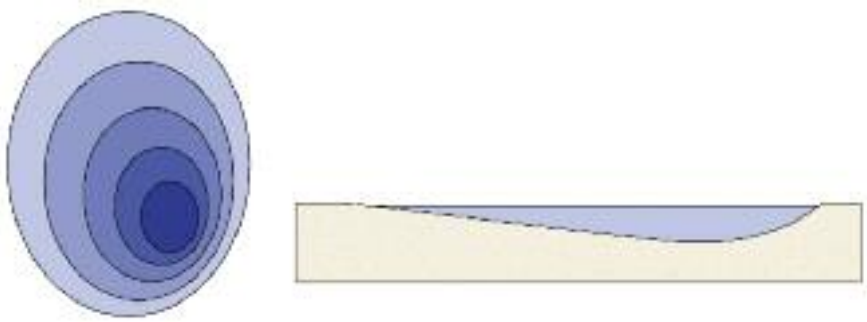


Figure 9. Asymmetric profile – useful to combine shallow water areas with greater depth.

Scalloped edges

Another classic way to increase the area of shallows and the length of pond margins is by creating embayments around the pond edge. This works well on ponds of all but the smallest size.

4.3 Deeper water

Traditionally it has been thought that deeper open water areas are an essential component of a successful wildlife pond, and older guides used to suggest that new ponds should be dug to at least 1.5-2 m deep. In fact, deep water is quite a specialised habitat, vital for few species.

This said, although deeper water (more than 30 cm deep) is not necessary in a pond, it can be useful within a pond complex. From a wildlife perspective deep water can also be valuable habitats – but the water needs to be clean. From a practical point of view:

- Where vegetation is not grazed down by stock, deep water can be used to stop marginal emergent plants dominating all ponds.
- Deeper ponds will take longer to fill in with sediment, so the permanent-water phase of the pond is more prolonged.

Designing deep water areas

A general rule in pond design is: the poorer the water quality, the shallower you make the pond. This is because submerged deep water plants, which provide homes for many animals, don't grow well in polluted water. So if the water is polluted, its best to go for shallow ponds where unfussy marginal plants (like yellow flag, water mint, and wetland grasses) can grow – at least then you don't end up with a rather scummy, cloudy pond with an impoverished deep water zone.

BUT – one of the many benefits of ponds created as part of the Million Ponds Project is that, because they have clean water, deep-water ponds can be created without worry. Most clean water ponds will support rich submerged plant communities and since many native submerged plant species are now uncommon and declining, this is a major opportunity to benefit wildlife.

Amongst the particular target plants for deep clean water ponds are the many submerged stonewort and pondweed species which are now becoming rare in the UK. We can design the deep water areas of our ponds to help these species thrive (Figure 10).

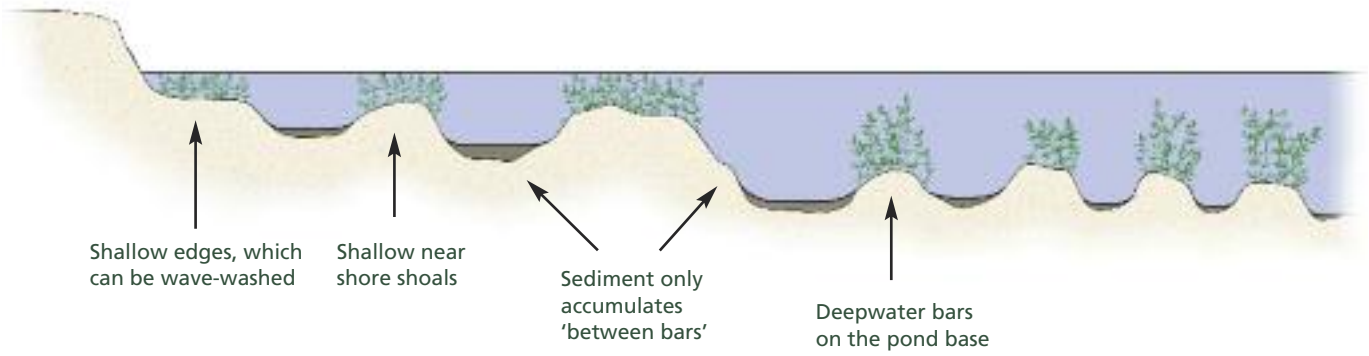


Figure 10. Organic sediments don't accumulate on top of submerged shoals and bars – so uncommon submerged stonewort and pondweed species can thrive.

