sweep

Operational Wave and Water Level model
Impact Case Study #1

OWWL

Justin Ridgewell, Environment Agency Coastal Advisor

What threat did Hurricane Epsilon pose in terms of coastal flooding?

The remnants of Hurricane Epsilon moved into the North Atlantic driving storm-force winds between 26th - 28th October, 2020. This had the potential to develop unusually large and extremely long-period waves affecting western facing coasts of the UK.

Wave overtopping at Perranporth beach during Hurricane Epsilon

What was your job in relation to this?

As part of my incident management role in Cornwall's EA flood warning team, I needed to consider the potential flooding impacts of this event on our coastal communities.

Initially, astronomical tides were being rated as only small to moderate and it seemed unlikely that water level alert criteria would to be activated. However, due to the unusual nature of this swell event, and the lack of previous observations for such conditions, it was clear I needed to utilise all available forecast information products to best understand likely impacts. This would assist my decision making about any requirement for precautionary alerts, and ensure I gave the most effective advice to duty managers for appropriate responses to protect local communities.

My primary specific concern was the potential for the very substantial energy in the waves to drive extreme wave run-up and infragravity surge, overcoming what would ordinarily be an unproblematic water level.

### What forecasting products does the EA have?

The EA has a range of forecasting data and modelling products which feed into our National Flood Forecasting System (NFFS), providing detailed information for operational duty officers. These include a variety of wave parameters, wind, and water level, with values provided for a series of offshore node points around the coast and referenced to class A inshore tidal gauge sites.

What additional value did the SWEEP-OWWL model offer you?

With concerns about how the offshore conditions of Hurricane Epsilon might translate specifically to wave impacts at the shoreline, the SWEEP-OWWL model provided an obvious complimentary layer of information to our forecasting system, with locally tailored wave overtopping forecasts available for specific defences.

The model outputs translated these very unusual wave climate parameters into quantified overtopping forecasts and having this, strengthened my decision making and helped me tailor the advice I was providing for an more effective management response. I would say the key benefits of the SWEEP's OWWL model outputs during this event were:

- Supporting the theory that some minor impacts in different coastal locations were possible, despite the perceived unproblematic water levels –also the thinking that these were unlikely to become significant impacts in any locations.
- Supporting my advice that issuing precautionary flood alerts was the right thing to do for certain locations, (i.e. property flooding was *possible*, but not *probable*, plus general conditions in exposed coastal locations might be hazardous).
- Informing and targeting reconnaissance efforts in areas where we would learn the most by having observers on location.
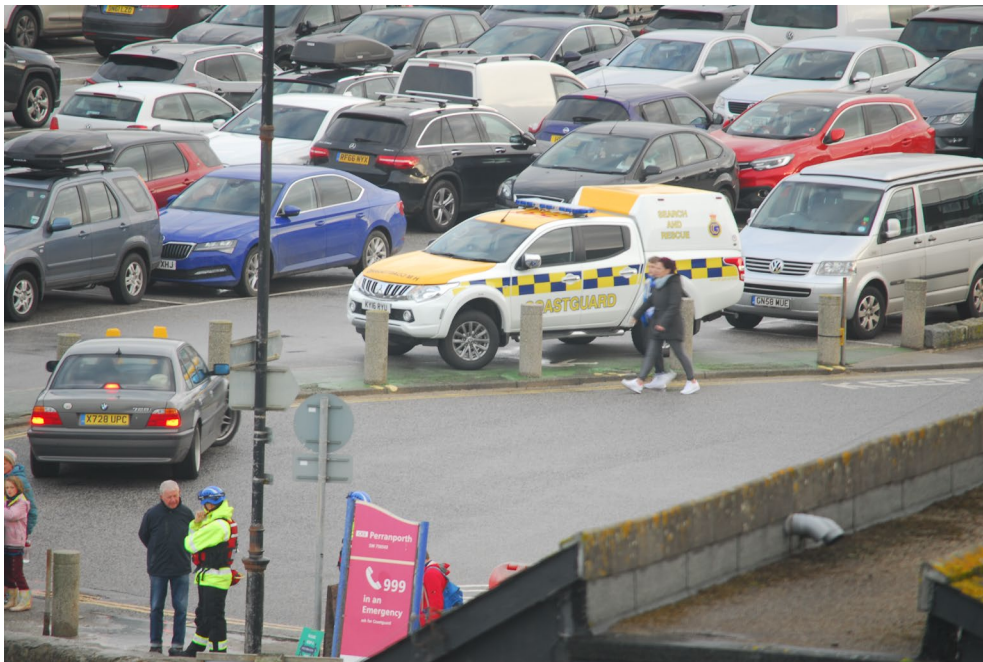
Emergency services monitoring the wave overtopping situation at Perranporth during Hurricane Epsilon

Operational Wave and Water Level model
Impact Case Study #2

Sean Norsworthy,
Coastal and Flood Risk Project Engineer, Dorset Council

I've worked as a Flood and Coastal Project Engineer at Dorset Council for over a year and half, also as a Duty Engineer responding to out of hours flood/coastal incidences. Before that, I worked in similar roles related to flooding at Plymouth City Council and the Environment Agency.

I have been signed up to the OWWL forecast for the last 18 months and use it during predicted storm events.

What threat did Storm Eunice pose to you, and your area of the coast?

Storm Eunice brought the risk of high waves and wave overtopping in a number of areas. It also posed a threat to beach level changes and undermined flood risk assets.

The OWWL beach profiles cover the Western area from Lyme Regis to Portland and these were areas considered at risk from wave overtopping during Storm Eunice

What was the benefit of the OWWL forecast to you before, and during, Storm Eunice?

In conjunction with EA Flood Warnings and guidance from the EA incident room, we used the OWWL reports to decide to deploy temporary flood barriers to prevent wave overtopping at West Bay's West Beach. These were deployed a night before and the OWWL report was key in justifying this decision.

The barriers are designed to deflect wave overtopping back into the harbour and away from low lying areas of West Bay and early deployment the night before the event gave us more breathing room to respond more effectively to possible problems during the event.

What are the most valuable features of the OWWL model and forecast?

I'd say the fact that it arrives in an easy-to-use format, 3 days in advance providing us with sufficient time to review options and actions, and that it is specific to our area.

Unlike other sources of information that just offer flood warnings, OWWL provides us with a locally appropriate and accurate wave overtopping hazard forecast which gives us the confidence to implement our defences.

What are the main benefits of the OWWL forecast to you and your work?

- It increases our confidence, and accuracy, to make the right decisions about predicting and managing coastal overtopping, disruption and damage at our sites
- It provides important additional overtopping risk information that contributes to more efficient targeting of resources and ultimately cost savings
- The OWWL reports are most useful on large swell events that are often not forecast as accurately as large storm events.
- We will provide the OWWL forecasts to any projects being undertaken on the coast within Dorset Council area to help improve health and safety decision making.

How would you like the OWWL model to develop so it can better support you?

We find the OWWL model incredibly useful and would love to see it further expanded to provide:

- A 5-day in advance forecast for the whole of Dorset, rather than just from Lyme to Portland. We'd particularly like profiles and alert reports at Weymouth and Swanage as these areas, although not exposed to as many storms, see much more damage in the less frequent easterly storms.
- Potential overtopping flood water levels at adjacent sights, or a risk category of events that cause inundation at the site, would be helpful for making decisions on the deployment of men and equipment.
- Yearly statistics on risk alerts to help justify getting new projects off the ground.

