Introduction

Thank you for your support of the LIFE Recreation ReMEDIES project. This information pack summarises the types of Advanced Mooring Systems that we would like to trial as part of this project. The pack is to help guide decisions about the types of moorings that may be suitable in your area and that you would be happy to use.

What is included:

- Summary comparison table covering costs, conditions, installation and maintenance etc
- Brochures for Hazelett, Seaflex, Stirling mooring systems and the Helical screw anchor
- Project data sheet and quote forms for Hazelett and Seaflex moorings (the information required to determine the specification for the mooring and get a quote)
- Manufacturers contact details for further technical queries

The LIFE ReMEDIES project will pay for these mooring systems. The project also has some funding for installation and maintenance if required.

We are looking for your help with the following:

1. Decisions about what systems and how many may be suitable to install in your area (a range of options will help the project team decide based on available budget)
2. Completing the data sheet and quote forms, as relevant, to ensure specifications are correct
3. Deciding whether you would like to purchase the whole system or just the mooring components (e.g. using other buoys/ropes that you already have)
4. Arranging installation with your existing contractors where relevant (guidance will be provided by manufacturers/training for helical screw installation)
5. Ensuring appropriate insurance cover
6. Evaluating and reporting back on success and use of moorings including liaison with manufacturers if any modifications are required
<table>
<thead>
<tr>
<th></th>
<th>Hazelett</th>
<th>Seaflex</th>
<th>Stirling</th>
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</thead>
<tbody>
<tr>
<td><strong>Water depth/tides</strong></td>
<td>Tidal range cannot be greater than low water depth – min depth 2.5-3m</td>
<td>Up to 8m. No limit on water depth – designed accordingly. Increased depth = increased cost.</td>
<td>Similar to traditional mooring.</td>
</tr>
<tr>
<td><strong>Life span</strong></td>
<td>30 year design life, 10 year recommended replacement cycle</td>
<td>20 years expected.</td>
<td>Component life expectancy 3 years.</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>&lt;5 tonnes: Single elastic £760 Full system £1602</td>
<td>Up to 12 meters: £1062 full system</td>
<td>Including helical screw and installation by divers:</td>
</tr>
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<td></td>
<td>6-15 tonnes: Double elastic £1399 Full system £2186</td>
<td>12 to 18 meters: £1487 full system</td>
<td>&lt;3.5 tonnes (16mm chain) £1545</td>
</tr>
<tr>
<td></td>
<td>16-25 tonnes: Triple elastic £2159 Full system £3455</td>
<td>18 to 20 meters: £2321 full system</td>
<td>&gt;9.5 tonnes (20mm chain) £1710</td>
</tr>
<tr>
<td></td>
<td>26-35 tonnes: Quad elastic £2799 Full system £4119</td>
<td>20 to 25 meters: £2866 full system</td>
<td>Modify existing moorings on request</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td>Recommend annual inspection by divers</td>
<td>Recommend annual inspection (divers or pull mooring up by boat) – likely can decrease after years 2/3</td>
<td>Same as traditional mooring – annual checks to monitor chain and additional buoy floats to maintain.</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>If helical screw – diver required. If block anchor can deploy from barge (hook up system beforehand – recommend diver still inspects connection). Note: Richard Robinson from ABC anchors has devised system that doesn’t require divers with helical screws. Method used in Calstock. Check is done with camera.</td>
<td>If helical diver required. If block anchor can deploy from barge. Note: Richard Robinson from ABC anchors has devised system that doesn’t require divers with helical screws. Method used in Calstock.</td>
<td>By divers or from barge</td>
</tr>
</tbody>
</table>
### COMPARISON TABLE: ANCHOR DESIGNS

<table>
<thead>
<tr>
<th></th>
<th>Helical screw/pile</th>
<th>Traditional concrete block</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substrate</strong></td>
<td>Any—although need to check depth of sediment and underlying bed rock (can be used in rock but requires different installation equipment)</td>
<td>Any</td>
</tr>
<tr>
<td><strong>Life span</strong></td>
<td>Unknown—depends on amount of metal used. Effect of salt water/freshwater combinations and tides still needs understood (100+years in soil)</td>
<td><em>(Harbour authority knowledge)</em></td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>£250 + installation cost</td>
<td>Variable. <em>(Harbour authority knowledge)</em></td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>Divers with training—although ABC anchors currently trialling installation from barges (faster and cheaper). See note above.</td>
<td>From barge or divers (although divers recommended to check mooring component anyway for Seaflex and Hazelett)</td>
</tr>
</tbody>
</table>