Many of our rarest submerged plants need mineral soils to root into – they are happy in the bare clay or sand at the bottom of new ponds, but not in the dark organic-rich silts that build up as ponds age. You can keep mineral substrates exposed on the pond bottom for longer by creating underwater hummocks and bars. Organic sediments slip off the top of the bars, filling up the low troughs between the bars, and leaving the bar-top sediment-free for plants to root into (Figure 10).

The main draw back with this design is safety – rapid changes in underwater slopes can be treacherous for people wading in the pond – so this is not an ideal design for sites with public access.

5. Varying pond area

There is no right size for a pond but the landuse in which a new pond is created can influence the size of ponds that work best.

Tiny pools

Even tiny micro pools just a meter or so in diameter can be rich in wildlife – and will support different species to those in nearby deeper pools (Figure 11). Small pools are quick to make, and can be useful for adding variety to larger sites, since you can create many ponds in little space. The smallest pool that can easily be dug with a digger bucket is about 0.5 m diameter.

The main consideration which will determine whether it is worth creating very small pools on a site is the site's subsequent management. If ponds are not grazed by stock, tiny shallow pools usually fill in quickly. If they are grazed, even the smallest shallow pools can be very long-lived (Figures 3 and 11).

Figure 11. Even tiny pools can be good for wildlife – particularly where they are kept open by grazing.

Large ponds

The number of wetland bird species you can attract to a pond increases with pond area. For most other plant and animals however, the relationship is less clear cut – very roughly to double the number of species you need to increase the area by tenfold. So doubling the size of a pond can double the cost of excavation, but makes little difference to the number of species that will occur there.

Evidence shows that you will get more species if you create many smaller ponds rather than one single large waterbody in a given area. This said, there are situations where larger ponds are at a distinct advantage:

- In wooded landscapes larger ponds don't get completely over-shaded.
- Large ponds give you scope to create complex waterbodies: it's possible to combine extensive undulating shallows, deep water and islands in a single pond.
- Large ponds often have wind-blown waves, which can be used to advantage (see next section).

6. Wind, fetch and bank erosion

On larger ponds strong winds will often whip up waves. The longer the fetch (length of water across which the wind blows), the bigger the waves (Figure 12). As waves hit the far bank, they can erode small sharp-edged cliffs. The prevailing wind direction in Britain is broadly from the south-west. So, in a large pond, the opposite (north-east) banks will be the most eroded. Even moderate-sized 20-30 m diameter ponds can be affected by wave-wash, especially if the pond is located in an exposed landscape with few trees or hedges.

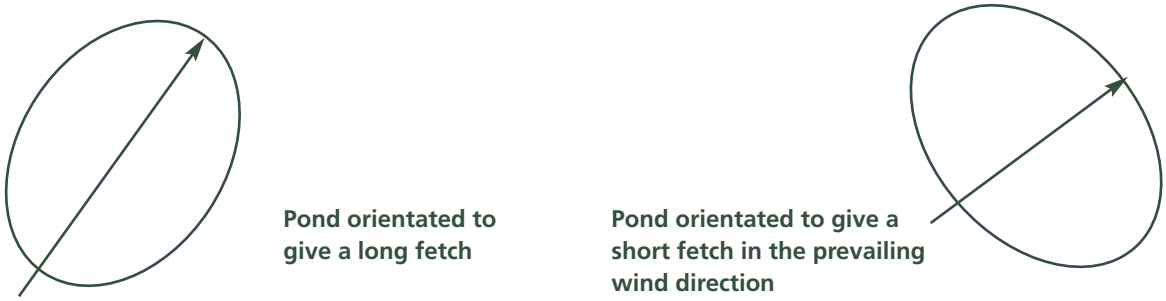


Figure 12. Wave wash.