Operational Wave and Water Level model
Impact Case Study #3

OWWL

Jon Griffiths (Coastal Advisor)
and Dave Picksley (Senior Coastal Advisor),
Environment Agency, Dorset

We have been using the OWWL forecast since its inception in 2018. Whilst not part of recognised Environment Agency procedures that directly trigger flood warnings or associated actions, it is a very useful piece of additional evidence. It is used alongside various other third party datasets/websites to provide additional assurance to forecasts particularly in the build up to a storm. In this way, it is a valuable part of our decision-making process.

What threat did Storm Eunice pose to you, and your area of the coast?

Storm Eunice caused flooding of roads and parks in various locations across Dorset including Christchurch Harbour and Poole. Five Flood Alerts and six Flood Warnings were issued along the Dorset Coast during Storm Eunice.

The potential for wave overtopping at West Beach, West Bay triggered the deployment of temporary sea defences by Dorset Council on the 18th February 2022. At East beach, West Bay, the Environment Agency organised flood reconnaissance to assess the morning tide and temporary defences were on standby to be deployed at short notice if on site observation noted wave overtopping.

At Chiswell, the forecast for a flood warning and potential for significant spray/shingle overtopping of the beach crest triggered a multi-agency response from the Local Resilience Forum (LRF) with various organisations on site throughout the day and into the evening on the 18thFebruary. A consideration of road closures at the Portland causeway road remained under constant review and could not be accurately forecast as unnecessary until late into the evening.

How and why did you use the OWWL forecasts before, and during, Storm Eunice?

We used OWWL forecasts daily in the build up to the storm and more often during the incident.

The wave and model animations, and buoy predictions, add an initial layer of evidence and confidence in the forecast predictions we use, as well as early warnings for long swell waves from sites further west, for example Porthleven.

What are the main benefits of the OWWL forecast to you?

The OWWL model provides us with accurate and timely data that increases our confidence so we're more able to make accurate decisions about predicting and managing coastal overtopping, disruption and damage at our sites. This offers us various benefits:

✓ It gives us further information to target resources efficiently (for example where to deploy operational field teams) to reduce coastal flooding and improve resilience.

✓ The early warning OWWL emails flagging overtopping at multiple sites up to 3 days in advance is advantageous for strategic and tactical planning across multiple agencies such as ourselves and other members of the Local Resilience Forum for example, police, local council etc. This enables a more co-ordinated, early and targeted response to the threats of coastal flooding, that ultimately will result in better allocation of resources and less disruption and safety risks to local businesses and residents.

✓ The value is such that we would like to see the OWWL model being further developed for example to include additional profile lines for example, East of Portland.

Operational Wave and Water Level model
Impact Case Study #4

Roger Quinn, Environment Agency,
Coastal S&W Team Advisor

Roger supports the maintenance and development of EA coastal forecasting service.

What threat did Storm Eunice pose to you, and your area of the coast?

Storm Eunice brought a high risk of coastal flooding from Lands End to Bristol and along the south coast to Christchurch

How did you use the OWWL forecast before, and during, the storm event?

I used the OWWL data to support EA forecasts for the impacts of long period waves at Chesil Beach. There are a variety of wave period variables which can be used to describe long period energy including the peak period (Tp) and this is currently only available to the EA in real time via the OWWL forecast.

What value does the OWWL forecast provide you for predicting and managing storm events and coastal flooding?

The OWWL model provides useful data in a real time environment to investigate options for improving local and national EA forecasting improvements.

By providing input data (peak wave period and wave height), the OWWL model and forecasts are enabling me to test out proposed forecasting solutions for wave energy based approaches. In the longer term these type of approaches may be better at quantifying the relationship between complex sea conditions and impacts and I hope, would improve the accuracy of forecasts, efficiency of incident management and provide longer lead times to partners/public. All of which, would enable more efficient resource management and safety responses at the coast.

Operational Wave and Water Level model
Impact Case Study #5

Barry Dixon and Marc Eisenstadt,
Wave forecasters and residents, Fort Picklecombe

'The SWEEP OWWL forecast is the only forecast that provides us with specific, localised information on the shape of the sea bed in front of Fort Picklecombe. This is a key factor affecting the development of incoming waves and therefore vital for predicting, and effectively responding to, wave overtopping & flooding'. **Barry Dixon.**

Wave overtopping at Fort Picklecombe

What's the overtopping flood risk at Fort Picklecombe?

Fort Picklecombe is a residential complex comprising 103 flats over 5 floors. It stands on the extreme south eastern coast of Cornwall, a few miles west of Plymouth.

Due to its location, the potential damage from storm events is significant, particularly if flood water enters the sea level garage and gets to infrastructure services such as electricity, distribution points, and the sewerage plant.

In February 2014, for example, there were two large storm events during which sea water flooded the garage as well as some of the ground floor apartments. Even without damage to infrastructure services, the cost of the damage was £500,000. YouTube coverage.

How and why have you developed a wave forecasting approach to tackle this?

Following the 2014 flood damage, insurers required the Fort Picklecombe Management Committee (FPMC) to undertake a Flood Risk Assessment and comply with its recommendations. This included increasing the resilience of the storm alert decision making element of the Fort Picklecombe Storm Defence Plan as well as obtaining some suitable sea defences such as flood barriers and storm shutters that could be deployed ahead of future storm events.

Expanding their wave forecasting capability, a group of Fort Picklecombe volunteers have developed a flood warning system that automatically generates a daily update of data drawing on various sources such as EA flood warning service, BBC, Windguru, Windfinder, NOAA, overlaid with local Fort Picklecombe tide information.

However, due to the general and less specific nature of this information, a fair amount of subjectivity is involved in assessing water levels and wave heights in advance of storm events. The forecasting system is monitored by just a few volunteers and we judge whether our three maintenance staff need to be deployed to activate storm defences.

How long have you used OWWL and what additional value does it offer you?

We started using the OWWL model and data during the 2021-22 season, during which time a specific Fort Picklecombe beach profile was added to the model. We use the OWWL data alongside existing data sources which enables us to deliver an increasingly better service, due to the following additional benefits:

New, improved knowledge, and capacity building
- **Highly localised capability** – unlike other sources of more general, offshore forecasts, OWWL offers location specific data that takes into account the foreshore bathymetry at Fort Picklecombe – a key factor affecting the development of incoming waves and wave overtopping at Fort Picklecombe. A forecast for Cawsand or Kingsand, even just a short way along the coast for example, can be very different.
- **OWWL forecasts pick up the peaks of storms better than other forecasts**.
- **More timely data** – OWWL data is easily accessible and timely all year round, 5 days in advance. This allows for flood mitigating action to be taken ahead of dangerous storm conditions that could prove a threat to the safety of those erecting sea defenses.
- **Increased capacity** - as a result of the SWEEP collaboration, we (the volunteers at Fort Picklecombe) and wider residents, have enhanced our wave forecasting knowledge and capability.

Influencing attitudes
- Working with SWEEP, and using data from its cutting-edge scientifically- robust OWWL model, has lent credibility to our work and enhanced the FPMC's knowledge and appreciation of what we do. We anticipate this will help secure further support from the board for further improvements of our sea defense plans and strategies going forward.

