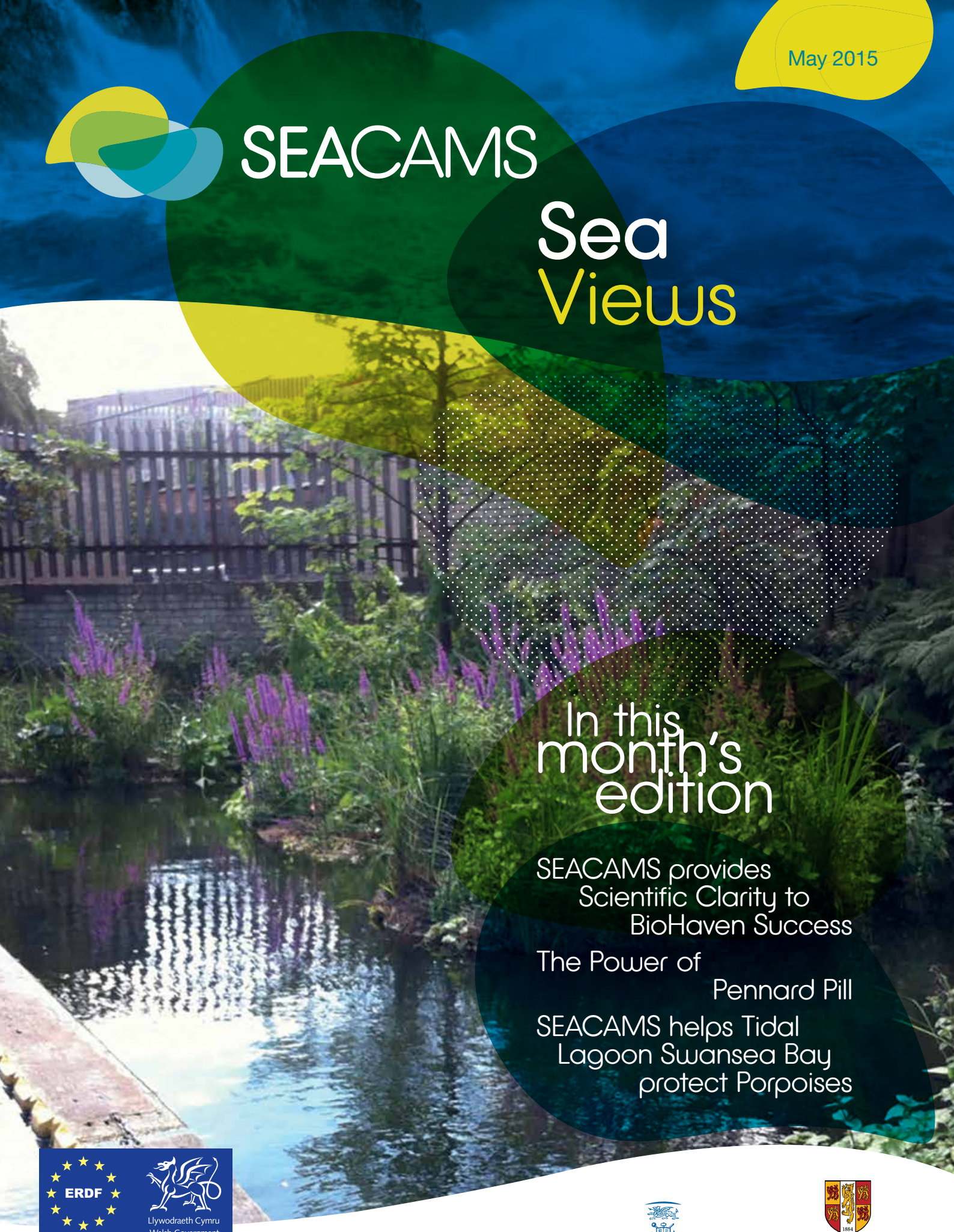
May 2015

SEACAMS Sea Views



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Testing a range of plant species

SEACAMS provides Scientific Clarity to BioHaven Success

Frog Environmental specialise in improving the quality of inland and coastal waters using an innovative floating island system called BioHaven. While the novel system works well, the complex biogeochemical processes that occur throughout the life of the BioHaven, as it removes pollutants, balances nutrients and enhances biodiversity, were not well documented. SEACAMS has provided a comprehensive document that brings scientific clarity to the BioHaven's effectiveness that is bringing confidence to the market. In addition, SEACAMS research support is helping to develop a BioHaven to treat marine aquaculture waste that may open up further markets.