Wave wash is often seen as a bad thing, and certainly steep eroded banks can be can inhospitable to wildlife. But, like many natural processes, waves can be a creative force. They are particularly useful for pond making in two ways (Figure 13):

- **Keeping bare sediments for submerged plants:** as noted above, clean-water ponds are good habitats for submerged plants like stoneworts which grow on bare sands or clays. Wave wash can help keep areas free of organic sediment and suitable for these plants by: (i) continually eroding sand and clay bank materials, and depositing them in the water (ii) keeping the pond base free of organic silt by washing organic silts into deeper water areas (Figure 10).
- **Creating wildlife rich backwaters:** a useful effect of the wind is that it blows seeds, spores, animal eggs and plant fragments across a pond and concentrates them along the wind-blown margin. If the right conditions are created, and these seeds germinate, the wave-washed margin can develop into a particularly rich habitat. The key is to slacken the wind and wave energy before it reaches the bank and erodes it. This can be done by creating islands or deep embayments along eastern margins. Very narrow-necked pools work particularly well, especially if their entrance is off-set so that they don't face the prevailing wind. Islands can be similarly protected from waves by creating submerged bars along their front edge.

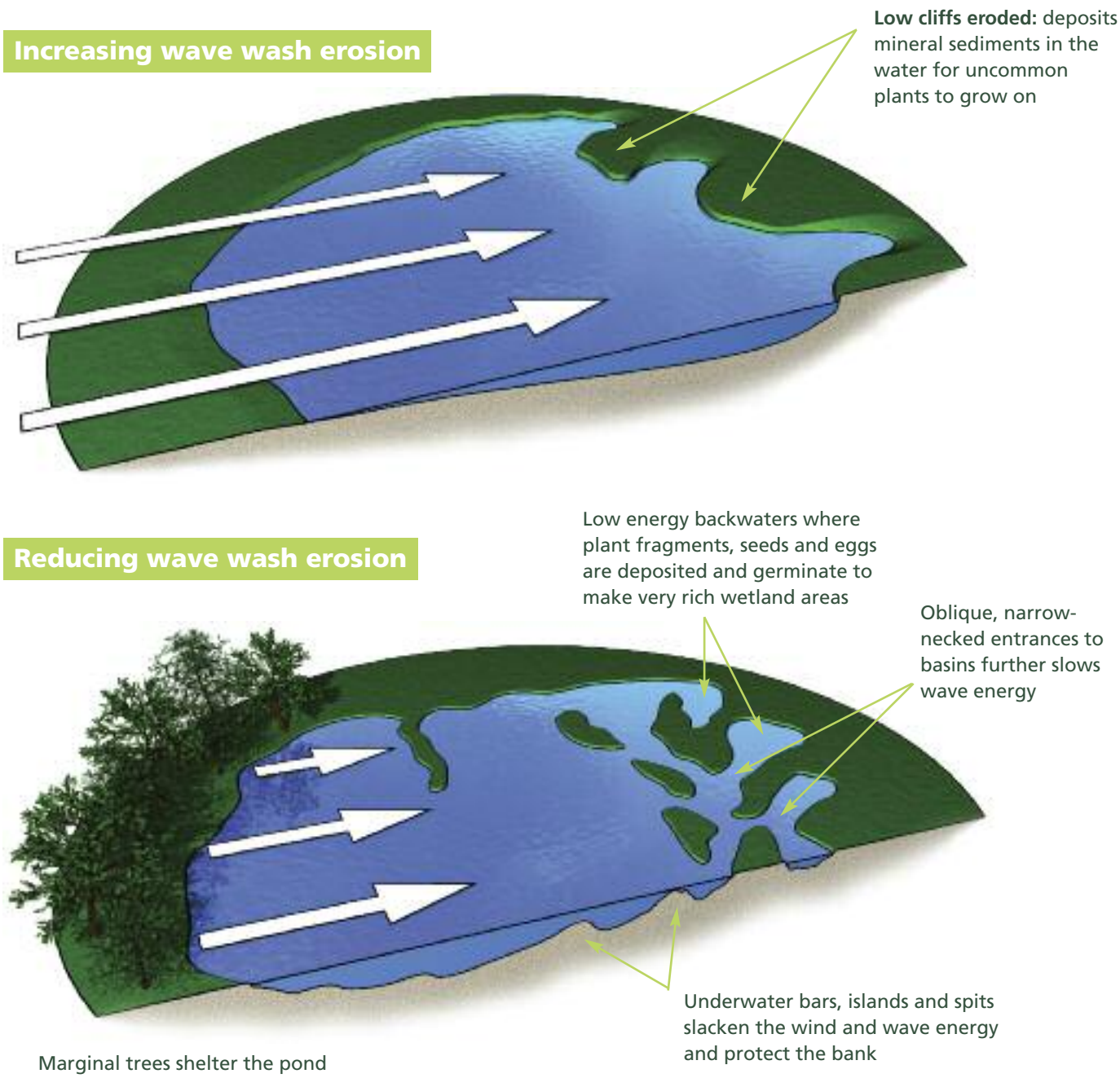


Figure 13. Using design to increase or reduce wave wash effects.