Improved forecasting, decision making and operational efficiencies
- **A simplified and more effective wave forecasting system** – OWWL data has been consolidated with existing data, to refine and clarify our colour-coded flood risk alert system. OWWL forecasts offers a numerical scale of flood overtopping risk based on litres of water per second per meter (l/s/m) predicted to overtop in any location. We have learnt that forecasts of <5 l/s/m pose no threat to Fort Picklecombe (no action required); between 6-15 l/s/m take us into our yellow warning (some risk to pedestrians and structural breakwaters – issue alert may be issued and areas roped off); >15 l/s/m climbs towards our amber warning (potential wave water in garage – erect water walls) and red warning (high risk of flat and infrastructure services flooding - storm boarding of ground level, as well as water walls, required). This is something we're continuing to assess and refine.
- **OWWL has already identified wave events that our current system has missed.**
- **Less subjective forecasting** – the benefits of the OWWL data ensure our decisions are based more on scientific facts rather than judgement, increasing their accuracy and credibility.

Better targeting of resources, improved safety, minimising disruption to residents by:

- Improved forecasting of potentially damaging storm events, enabling correct and more timely decision making around the deployment of sea defenses.
- Reducing false forecasting of potentially damaging storm events, saving costs and reducing disruption to residence and the maintenance staff required to deploy sea defenses. Erecting garage water walls for example, prevents residents from coming and going, and storm boarding the whole ground floor frontage takes a day, usually stays in place for 12 hours or more and prevents ground floor residents from seeing what is going on outside.

How might these benefits extend in the future, both for Fort Picklecombe and more widely?

- **Shift in strategic direction –** we will continue to use and validate OWWL data over the coming season with a view to this becoming the primary data source for our simplified, more effective forecasting alert system, that reduces reliance on volunteers. We anticipate that the predicted level of overtopping will be automatically converted into a numeric scale of flood risk which is linked to appropriate flood defense action to be taken by the Fort Picklecombe maintenance team. We plan to update the FPMC board at the end of the current season and consider how OWWL could be integrated into a revised sea defense plan and strategy.

- **Basis for future insurance** – we anticipate that this system for predicting and mitigating the risks of wave overtopping will increase the confidence of Fort Picklecombe insurers and could form the basis of future insurance.

- **More widely** – the benefits of this location-specific OWWL model could significantly benefit many other residential, business or public facilities especially on areas of coastline like the south coast of Cornwall where the myriad of bays receive waves at different angles resulting in a high divergence of exposure, from bay to bay, even from one end of a bay to another.

I've worked as a Flood and Coastal Project Engineer at Dorset Council for over a year and half, also as a Duty Engineer responding to out of hours flood/coastal incidences. Before that, I worked in similar roles related to flooding at Plymouth City Council and the Environment Agency.

I have been signed up to the OWWL forecast for the last 18 months and use it during predicted storm events.

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- Yearly statistics on risk alerts to help justify getting new projects off the ground.

Operational Wave and Water Level model
Impact Case Study #6

OWWL

Ian Cruickshank,
Director of Engineering and Delivery, HR Wallingford

How are you using the OWWL forecast?

HR Wallingford is a not-for-profit HR organisation that delivers smart solutions where water interacts with people, infrastructure and the environment.

I work as part of the specialist research and consultancy service helping to protect vulnerable communities, improve lives and create resilience in the built and natural environments and am involved with coastal safety at Carolyn Bay beach near St Austell on the south coast of Cornwall.

The Carlyon Bay beach site management has been receiving the SWEEP-OWWL forecast since the end of 2021. They use it regularly to support their management of the site as it offers me an easy to use daily alert for potential overtopping and the risk of coastal flooding.

What threat did Storm Eunice pose to you, and your area of the coast?

As with other large storm events, Storm Eunice posed a threat to the management of Carlyon Bay Beach (a bay and a set of three beaches near St Austell on the south coast of Cornwall). It's the site job to assess the level of risk from overtopping and recommend precautionary measures to be put in place when risks are high.

What is the value of the OWWL forecast to your work?

The SWEEP-OWWL forecast provides a timely and accurate overview of local HS (significant wave height) and Tp (wave period) data. As an easily digestible and locally applicable service, it is very useful to the site planning on a daily basis.

When the alerts arrive, the site staff review these to assess whether there is a risk to beach users. During Storm Eunice there was a heightened risk and the beach was closed.

The SWEEP-OWWL model and forecast alerts that we receive benefit us in several ways. They help:
- To increase our confidence in predicting and managing coastal overtopping, enabling the site management to make better decisions to reduce disruption and damage at the coast. Over time we plan to refine the level at which we trigger alerts. We anticipate this will enhance our operating procedures ensuring we respond more effectively to beach safety threats from storm events, thus improving safety for beach users. This would ultimately extend to evacuation alerts for very severe storms.
- With more efficient targeting of resources to reduce coastal flooding and improve resilience, which helps us to make cost savings. This is difficult to quantify, however, the ease of the alerts makes the management processes easier.
- Improve health and safety of coastal workers, public, property, businesses, leading to life and business preservation. This will become even more important and useful over time as new development planned in the area (the Beach at Carlyon Bay) will lead to a greater number of users in close proximity to the sea.

Operational Wave and Water Level model
Impact Case Study #7

Huw Morgans, Principal Engineer,
Vale of Glamorgan MLA (Welsh Local Coastal Authority)

What does your job entail?

I work in the Vale of Glamorgan Council with my manager Clive Moon (Engineering Manager Environment) and we have responsibility for coastal management, flood risk management and associated land drainage duties. Part of our job is to provide advice to the Waste Management team within the council who are responsible for managing the majority of the council's coastal structures.

Over the years we have undertaken a number of pro-active measures, such as the installation of a tide station at Penarth Pier and monitoring cameras at several locations. We are particularly interested in the impact of wave overtopping which has been one of the studies we have commissioned at sites of particular interest to us along the coast.

The main coastal areas in our region to suffer from coastal flooding are Penarth Promenade and Swanbridge. We regularly monitor and inspect structures at the coastal resort of Barry Island and other leisure beaches within the Vale of Glamorgan. Since Dec 2020, we have been heavily involved in investigating surface water flooding to communities within the Vale of Glamorgan.

How are you using the SWEEP-OWWL forecast and why is it of value to you?

We have been signed up to the OWWL model since 2019 and receive forecasts for the key regions that we're responsible for – Penarth, Whitmore Bay and Aberthaw.

The OWWL model is a really useful addition to the other sources of data we use to predict and respond to coastal flooding. With its 3-day in advance hazard warning for potential coastal overtopping, it helps increase our confidence in passing on the right advice to those (the waste management team and emergency planning team) who are making decisions on the appropriate response and resource allocation in relation to coastal flood risk.

A key feature of the OWWL model that is important to us is the wave height data. Penarth is affected by north-easterly winds which tend to bring the large waves that cause us the most problems in terms of overtopping and coastal flooding. It's difficult to predict overtopping from tide height and wind speed alone and other data available for wave height is patchy and often reliant on visual observation. So having the OWWL data is really helpful.

How have you benefitted from the OWWL model, for example during Storm Eunice, and how do you anticipate benefitting from it further in the future?

On the 17th of February, the OWWL model flagged overtopping warnings for Penarth Pier, Whitmore Bay and Aberthaw. In reality there wasn't a huge amount of overtopping due to the fact that peak wind and maximum wave reach didn't coincide with high tide, but it was still helpful to have advanced warning of the potential for this via the OWWL forecasts so we could be primed and ready to respond rapidly, if needed.

I'd say the key values of the OWWL model to us going forward are as follows - all of which will help improve how we target our limited resources and achieve cost-savings.