Potentially other anchoring options include:

- Eco-block (e.g. MARINEFF project) – eco-engineered concrete designed to increase surface area and structural niches for artificial habitat and improved biodiversity [http://marineff-project.eu/en/marineff-project/](http://marineff-project.eu/en/marineff-project/)
DOCKS AND WAVE ATTENUATORS

Docks and wave attenuators anchored with chains tensioned at high tide will wander at low tide when the chain becomes slack. When wind and waves build, chain-anchored structures will jerk violently as the chain becomes taut. Peak loads at the windward chain-to-dock connections can cause them to fail.

Docks and wave attenuators anchored with Hazelett Elastic Rodes (or a combination of elastic rodes and chain) are tensioned at low tide, so they stay put at low tide. As the tide rises, the elastics stretch. Docks and wave attenuators secured with Hazelett Elastic Rodes have a more gentle motion, reduced point loads, and are easier to walk on in rough weather.

Hazelett Marine
15 Palmer Court, Suite 212A, South Burlington, VT 05403

Elastic Mooring Systems — For Yachts, Docks, Wave Attenuators, Aquaculture Farms

www.hazelettmarine.com
The Hazelett Conservation Elastic Mooring System (A-D above) is an advanced alternative over traditional ball and chain moorings.

The Hazelett Spar Buoy (J) is a 6-inch diameter polyethylene tube that is filled with foam and concrete for ballast. Wave action does not have as much of an impact on our spar buoy as it does on a ball floating on the surface, and, as a result, wear on the metal-to-metal connection between shackle and anchor is minimized. Our spar buoy has a pocket molded into the top that houses a stainless steel swivel (I) where bridles or pendants attach, and a removable boot covers the swivel to protect the boat’s hull.

Instead of chain, our spar buoy is connected to an anchor by Hazelett Elastic Rode(s). The rodes (E) are manufactured of cast polyurethane elastics with polyethylene thimbles. The design is based on over twenty years of research and development, and all Hazelett Elastic Rodes are inspected, serialized, and load tested at our plant.

We recommend Helix anchors or concrete blocks to secure our elastic rode(s) system. We currently have three top terminations for Helix anchors: a fixed type (F) for a 1 ¾” shaft; a fixed type (H) for a 1 ½” shaft; and a swivel type (G).

With the traditional ball and chain system, mooring in twenty feet of water will require sixty feet of half-inch chain (based on the usual three-to-one scope). That length of chain will have about 360 moving metal-to-metal connections that wear and rust. On the other hand, the Hazelett Elastic Mooring, which can be set up with as little as a one-to-one scope, has only one metal-to-metal connection — at the anchor block. Yearly inspections are simplified with the Hazelett Elastic Mooring System and fewer repairs/replacements are needed.

Our mooring systems are also left in year round, reducing costly winter removal and spring reinstallation. The buoy also works as a “winter stick” that can slip under the ice.

Shellfish and finfish need eel grass to spawn and have protection for their young, but chain mooring systems destroy eel grass and other aquatic vegetation as the chain rakes the bottom when the wind and tide change direction. Water clarity is also diminished when the chain stirs up sediment, blocking precious sunlight to the plants. In contrast, the Hazelett Conservation Elastic Mooring System protects the sea bed because our elastic rodes are floated off the bottom. We have had many reports on the regrowth of eel grass and the repopulation of lobsters and scallops within two years of replacing chain systems with our elastic system.