Frog Environmental has been marketing the novel BioHaven across Europe for the last two years. Based in Llanwrda, Carmarthenshire it has been capitalising on the growing interest in this sustainable way to improve water quality through establishing floating islands of wetland habitat. The concept is not new, but the innovative BioHaven design is. An internally buoyant matrix solves the problems associated with other floating systems on the market that use a grid supported by an external floating frame that cannot support the growing media for long periods of time, are prone to mechanical damage and cannot be used effectively in turbulent waters. Interest in the BioHaven has been high and Frog Environmental were keen to provide supporting scientific information about how the system works. They called on SEACAMS to produce a report on the complex processes that contribute to the success of the floating island.

Dr Ian Dodkins led the SEACAMS team to review current scientific literature on the processes occurring throughout the life of the BioHaven. "The BioHaven's internal buoyancy is achieved by a closed cell polyurethane foam that holds together a matrix

of recycled plastic fibres that acts as a support for plant growth and importantly provides support for the establishment of bacterial biofilms. The biofilm sets the stage for biodiversity, providing food and a habitat for zooplankton, fresh water shrimps and other small organisms. This is the basis for controlling algae and supporting plant life. Carefully planted native wetland plants and wildflower species work in unison with the established biofilm to absorb and process harmful nutrients and contaminants, removing them from the water. As the BioHaven develops, so do key biogeochemical processes critical to establishing the correct balance of nutrients seen in natural sustainable ecosystems, giving the BioHaven longevity and the ability to become self-sustaining. The BioHaven system treats organic solids in the water creating the basis of a freshwater food chain. In addition it mimics the environmental benefits of wetlands, providing a healthy habitat for insects and birds," explains Ian.

The SEACAMS review has helped to bolster the credibility of the system and is being used both as an internal reference and as supporting material for potential customers. "The review has become our bible, it is utterly brilliant. It has brought clarity to the types of complex biogeochemical processes that happen within the BioHaven and the benefits they bring to improving water quality. Importantly it demonstrates to our customers that the effectiveness of the BioHaven is scientifically grounded, giving them the confidence they need to use this novel approach," reflects Leela O'Dea, Frog Environmental's Technical Director.

While the effectiveness of the BioHaven in freshwater systems has been proven and established with over 5,000 sites using the system internationally, SEACAMS has been helping them explore efficacy in marine applications. "There is a market to treat marine aquaculture waste that is developing as changes in aquaculture management practices seek to explore waste water recycling systems. SEACAMS have been conducting laboratory trials with a variety of plant species to assess their efficacy at removing ammonia, nitrates, phosphates and the biological oxygen demand associated with high solids contents in the waste water," says Leela.

The laboratory trials tested a wide range of plants and have identified a couple of potential species that may prove to be effective. "There is still more work to be done before a marine BioHaven becomes a reality. Only two plant species survived and grew in the levels of salt found in marine wastewater, though the surprise is that any survived given the extreme conditions. The rest of the plants simply died resulting in no net removal of nutrients and an increase in eutrophication as algal blooms developed." reveals Ian.

> "Explore waste water recycling systems"

While the BioHaven continues to provide effective wastewater treatment for freshwater environments, the SEACAMS trails have provided the basis for further development work by Frog Environmental on the marine wastewater applications. "The trial has proved very valuable in providing information that will direct further development of the system for the marine wastewater treatment market. It has also informed a planting strategy for our BioHavens that may encounter higher salinity environments" concludes Leela.

Laboratory trials assess efficacy

Monitoring water flow

The Power of Pennard Pill

The Gower Heritage Centre invited SEACAMS to assess the potential of the Pennard Pill to provide hydro-electric power for its centre and to sell to the grid. While the river drives a water wheel in the centre's mill, Y Felin Ddŵr, the Trust managing the centre were keen to see whether capital investment in hydro power would be economical. SEACAMS scientists set about measuring water flows over a year to calculate the quantity of electrical power that could be harnessed.