- Reduce disruption and damage to local businesses, especially near Penarth Prom. Providing accurate and timely advise to our response teams so they are able to deploy if required measures (such as sand bags) to prevent structural damage.
- Reduce damage of flooding to properties located close to the sea
- Increase the safety of local people, who often head to the coast to observe the stormy weather and overtopping waves.
- Minimise disruption to local highways, especially at Penarth and Swanbridge
- Protect the Welsh Water sewerage pumping station on Penarth Prom which, if overwhelmed with water (both rainfall and overtopping), will lead to significant sewage flooding both in the immediate area and more wide spread due to its connection with other pumping stations. This has in the past led to significant disruption and costs both from a sewerage clean up perspective and if repairs are required to the pump (which costs c.£50,000) and the pumping station (which would cost £100ks to repair or replace)
- Provide an early warning system to help with strategic decision making for example, in connection with the power station site near Aberthaw, where £8m has already been spent by a consortium of local councils and a further £36m investment is planned.

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Operational Wave and Water Level model
Impact Case Study #8

Simon Bunn, Flood Risk Manager,
North Somerset Council (NSC)

OWWL

Despite only using the OWWL forecast for a couple of months I'm already seeing the benefits of this for my work. Storm Eunice highlighted these benefits, as we faced a flood alert along Weston-super-Mare with advice from the Environment Agency to shut flood gates and, two days later, a flood warning for the coast at Clevedon.

Wave overtopping at Western-super-Mare

Tell us a bit about your work

I've been Flood Risk Manager at NSC for just over a year. As part of my job I provide information to operational staff at Weston-super-Mare to help enable them to make effective decisions that minimise damage and disruption from coastal flooding e.g. by closing the sea front flood gates.

What are some of the difficulties you face?

Previously, this gate closure has happened in response to an operational alert from the Environment Agency. The problem with this, is that the operational alert doesn't provide any indication of the potential magnitude of the event, and also appears to be overly cautious. This means that in the vast majority of cases where gates have been closed, it has proved unnecessary. Understandably, this isn't popular with local businesses who are directly affected.

These alerts also don't provide us with sufficient information on the predicted weather to help us make decisions in relation to the different options we have around *which* gates to close.

In what ways are you benefitting from the OWWL forecast?

In contrast to the EA alerts, the OWWL forecast offers us a more nuanced understanding of what the impacts of any storm event are likely to be. This allows us to make better decisions in response to the potential risk of coastal flooding, allocate resources more appropriately, and act more effectively, particularly around flood gate

closures. These are often closed unnecessarily, due to inaccurate overtopping predictions, adversely impacting local businesses and infrastructure.

The forecasts are easy to use, arriving directly to me via email before being automatically forwarded to the seafront team at Western-super-Mare. They helpfully provide overtopping data which allows us to better understand the risk to individual parts of our coast.

Our flood risk team is small and not able to monitor all locations for potential impacts. The OWWL forecast allows us to raise concerns and suggest that operation staff concentrate resources in certain areas and not in others.

Any road closure is unpopular. During Storm Eunice I was onsite and able to advise the highways team on the length of the closure, based upon what was happening on the ground and the OWWL model predictions. This helped to minimise disruption.

Without the OWWL forecast I wouldn't have been able to feedback on the potential magnitude of the impact to the operational staff or known where to prioritise undertaking post storm inspections on North Somerset Council sea walls.

How do you see yourself, and your team, using OWWL going forward?

I see the OWWL forecast as a reliable source of information the team can have confidence in to make the right decisions. As such, I'm currently working to raise awareness of the OWWL forecast and embed it within our operations teams.

It is still early in a change of practice away from an overly precautionary approach, but the benefits of doing so are obvious. More accurate gate closure will not only benefit us in being able to be more efficient with our resources, but it will be popular locally as access to businesses (the Grand Pier, Revo and numerous cafés) and car parking is impacted by any gate closure.

We would love to see the model extended to cover others areas of concern to us. For example, in Portishead/Portbury where public and property safety is a concern in, and near to, a well-used nature reserve only separated from the sea by an earth bund and therefore liable to flooding.

sweep

Operational Wave and Water Level model
Impact Case Study #9

Tony Flux, National Trust,
Trust's Coast and Marine Advisor

OWWL

What does your work entail?

As Coast and Marine Adviser (SW), my role is to take a strategic view of coastal, erosion access and infrastructure resilience flooding for the National Trust (NT) in the face of ongoing climate change and sea level rise in particular. I am also responsible for providing integrated coastal management advice to NT project teams ranging from habitat creation schemes to new jetties!

How do you use the SWEEP-OWWL forecast and what value does it offer you?

After meeting the SWEEP-OWWL team in September 2021 I was keen to sign up to all the regions covered by their forecast and to be a hub for further dissemination of reports to our NT operational teams in Dorset, Devon, Cornwall and Somerset.

The forecasts arrive directly into my inbox. I check the specific locations at risk, and which of the four levels are being specified, before judging whether or not to forward the details on to the relevant ops team.

I find the OWWL forecasts easy and straightforward to use, and the level and type of data really helpful. Of most value to us is:

- The 3-day in advance time period for warnings which allow the teams plenty of time to prepare for adverse and potentially damaging storm conditions.
- The four levels of warning, and higher degree of specificity of location, as this allow us to judge more accurately when, and how, to deploy/ target our resoucres and take appropriate preparatory action, such as closing a car park or café.

We manage over 300 miles of coastline in the south west and our ops teams are always busy. As such, there is limited capacity at all times so we need, and value, systems such as OWWL that help our teams react to bad weather conditions in a timely fashion. Early warning significantly helps to reduce stress and allows time to make preparations to minimise risk and damage.

I see the OWWL model as an important part of the range of data we use, benefitting our ops teams by providing accurate advanced warning of problematic overtopping and potential coastal flooding.

Looking forward

Due to limited time and the large number of NT sites, I'm only able to transmit the two highest warning levels. I'm keen for local ops teams to sign-up to the email warnings independently so that they can benefit directly from the forecasts.

Although its early days and further engagement is needed on the ground, in my opinion the OWWL forecast has great potential to benefit the National Trust in a variety of ways, including:

- Improved resource targeting, leading to a reduction in business interruption and subsequent cost savings
- Improved public safety due to more informed, and better timed, warning signs for the general public
- Increased resilience of NT coastal infrastructure e.g. access points such as car parks and footpaths; amenity facilities such as cafes; holiday cottages; toilets
- Informing current discussion and policy development in relation to emergency resilience against coastal destruction, and climate change adaption and mitigation – draw on SWEEP's future scenario modelling work.

Over a longer time period (say 3-5 years) I think it will also be possible to build up a clearer picture of just how many interruptions due to storms/overtopping there have been and to identify the most targeted hotspots. In this way, a sharper focus on where to implement comms programmes or even new works may be contemplated.

Operational Wave and Water Level model
Impact Case Study #10

Neil Counsell - Specialist Advisor,
Flood forecasting, Natural Resources Wales

What is your interest in the SWEEP-OWWL forecast?

Natural Resources Wales (NRW) currently provide a national coastal flood forecast and overtopping system. It's been interesting to talk with the SWEEP team and explore the additional value that the SWEEP-OWWL forecast could potentially provide us – particularly around data input from a greater number of more localised, dynamic beach profiles (rather than the static, winter survey based profiles currently used by NRW), with annual/bi-annual updates of these profiles.