7. Islands

There are pros and cons to including islands in a new pond (Figure 14). For waterfowl and wading birds, islands can provide safe areas for feeding, roosting and nesting. However, if large numbers of feral geese or gulls regularly congregate, this may damage pond vegetation and degrade water quality.

Islands can add new habitats to ponds, especially if the pond margins are closely grazed, and the ungrazed island edges have tall wetland vegetation. However, in small ponds, their edges can be colonised by emergent plants like bulrush that quickly spread across the rest of the pond.

The main problem with islands is that it can be difficult to get their height just right. Often they are created too high, and quickly become wooded, blocking views and, in some cases, providing perching places for crows on the look out for wading bird chicks.

If islands are too low this is much less of a problem: they just become submerged bars – useful for aquatic plants to root in.

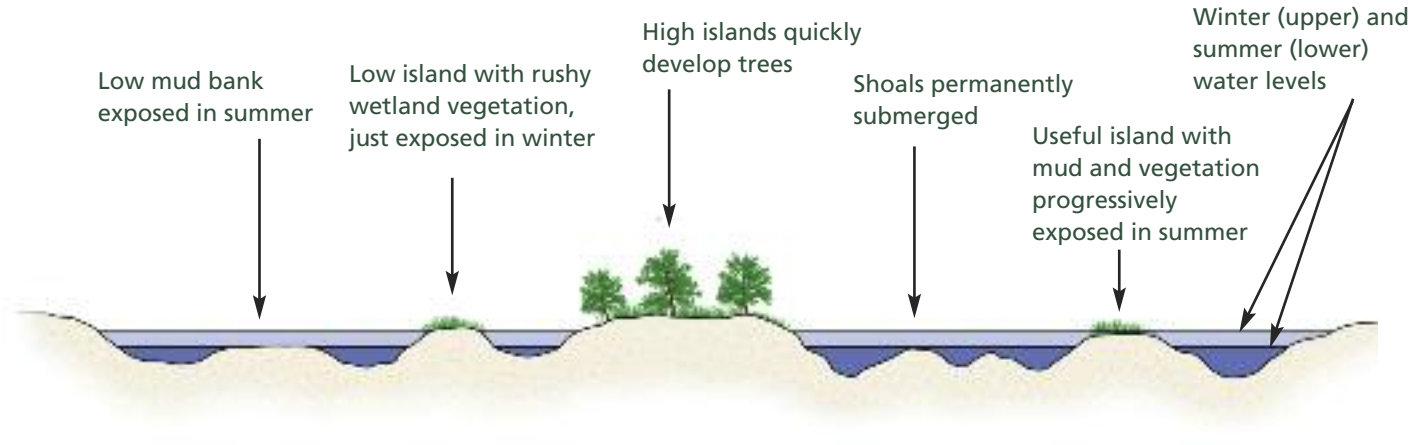


Figure 14. Design islands to minimise the need for management – ideally keep them low.

To minimise the need for management, create islands so that they are submerged in winter and early spring, which will kill off tree and shrub species, but become progressively exposed in summer to provide feeding and roosting areas. Higher islands, 20 – 50 cm above average spring water level, can be useful for water fowl and waders but plan in time to allow for periodic management. If management (or monitoring) is likely, consider creating a submerged causeway which will allow you access by wading rather than requiring a boat.