Hazelett Elastic Moorings can increase mooring field density by about forty percent, since our mooring system can be installed with a scope as short as one-to-one instead of the three-to-one scope of traditional ball and chain systems (K).
BOAT MOORING QUOTE FORM

Please supply us with the following:

NAME:

PHONE: EMAIL:

INSTALLATION LOCATION:

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DEPTH AT MOORING LOCATION

HIGHEST ASTRONOMICAL TIDE: LOWEST ASTRONOMICAL TIDE:

BOAT TO BE MOORED

SAIL BOAT: POWER BOAT:

LENGTH:

WEIGHT:

CONDITIONS

PREDOMINANT WIND DIRECTION:

FETCH:

MAX WAVE HEIGHT:

MAX WIND SPEED:

CURRENT (IN KNOTS):

--------------------------------------------------------------------------------

BOTTOM

SAND: MUD: ROCK: OTHER:

ANCHOR TYPE

CONCRETE BLOCK: HELIX: OTHER:

SYSTEM COMPONENTS NEEDED:

Full system includes helix anchor, shackle(s), trawl floats, elastic(s), uniline, spar buoy, swivel and pennant
The Seaflex buoy mooring system - keeps your boat secure in place while dampening forces from waves and wind.

The SEAFLEX mooring system was invented to provide a secure and dampening mooring solution for floating applications worldwide. Before long, it was not only used to moor docks, but navigational- and mooring buoys alike. Over time we realized that there was improvements to be made to the world’s buoy options as well, resulting in the development and launch of our own revolutionized SEAFLEX buoy complete.

Contrary to swing moorings, or single-point moorings that are moored with chain, our complete buoy system does not utilise multiple shackles or swivels, lowering the risk for moving parts showing wear or coming undone over time. Our traditional model is attached with a powertex round sling that has over 10kN break-load.

Swing moorings moored with chain have excess chain dragging on the seafloor, this damages the seabed creating dead spots as seen pictured above. Seaflex environmental mooring buoys stay off the sensitive seafloor at all times, providing minimal disturbance to the marine ecosystem. This minimal environmental impact makes it especially suited for locations with regulations against traditional mooring methods. Our design also has a much smaller swing radius, allowing more permanent moorings to be installed in a smaller area.

For more information visit
www.seaflex.net
Sign this to acknowledge that this is the data that will be used to dimension the type of Seaflex needed for this project. Confirm that this is not average data but in fact the worst case scenario forces for which you need the SEAFLEX mooring system to handle.
Stirling Advanced Mooring System SAMS

The Sterling Advanced Mooring System (SAMS) is an adaptation to traditional mooring configurations that provides the security of the traditional mooring, whilst reducing the impact on sensitive seabed habitats.

The SAMS has been developed by the Ocean Conservation Trust over the last 5 years in conjunction with Harbour Authorities on the South Coast of England and mooring service providers. The aim has been to create a cost-effective flexible mooring solution that remedies the impact of traditional moorings on habitats that have ecological value.

Alterations to standard configuration are:

- The ground block / sinker is replaced with a helix anchor / screw pile, securing the riser and vessel to the seabed safely.
- The thrasher chain has been removed since this is the most impactive component of a traditional mooring on sensitive habitats.
- The lower portion of the SAMS riser is suspended off the seabed utilising mid-water buoys.
- The upper riser section of the SAMS will be secured between the mid water buoy and surface buoy.

Mooring safety is influenced by environmental conditions which are unique to each location. The SAMS provides a fully customisable approach to local conditions and different habitat types.

The SAMS consists of two components;

1. **Helical anchor** (or where helical anchors cannot be deployed it is possible to use a ground block / sinker)- This component holds the boat in position and anchors the vessel to the seabed and has two options depending on what is suitable for the deployment location.
   - Helical screw anchor, screw pile drilled into the seabed at a penetration depth and kilonewton torque defined by the size of the vessel needing to be moored. Minimum screw pile depth is 2m*. The success of installation is dependent on sediment type, however different helical anchors are available for various sediment types. Where the bedrock is shallower than 2 meters this option can not be deployed. Anchor includes swivel anchor head.
   - Traditional sinker block, the size of which is defined by the size of the vessel needing to be moored. Whilst cost effective and flexible** within its deployment and retrieval this method creates a footprint on the habitat the size of the mooring block.