Initial engagement with the OWWL model has provided evidence that some additional forecast locations may be beneficial within NRW's model to support the coastal flood forecasting service.

How do you see NRW benefitting from the SWEEP-OWWL model in the future?

NRW are interested in looking at comparative sites with the two systems, to help our understanding of the accuracy and validity of our existing system compared with a demonstrable alternative. In particular, we would like to compare post event outputs and verification data at Saundersfoot and Mumbles where we have shared forecast locations.

We would also like to expand the number of profiles captured by the OWWL model that match NRW forecast locations, so we have more comparative sites to review and build an evidence base.

I believe the modelling approach taken by SWEEP OWWL would be considered to inform any future wholescale review of NRW's coastal forecasting model.

STORM EMMA:
REAL-TIME COASTAL FLOODING PREDICTION DURING A 100-YEAR STORM EVENT

Location: South Devon and Cornwall, UK.
Dates: 1st – 2nd of March, 2018
**Project**: South West Partnership for Environment and Economic Prosperity

A real-time coastal flood warning system is being developed for the entire southwest of England that, for the first time, predicts the potential hazard of wave set-up, runup and overtopping in the region. These elements can contribute many meters to the total elevation of the sea and cause significant flooding during a storm. At the core of the system is a 1 km resolution Delft3D wave and hydrodynamic model. 246 topographic profiles, representing the most at risk areas for each stretch of the ~900 km coastline of south west UK, are used for the prediction of wave runup and overtopping, using different formulae for profiles featuring gravel beaches, sandy beaches, and sea defence structures. During Storm Emma, which featured easterly wave –

Damaged A379 road, Slapton Sands

heights of 5.5 m (~100 year return period - middle figure), the model predicted extreme wave runup far exceeding the crest height of the gravel barrier at Slapton Sands (bottom figure). The runup was predicted to add 6 meters to the vertical reach of the sea during this storm, and caused severe damage to the A379 road atop the barrier (top figure). Predictions of tide and storm surge alone would not have predicted the hazard that this event posed, due to the extreme degree of wave runup. We are working with the Environment Agency to further test the model over the 2018/19 winter.

Wave Height (Hs): 02/03/18 03:00

Slapton Sands (profile 6b01257)
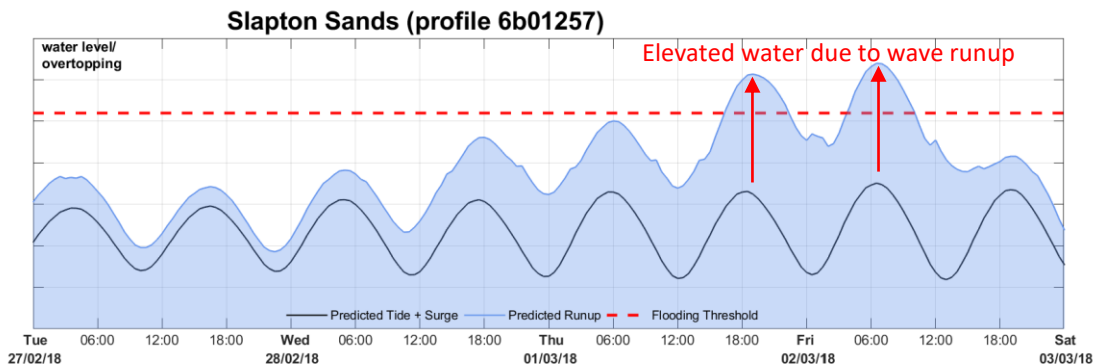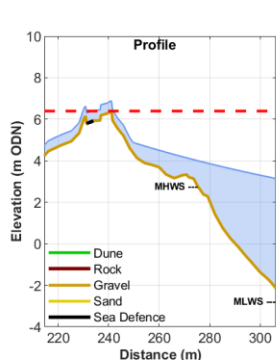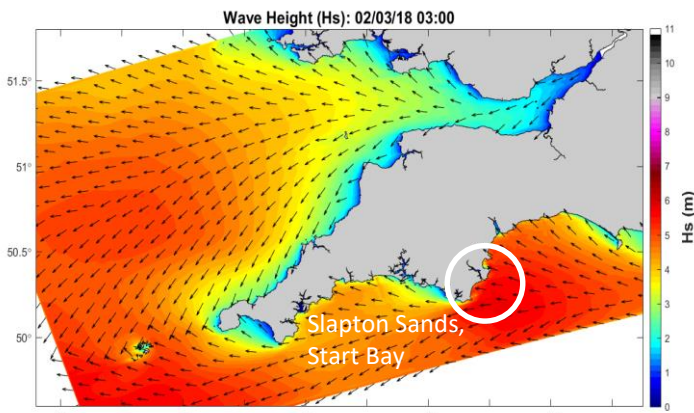
NEVO Case Study
Reconnecting and improving the River Wey
NEVO Team & Kay Lidgard (Environment Agency)

Introduction

The NEVO Tool is a web application (accessed at https://www.leep.exeter.ac.uk/nevo) developed by the Land, Environment, Economics and Policy (LEEP) Institute at the University of Exeter with support from DEFRA and NERC.

NEVO's primary purpose is to help explore, quantify and make predictions about the benefits that are derived from existing and altered land use across England and Wales. This short case study uses NEVO to add value to reconnect and improve the River Wey. The tool is used to assess current ecosystem service flows and consider the impacts of natural flood management interventions.

The case study then proceeds to consider how NEVO can be used to explore alternative project options and compare their predicted impacts.

Scale, Services and Functionality

2km Grid and County

The Case Study Area

The NEVO interface is a navigable map which illustrates ecosystems services in England and Wales. In *Figure 1*, we have zoomed into the area of the case study on the River Wey, which we centred on Cranleigh, as it was identified as being a good candidate for Natural Flood Management (NFM). In 'Select' mode we are able to choose to view output at the catchment level for the Thames. Clicking on the Thames catchment on the map opens the details panel displaying aggregates outputs for the catchment.
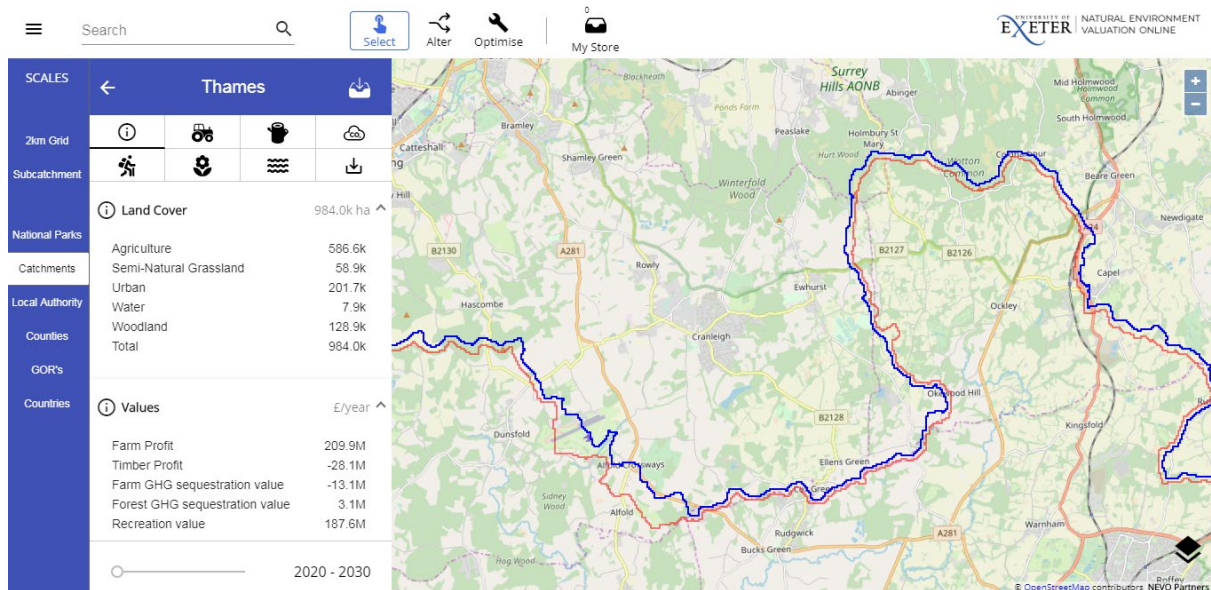