Gower Heritage Centre is set in the heart of the Gower Peninsula in South West Wales. It is a popular visitor attraction and rural life museum based around a working 12th century water-mill. Established in 1990 the site has a renovated 12th century water powered corn and saw mill. The Pennard Pill river runs along the western boundary of the centre through a small mill leat controlled by a sluice to power the mill wheel. In turn the mill wheel turns a mill stone that is in operation during the day as one of the tourist attractions at the centre. Y Felin Ddŵr were keen to understand whether the water wheel could be connected to a turbine at night to generate power or if alternative power generation was possible. Using the head of water in the leat to drive a small conventional turbine or installing an Archimedes screw turbine were possibilities under consideration.

A SEACAMS team, led by Dr Chris Lowe, set about determining the potential the Pennard Pill had at the site to generate electricity. "Using the river to turn a wheel that drives a mill stone is a completely different proposition to having enough water volume and flow to generate economically viable hydropower, so we wanted to calculate the amount of electricity that could realistically be generated over a year, so appropriate investment decisions could be made by the Trust," said Chris.

The SEACAMS team set up a year-long monitoring programme to accurately measure water flow in the leat. "It is important to understand the daily and monthly changes in water flow to be able to calculate the real potential for generation. Measuring just a few months of data can lead to a grossly inaccurate picture and result in bad investment decisions," reflects Chris.

> *"Calculating the real potential for generation"*

The amount of energy available at the site from the river results from a combination of the volume of water flowing, its rate of flow and the height that the water flows from as it enters an electricity generating system. The SEACAMS team began by measuring the height the water falls around the site. They found that the water enters the site at 14 metres above sea level and falls 3 metres before getting to the top of the mill wheel where it drops a further 3 metres to the base of the wheel.

The team began examining flow rates using a water current meter that logged water flow continuously in

Capturing the data

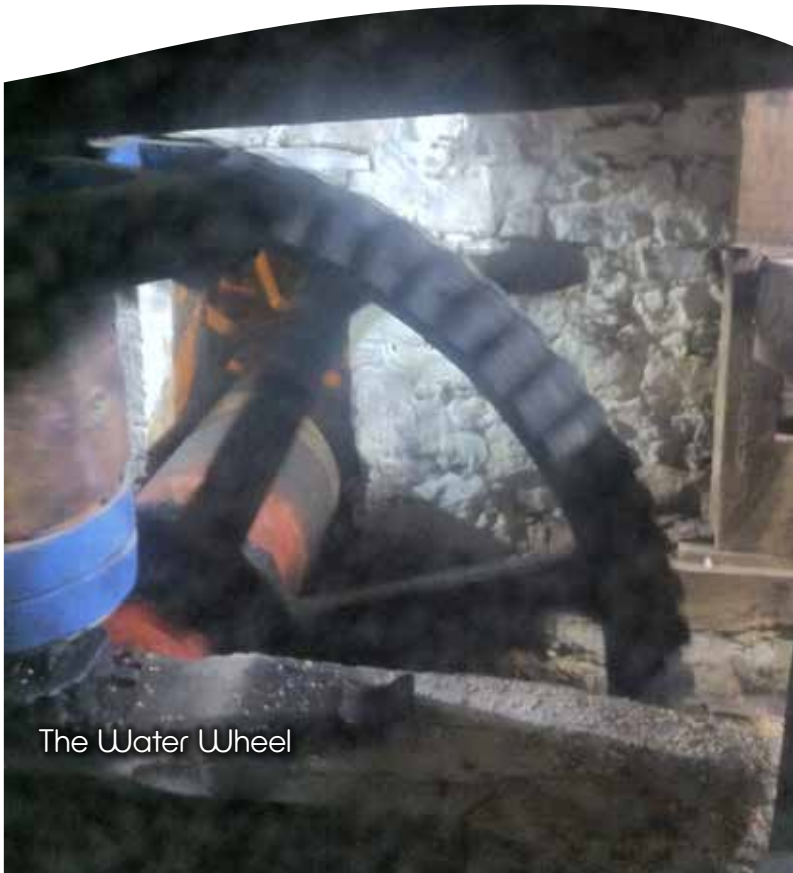
Gower Heritage Centre may still consider a small hydro scheme, but if they do install one it will be to illustrate the principles of renewable power generation in keeping with their museum rather than powering the centre and generating electricity to upload to the grid. "It's important to assess the resources available for energy generation in any renewable scheme and SEACAMS has helped Gower Heritage Centre save money through understanding that the energy available from the Pennard Pill does not justify the capital investment required, nor yield a solid financial return on investment," concludes Chris.

the leat over 100 metres upstream of the water wheel. "Previously the Trust had calculated water flow based on timing the movement of a float down the leat, but the sophisticated water current meter we used was able to provide a much more accurate measurement throughout the year," explains Chris.