   * Screw part deployment provide SWL of 6 tonnes with a MWL 12 tonnes.
   ** Retrospective fitting of the Stirling riser to existing sinker is possible.
2. **Sterling Riser** - An adaptation of a traditional chain riser with the addition of securely fixed floatation to suspend the riser chain off the seabed protecting sensitive habitats, this suspends the riser in the water column. The length of the riser is dependent upon the water depth. The chain gauge used within the construction of the riser is defined by the size of the vessel needing to be moored, vessels < 3.5 tonnes, 16mm gauge, vessels > 9.5 tonnes 20mm gauge. Once the size of the vessel, the water depth and the gauge of the riser has been identified, the correct amount of floatation is calculated and balanced on the riser. The SAMS riser creates a catenary fixing between the seabed and the pick up buoy, allowing the system to rise and fall with the tide, suspending the riser from the seabed throughout the whole tidal cycle. This is suitable for locations with large tidal variations.

Area of habitat impacted by traditional mooring install:
5 meters scour of traditional mooring = \( \pi \times 5^2 = 78.53 \text{ meters}^2 \)
0.5 meters traditional sinker block = \( \pi \times 0.5^2 = 0.78 \text{ meters}^2 \)

Adaptations to the Stirling riser removes scour of a traditional mooring, in this example adapting the riser to the impact of the sinker reduces the scour impact by 99%. The use of the helical anchor reduces the impact to a minimum impact, the radius of the pile \( \sim 7.5 \text{cm} \).
SEAGRASS, A VITAL PART OF THE MARINE ECOSYSTEM DUE TO THEIR PRODUCTIVITY LEVEL, SEAGRASSES PROVIDE FOOD, HABITAT, AND NURSERY AREAS FOR NUMEROUS VERTEBRATE AND INVERTEBRATE SPECIES. THE VAST BIODIVERSITY AND SENSITIVITY TO CHANGES IN WATER QUALITY INHERENT IN SEAGRASS COMMUNITIES MAKES SEAGRASSES AN IMPORTANT SPECIES TO HELP

The SAMS is an approach to customising standard mooring components, therefore the system can be used in most environmental condition within coastal waters and shallow inlets for mooring recreational vessels. Where traditional moorings are deployed the SAMS can be also be deployed. The only environmental restriction to this deployment is the sediment depth, helical anchors cannot penetrate where the sediment type is not suitable i.e. where the bedrock is less than 2m below the seabed.

The cost of the SAMS is not disproportionately more than a standard mooring. The starting point for development has been to create a cost-effective and flexible Advance Mooring System suitable for deployment within sensitive habitat of ecological value. Cost depends upon the options selected: water depth and the weight of vessel to be moored. For example a mooring for a 3.5 tonne vessel in 8 meters of water with a helical anchor would cost circa £1550 per mooring for install, including stock deployed. Once the helical anchor has been deployed the expected life of the anchor is an excess of 15 years. Riser components can be exchanged when required after yearly inspection.
Installation of the Sterling Advanced Mooring System is performed by a fully registered and experienced mooring service provider and commercial dive team.

Process of installation for Harbour Authorities:
1. Single point of contact for the life of the mooring with the Ocean Conservation Trust.
2. Harbour Authority to provide environmental specifics of the install location.
3. Approval of the project plan by Harbour Authority to Ocean Conservation Trust.
4. Approval of all stock deployed by Harbour Authority.
5. Installation by approved mooring contractor.
6. Annual inspection by approved mooring contractor.

Deliverables from Ocean Conservation Trust to Harbour Authority
- Suitable fully equipped work boat.
- Installation Team
- All diving and associated equipment, in accordance with DWR 97.
- Diving project planning and risk assessment.
- Deployment of helix anchor / installation procedure (with manufacturer approval).
- Supply of all stock, following approval by Harbour Authority.
- Installation mooring assemblies.
- Annual inspection of moorings throughout the life of the mooring.
- Final recovery of helical anchors piles upon completion of ReMEDIES trial period. If required.
- Copies of all studies and publicity materials related to the mooring deployment for Harbour Authority.

Costs of SAMS installed.
Estimate as follows (subject to seabed composition appropriate for helix screw pile installation)

16mm riser chain assembly (appropriate for vessels up to 3500kg) £1545.50 +VAT
Helical anchor deployed to 2m / 4kn.
20mm riser chain assembly (appropriate for vessels up to 6500kg) £1710.50 +VAT
Helical anchor deployed to 2m / 4kn.