Figure 1: Exploring the River Wey

Exploring ecosystem services in the catchment

The Thames catchment was explored to establish the baseline. Over half (60%) of the land cover in the Thames catchment is identified as agriculture, with urban providing the second-biggest cover (21%), followed by woodland (13%). Semi-natural grassland and water make up the remaining land cover. Switching to view the values in 'Annuity' mode, we can see that the largest value comes from recreation, which accounts for £797.1M/year. Farm profit is valued at £184.3M/year. Forest GHG sequestration is smaller at £2.9M/year. Timber profit and farm GHG sequestration provide negative values per year.

The River Wey

The River Wey was initially assessed by selecting subcatchments. These are broadly similar between the NEVO dataset and our internal dataset. Minor differences were noted where some subcatchments in NEVO are subdivided into smaller subcatchments in our internal dataset, as illustrated in *Figure 2*. The process was intuitive, with the map-based select function proving very easy and simple to use. The Ordnance Survey map layer was found to be the best for showing rivers and woodland. The 'Follow River' function was particularly interesting; the ability to track the river and see how its properties and values change through the catchment was useful. It would be helpful to be able to select multiple scales at once, e.g. catchment and subcatchment. This would aid the initial assessment of the area.
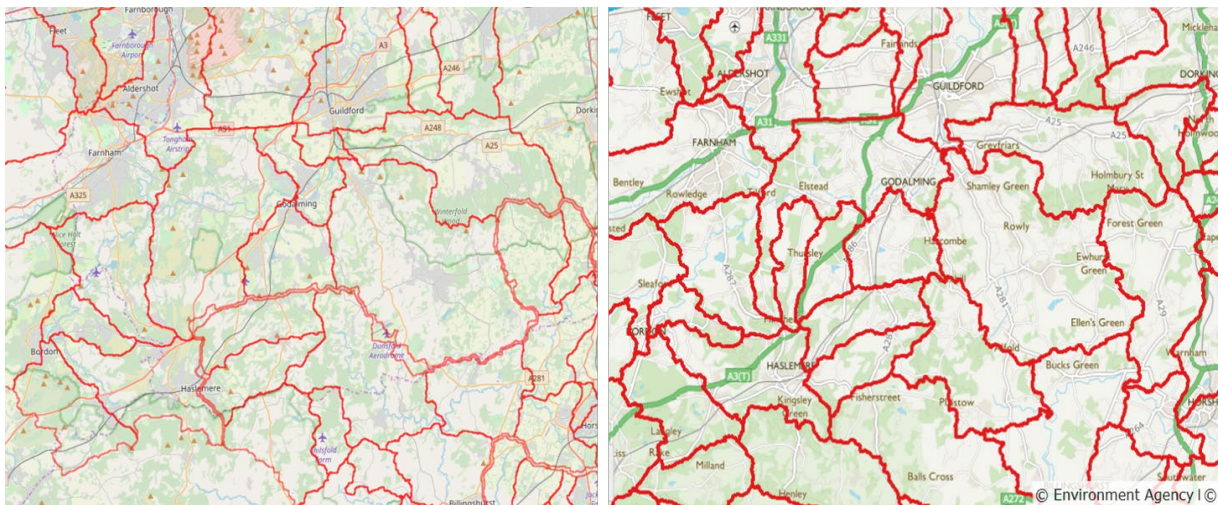

Figure 2. Comparison of subcatchments in NEVO (left) and our internal dataset (right)
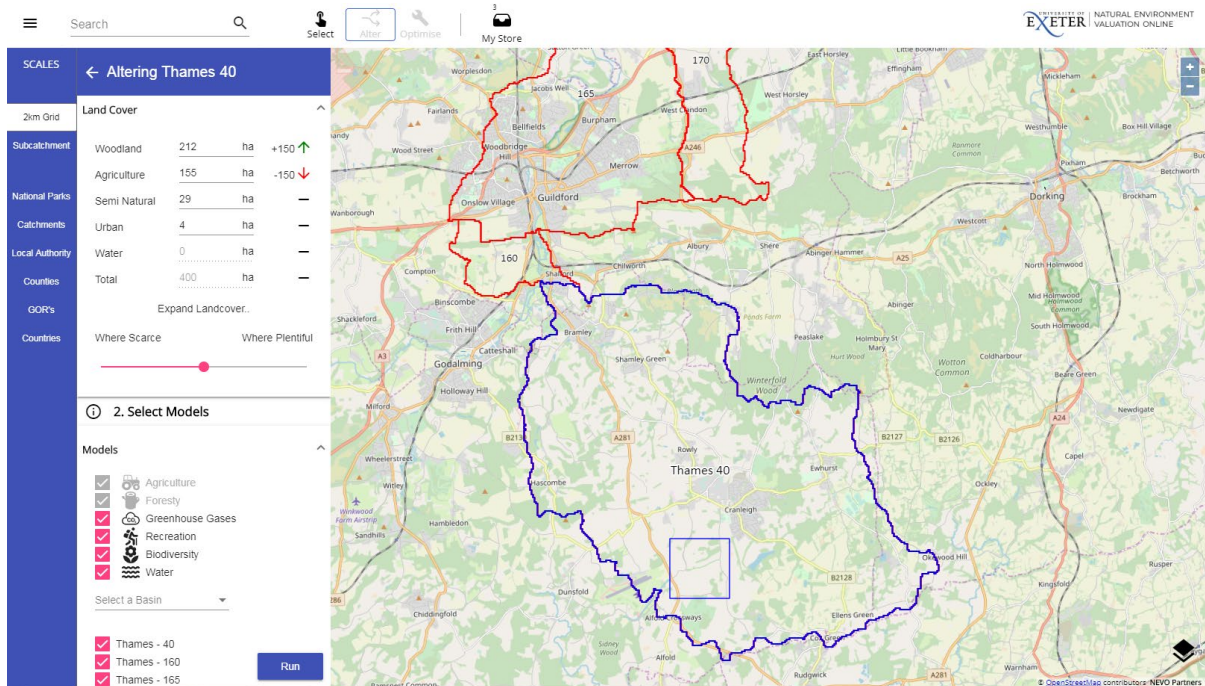
Figure 3. Using the 'Alter' mode for woodland planting in cell #163868, selecting 3 subcatchments for viewing water quantity and quality output

Scenario analysis

NEVO was used to assess the effect of NFM projects on water quantity and quality, as well as the additional benefits such as species richness, GHG sequestration and recreation. The 'Alter' mode was used at the 2km grid scale. In order to simulate NFM woodland planting, approximately 50% of agriculture was replaced with woodland for several grids in the headwaters around Cranleigh.