The SEACAMS team also devised a second measurement of water flow by measuring the revolutions of the mill's water wheel using a magnetic reed switch. In addition, the amount of rainfall over the year was monitored using data from the nearby Swansea bay weather station.

"After looking at the data for the whole year, we were able to calculate the amount of electricity the Pennard Pill can generate as it flows through the heritage site. The generating potential of the river is related to the flow of water in the leat and this varies depending on the amount of rainfall, and when the mill wheel is running during public opening hours. Taking all factors into consideration including inefficiencies associated with generation of the electricity we concluded that the water flow could generate enough power to light the mill with 25 low energy 30W bulbs, so any hydro scheme would not be economically viable given the associated capital outlay," reports Chris.

> "Measuring flow rates"



The Water Wheel

Harbour Porpoise

SEACAMS helps Tidal Lagoon Swansea Bay protect Porpoises

The proposed tidal lagoon in Swansea bay promises to harness valuable power from the bay, create jobs in Wales and become a tourist attraction. Tidal Lagoon Swansea Bay plc (TLSB) are working in partnership with SEACAMS to effectively study porpoises that are known to be present in Swansea Bay and the wider Bristol Channel area.

The harbour porpoise (Phocoena phocoena) is familiar to whale and dolphin watchers as it stays close to coastlines and river estuaries making it easier to spot. One of six species of porpoise it is also one of the smallest marine mammals. While conservation groups can occasionally see porpoises from vantage points along the Mumbles coastline or out on boats in the wider bay, there has not been a published scientific study on their presence in the bay. SEACAMS is using acoustic monitoring methods, based on recording porpoise vocalisations, which enable the scientists to assess how often porpoises are present in an area and how they use the area during different times of the day and night.

Harbour porpoises use echolocation clicks to hunt for their prey, such as flat fish and small herring. They emit intense ultrasonic signals in a narrow sound beam and listen for the returning echoes. Dr Hanna Nuuttila is leading a SEACAMS team that has been working on a collaborative project with TLSB. The study uses acoustic monitoring devices, known as C-PODs, that listen for these ultrasonic signals and records the times and durations of acoustic encounters.

SEACAMS have been undertaking a study to look at effective mooring systems and monitoring sites in the Bay area. The system is designed to help keep the C-PODS in position, but be easily identifiable for recovery and avoidable by sea-faring traffic. Initial trials with C-PODs off Mumbles and in the Bay area, have resulted in a mooring system that is suitable for the sea conditions and traffic. "Initially we were using a mooring structure that secured a C-POD to the seabed in a variety of tidal

RV Noctiluca sets sail

conditions making it highly visible to shipping. It was important to have a tracer buoy and a shot line made of leaded rope to ensure that it was negatively buoyant, so any slack needed to account for tidal range did not drift on the surface and get caught up by passing ships," reveals Hanna.