The above assumes min of 5 moorings per order. Additional moorings in multiples of 5.
A5 Polyform net buoy on surface (excludes boat ropes and pick up buoys).

Additional 2m extensions to the screw pile supplied and installed at additional £121.65 each.

Retrospective fitting of Stirling Riser also possible to existing block and surface buoy on request. Heavier moorings on request.
### SPECIFICATION | DEFINITION | 89R
--- | --- | ---
Wall thickness | Thickness of the screw pile tube wall | 9.5mm
Torque limited | The ability of the pile to transmit torque is always the limiting factor. This is therefore the ultimate practical pile install torque capacity. | 25kNm
Ultimate strength single helix | This figure shows the load which can be supported by a single helix- most piles use multiple helixes, but if a single one has to support more load, although non standard, this can be accommodated. | 220kN
Empirical torque factor $K_t$ | This is the "Empirical Torque Factor" expressed in metric units when torque is measured in kNm and force in kN. Its value decreases as pile diameter and helix plate thickness increases. This is due to a combination of skin friction and the energy needed to displace the soil. | $25m^{-1}$

### Installation Equipment

The 89R Anchors can be installed using the excavator mounted 2500X/XG.

- The 2500X fits excavators from 5-10 tonne.

**2500X**

This machines offer torque read outs, allowing the pile capacity to be calculated instantly.

<table>
<thead>
<tr>
<th>2500X</th>
<th>2500XG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate Capacity (un-factored) @ 25kNm torque</td>
<td>625kN</td>
</tr>
<tr>
<td>Safe Working Load (2.5 FOS) @ 25Nm torque</td>
<td>250kN</td>
</tr>
</tbody>
</table>

- **Un-factored Load** - A Maximum load that the Pile will take before deflection exceeds standard limits
- **FOS Factor of Safety** - is the ratio between the un-factored load and the working load
- **Safe Working Load** - The actual load the pile is taking, when the building is in place

### Pile Life/Corrosion

In most conditions, provided the top 2 metres are galvanised the pile life will be in excess of 100 years. Where the soil resistivity is less than 10 Ohm- further steps must be taken. This means salt water, wet peat and where soils are subject to saturation. For more information please download the soil corrosion chat on www.abcanchors.co.uk

The estimated life is based on the assumption that a loss of 40% in thickness is acceptable without adverse effect on structural integrity. The atmospheric exposed areas of the piles are coated with high build zinc rich coating system or galvanised. There is a safety factor of x2 included for the anode design to take account of variances in corrosion conditions and ground resistivity.

| Tube Specification | EN-10210 S355 J2H |
| Helix Specification | EN-10025 S275 JR |
| Fasteners Specification | Metric M22 GR 8.8 |

An example of a torque reading from an installation:-

*A gauge reading of 25kNm means an Ultimate Capacity of 625kN and working load of 250kN with FOC 2.5*
Contacts

Hazelett

Homer Hill
Hazelett Marine LLC (based in US, Homer based in France)
Direct +33 (0)6 28 22 14 14
hhill@hazelettmarine.com
www.hazelettmarine.com

Seaflex

Robin Wilhelmsson
robin.wilhelmsson@seaflex.net
Sales Executive
Seaflex AB
Based in Sweden
Phone +46 90 160658
Mobile +46 76 1302058
Web www.seaflex.net

Stirling Mooring System

Mark Parry
01752275204/07875529267
mark.parry@oceanconservationtrust.org

ABC Anchors (Helical screw)

Richard Robinson CEng HonF IAgrE
ABC Anchors
Tel: 01380 850885
Fax: 01380 850010
Stockley Road, Heddington, Nr Calne
Wiltshire, SN11 0PS

website: www.abcanchors.co.uk

Natural England
Jan MacIennan (National coordination for moorings deployment for Remedies project)
02080267450/07795825996 jan.maclennan@naturalengland.org.uk

Fiona Crouch (ReMedies project manager)
07880432545/02080265337 fiona.crouch@naturalengland.org.uk

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