An example of 'Alter' mode for grid cell #163868 is shown in Figure 3. We assign 150 hectares from agriculture to woodland, run all available models and select 3 Thames subcatchments to view water quantity and quality output.

The effect on water quantity and quality for this change in the Thames 40 subcatchment is shown in Figure 4. As expected, the introduction of woodland has reduced flow levels in the subcatchment. The 5th percentile and mean level of flow have been reduced by 0.011 and 0.002 m^3/s respectively. Water quality has also been improved, with levels of various nitrogen and phosphorus

concentrations reducing. For example, the average annual concentrations of organic nitrogen and phosphorus have fallen by 0.072 and 0.017 mg/l respectively. As we move downstream to study the impact in the Thames 160 and Thames 165 subcatchments, the effect diminishes as we would expect.

The additional ecosystem services benefits of woodland planting can be assessed using the Info tab in NEVO, shown in Figure 5. We see that while farm and timber profit is reduced, farm GHG sequestration, forest GHG sequestration and recreation values are increased. Recreation value only increased by £900/year, however this is using the 'alter current paths' option in 'Alter' mode. If instead we allow the new woodland area to provide new recreational access via a new path network, this value increases to around £37,000/year. Further still, if we treat it as a new recreation park the value rises to £170,000/year. In terms of biodiversity, species richness shows a small increase. It was useful to see the breakdown of richness across species.

This process was repeated for several 2km grids in the headwaters around Cranleigh and indicates how NEVO can be used to identify where NFM can yield the most additional benefits and therefore help direct decision making on where to focus projects.

The outputs of NEVO could help us with the challenges of levering funding for multi-benefit schemes. We would be able to show where there is a marked increase in the value of other ecosystem services to facilitate public and investor buy in.
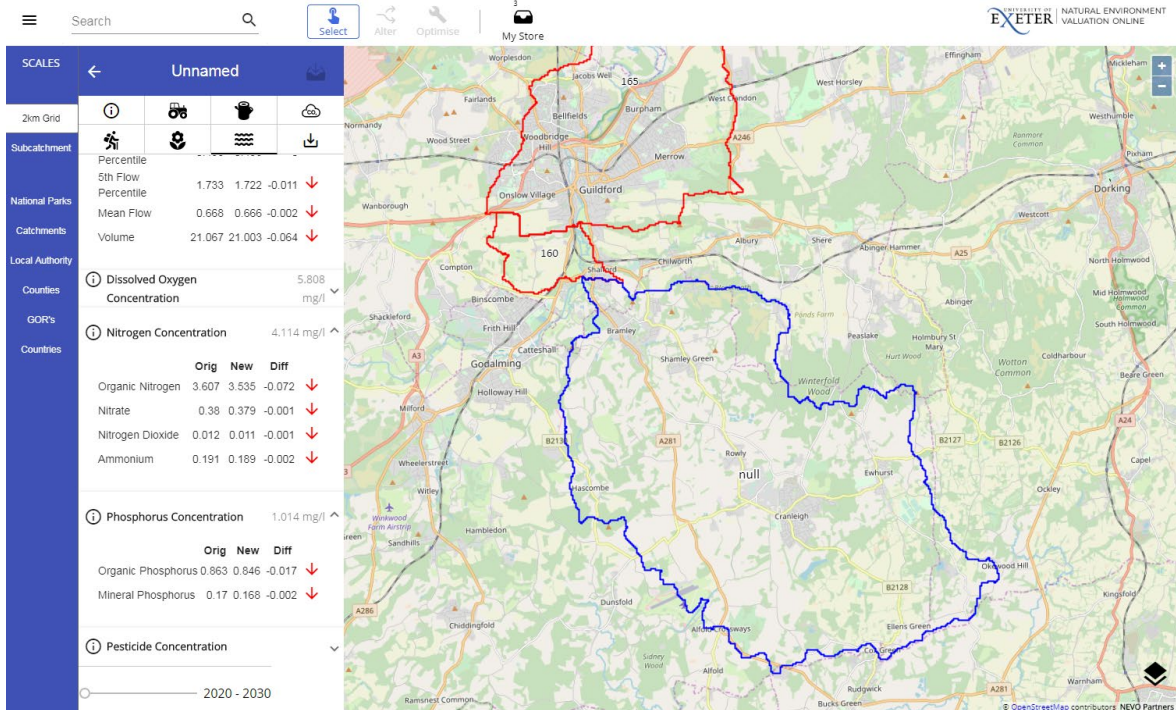

Figure 4. The impact of woodland planting on water quantity and quality for the Thames 40 subcatchment
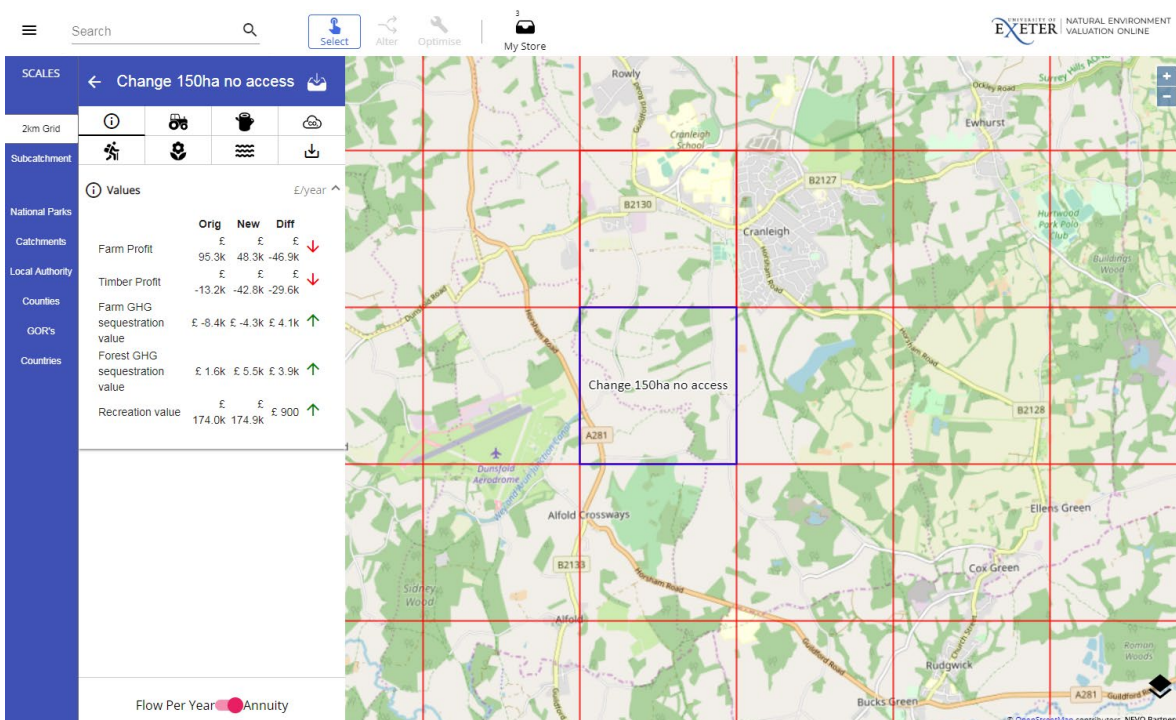
Figure 5. The additional ecosystem service benefits from woodland planting

Potential Extensions

The ability to optimise for water outputs would be useful for helping direct decision making on where NFM projects should be located to achieve the most benefits. A wetland option in the alter tool would be beneficial as at the moment we are only able to assess woodland planting projects. It would also be useful to translate water outputs into Water Framework Directive (WFD) ecological status to allow a direct comparison of the current and potential status as a result of different schemes.