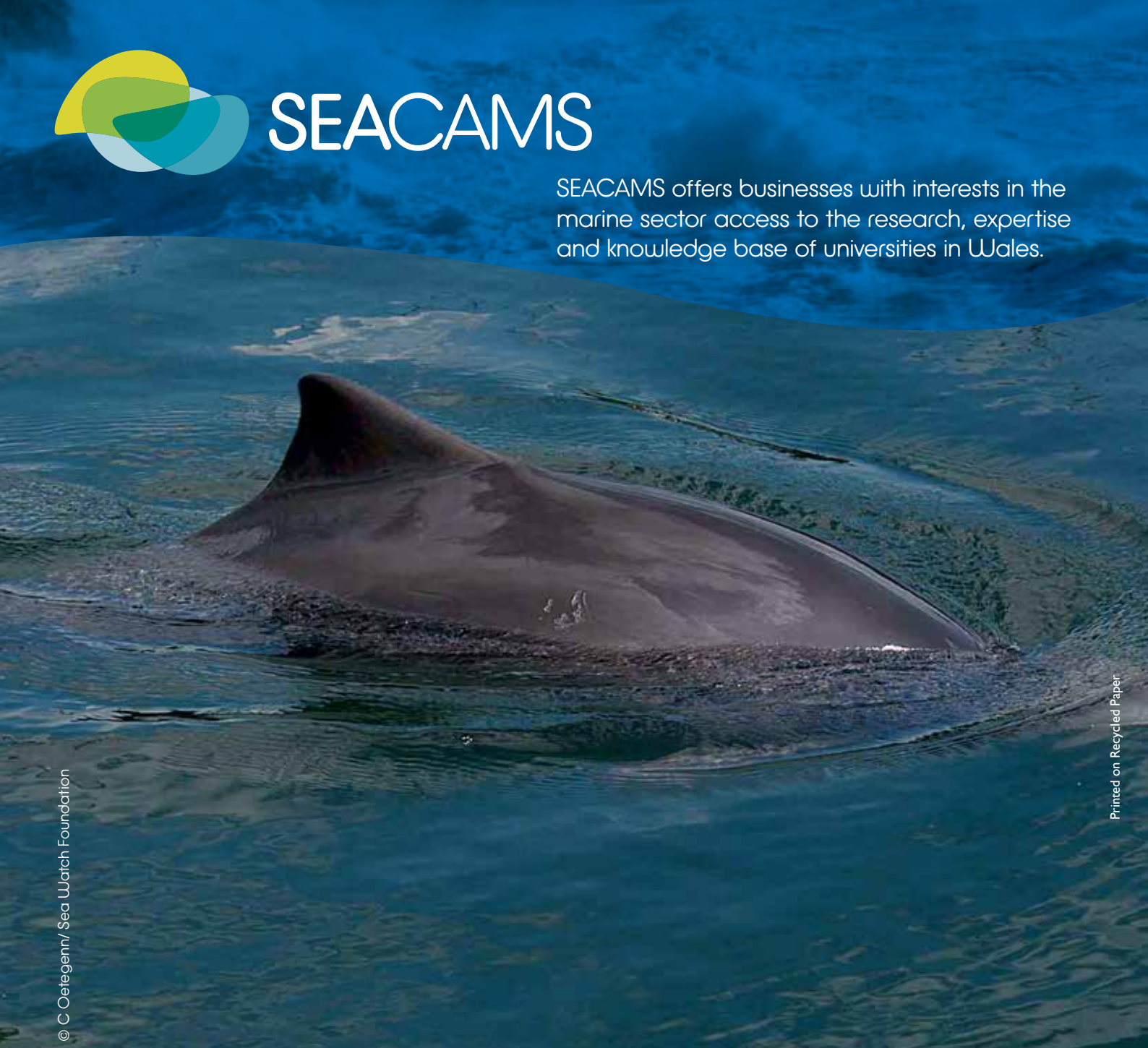
However, despite high visibility markers, one of the devices was lost, probably due to it being entangled with shipping. As a consequence, an alternative mooring system has been trialled utilising an acoustic release mechanism. This system allows C-PODs to be deployed with just a small weight to hold it in place and no ropes or surface markers to risk entanglement. When recovering the C-PODS a signal is transmitted from the boat that is read by a transponder attached to a canister of high strength rope, in turn tied to the C-POD. The signal received by the transponder causes it to float to the surface deploying the rope that can be used to retrieve the C-PODs. The system is proving effective and is being supported by helpful local fishermen allowing the project to deploy C-PODs in areas close to fishing activities. It also allows monitoring over longer periods of time as the C-PODs can sit undisturbed on the sea bed without ropes and buoys interfering with shipping. "The value of the monitoring comes from collecting continuous data over a long time frame and our sampling strategy is proving effective," reports Hanna.

The C-PODS are being deployed for periods of 3 to 4 months. They are then recovered aboard SEACAMS' research vessel RV Noctiluca and the data downloaded before being redeployed. Analysis of the data will provide an understanding of when harbour porpoise visit the bay, how regularly and for how long, and inform a long term monitoring strategy. The pilot monitoring strategy is described in the Tidal Lagoon Adaptive Environmental Management Plan and further results, in terms of success of the potential sites, will feed into developing the strategy further.

> "C-PODs sit undisturbed on the sea bed"

SEACAMS

SEACAMS offers businesses with interests in the marine sector access to the research, expertise and knowledge base of universities in Wales.



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