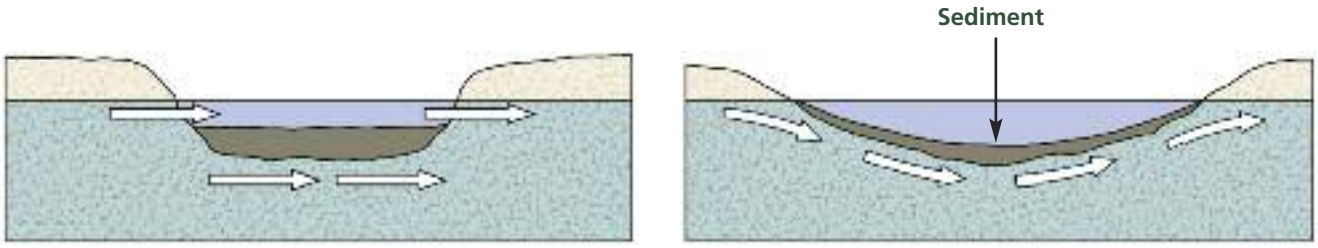
Islands, just like pond margins, can be varied habitats: depending on their height and exposure they can create either a marshy wetlands or, if lower, off-shore mud-banks for feeding waders. They can also be used in many ways to create shelter and seclusion to adjacent bank areas.

Where possible, locate islands at least 4-5 m away from the bank and maintain at least 0.5 m depth of water in summer, to provide birds with some protection from predators.

8. Adding even more variety to sites

Anything that adds to the natural variability of a site will usually add to its richness. Here are some examples:

- **Different water sources and substrates:** Groundwater fed ponds have a different chemistry and water regime (e.g. drawdown height) to surface water ponds, and in many places it is possible to create both pond types. Similarly, if geology varies, it is sometimes possible to create gravel, clay and peat-based ponds on a single site.
- **Different locations:** Even within one field, ponds created on a hedge line with its shade, shelter and leaf-litter will support a different fauna and flora to a mid-field pond.
- **Different bank angles:** Shallow edged ponds are especially useful for wildlife, but steep edged ponds can work too. This is especially true in gravel and sand based groundwater ponds where steep banks can keep the pond connected to groundwater after it has begun to silt-up (Figure 15).



This waterbody has steep banks. This stops sediment accumulating at the edges, so the pond continues to be groundwater fed – an advantage if the groundwater is clean.

This waterbody has shallow slopes and has now become sealed-off from groundwater by its own accumulating sediments.

Figure 15. Steep banks can sometimes be useful in groundwater fed ponds.

9. Design for change

Pond creation is not an exact science: often you won't know exactly where the water will sit before the pond is made, and may want to modify the pond a little when you do. Some features will also work better than others and you may want to dig new pools or alter banks.

When designing a pond, its worth planning for change from the outset. In particular: try to maintain access to all edges of the pond, leave borders along fence lines, ensure spits are wide enough to take a digger, and think about shallow-water pathways to islands.

10. Pond designs for Biodiversity Action Plan species

There are over 80 Priority Species that use ponds in the UK. They include animals like Lesser Horseshoe bats and Tree sparrow which feed over and around ponds, together with 70 or more specialised plants and animals that live in the water and around the pond edge.

Clean water is critical for many of these species. A recent review showed that 85% of the rarest Priority Species need good water quality to survive.

A major aim of the Million Ponds Project is to create clean water ponds that will support the populations of many of these species. To do this 1,000 ponds will be specifically created for them over the next four years.

During 2009-2010, *Species Dossiers* will be available for key Priority Species, to provide guidance about the places, habitats and designs which will best support these species.

11. Design practicalities

This factsheet focuses on pond designs that will create good wildlife habitats. But on any site, wildlife will be only one of the factors that influence design.

As the planning phase continues and you understand more about the site (e.g. its hydrology archaeology, location of service pipes), the original design may need to be modified a number of times. The implication is that it can be useful to keep designs rough, and flexible in the early stages, so that changes can be more easily accommodated.

Other issues, such as location, project planning, access, safety and particularly budget will constrain what is possible (see *Factsheets 5* and *6*).

12. The Design Bank

More detailed design ideas for new ponds can be found on the *website*.
They currently include:

- Woodland ponds
- Grazed ponds

Future factsheets will include:

- Heathland ponds
- Ponds in wetlands
- Moorland ponds and bog pools
- River floodplain ponds – how ponds fit in with river restoration
- Dune slack pools
- Ponds near paths – designs to minimise problems from dogs, fish and alien species
- Ponds and safety
- Designs to minimise risk of bird strike
- Ponds on farmland
- Agri-environment grants – designs to maximise funding benefits
- SUDS ponds

For further information about the Million Ponds Project please visit *www.freshwaterhabitats.org.uk/projects/million-ponds* or email enquiries to *info@freshwaterhabitats.org.uk*