To aid NFM assessment, it would be useful to see floodwater volume as an output, since the water quantity in the tool is based on flow data and not flooding. Flood mitigation summaries would also be helpful.

The option to view land ownership would be useful, for example private versus Local Authority owned land, as this would have a bearing on where to initially direct the location of schemes.

References

NEVO technical documentation

https://www.leep.exeter.ac.uk/nevo/documentation/

Video user guides

https://www.youtube.com/watch?v=b0qKcO8dE0s&list=PLG5Rz1SU4uYcRqLMEosaUucRsVvv9A7ny

Wildlfowl and Wetland Trust (WWT) Impact Case Study

Enabling a more robust and evidence-based approach to the economic assessment of health and wellbeing benefits being delivered from WWT's wetland sites and programmes.

What was the need?

WWT protects, restores and creates healthy wetlands, and brings people closer to nature. One of its current priorities is its Blue Prescribing project; a wetland-based health programme designed to enhance people's connection with nature and improve their wellbeing. This high profile work is an example of green (or nature) prescribing which forms part of the government's Green Recovery drive and its wider 25 Year Environmental Plan. WWT is rolling out Blue Prescribing at two key sites - Steart Marshes (a managed realignment site) and the London Wetland Centre.

WWT increasingly needs to provide evidence of the breadth and value of human health impacts delivered from these programmes, as well as from wetlands in general, considering their wider importance in delivering natural capital services such as flood prevention and carbon sequestration. This is critical information for funders and opens opportunities to create more robust financial business cases for the co-benefits of wetland creation.

How did SWEEP help?

Drawing on its own database of evidence, and wider sources, the SWEEP team developed two bespoke reports for WWT. These highlight both frameworks, and measures, for assessing the economic value of health and wellbeing benefits arising from natural environment-based interventions. The resources present and analyse evidence from literature, and relevant case studies, from which WWT can assess those approaches and data most relevant to their own needs.

Outcomes and impact

Enhancing knowledge and changing perceptions and attitude

The bespoke SWEEP evidence reports have enhanced WWT's understanding of how best to economically assess the health and wellbeing benefits of their work, particularly at the Steart Marshes site. Additionally, the wider suite of SWEEP resources provided a much needed connection with other practitioners especially during the pandemic and have inspired new ideas.

'Working with SWEEP has built our confidence and extended our understanding about how academic evidence can help us do our job better. It has allowed us at WWT to think about, and act on, how we best deliver health benefits from our wetland nature-based interventions and communicate more clearly and credibly about the value of this to society'. **Jonathan Reeves, WWT Principal Research Officer for Health & Wellbeing.**

Enhancing delivery

- **New approaches** – drawing directly on SWEEP's resources WWT employed an SROI (Social Return on Investment) approach to assess the economic impact of its Blue Prescribing programme at Steart Marshes.

  'Working with SWEEP has boosted our knowledge and capacity to use some of the best available evidence-based metrics and methods for economically valuing the health and wellbeing benefits from our wetlands nature based health interventions. SWEEP's resources were key in our decision to undertake a SROI (Social Rate of Investment) assessment at our Steart site. For the first time, we hope this will give us concrete economic data on the health benefits we deliver, making our work more policy relevant and strengthening our ability to leverage further funding'. **Jonathan Reeves.**

- **Accelerated timelines and cost-savings** - SWEEP provided the capacity WWT lacked in-house to collate and analysis best practice evidence in response to its needs.
- **Leveraging further funding and securing jobs** - SWEEP informed WWT's SROI work at their Steart Marshes site, and this work demonstrated a commitment to evaluation and was a contributing factor in securing additional funding to extend the work (and project officer post) by 6 months.
- **WWT leading the way** - economically evaluating health and wellbeing benefits from environmental interventions is notoriously difficult but, with SWEEP's help, WWT is now more effectively engaged with the process. The experience of applying the SROI approach at the Steart Marsh site will provide valuable data, as well as learning, to drive further improvements in this area.

*'Nature prescribing projects are logistically challenging and the project management occupies a lot of staff time. SWEEP helped to accelerate WWT's thinking and our ability to start assessing the economic value of its social prescribing work, providing the much needed capacity that WWT simply didn't have in-house to undertake this important aspect of our work'. **Jonathan Reeves.***

- **Feeding into wider WWT strategies and approaches –** SWEEP's resources (the bespoke WWT reports and [Five Capitals Model resource](#)), as well as the SROI assessment at Steart Marshes (informed by SWEEP's evidence report) is already beginning to inform WWT thinking at a senior level. As WWT approaches its next strategy cycle later this year, discussions are underway to determine how best to approach the wider economic assessment of WWT's health and wellbeing impacts, both from its wetland-based health programmes, and from wider wetland natural capital service provision such as flood prevention and carbon sequestration. It is expected that SWEEP's work will inform a more standardised and robust approach that can be used across all WWT's sites and activities including wetland visitor centres, wetland restoration and creation projects and programmes of interventions.
- **Stronger partnerships** - SWEEP has provided an opportunity for WWT to consolidate and develop its relationship with the University which has generated new ideas and fed into broader work. WWT has shared the SWEEP resources with various partners, thereby better supporting them with their own activities to assess the economic value of health impacts arising from their work.

Legacy – creating lasting change
Time is required to realise the full impact and benefit of this work for WWT. However, it is anticipated this will be significant and the following are just a couple of the expected pathways to impact:
- **SWEEP PhD** – continuing until 2024, this will ensure that the foundations of this SWEEP work will be sustained and extended.
- **Collaboration** – new policy relevant funding from NIHR will enable WWT and Exeter to work together on a high-profile feasibility trial for green social prescribing, helping deliver the Government's commitment to enhancing the use of natural environments to enhance mental health.
- **Contributing to national policy** – the creation of wetlands, and coastal managed realignments like the Steart Marshes site, are moving up the political agenda. Drawing on its own experiences, such as this work with SWEEP, WWT is in a strong position to inform and strengthen national policy around best approaches for assessing and valuing the cost effectiveness of new wetlands, particularly in relation to health and wellbeing benefits. One recent example is WWT's contribution to the new 6,140 hectare ['super' National Nature Reserve](#) in Somerset, protecting saltmarsh, heath and wetland habitats.

*'The SWEEP resources are prompting discussions, informing conversations and sowing the seeds for a different way of thinking at WWT. This first step is the most important as it has significant potential to influence how we decide to assess and value the health benefits of our work and ultimately how we manage and develop new sites, and advise policy development in this area.' **Jonathan Reeves.***

The Heligan Wildflower Project

A case study illustrating the potential opportunities and benefits of wildflower seed production in Cornwall and the Isles of Scilly

The Lost Gardens of Heligan

BEE-STEWARD

Case Study – The Heligan Wildflower Project

Who should read this?

This case study will be of interest to any landowner, land manager, environmental practitioner or policymaker interested in how the production of local wildflower seed can boost local businesses, enhance biodiversity and increase the health and wellbeing of residents and visitors to Cornwall and the Isles of Scilly, and beyond.

Introduction

The Lost Gardens of Heligan are a 200-acre historical garden and estate in Cornwall. It is one of the top 10 visitor attractions in the South West of England, attracting 350,000 visitors every year. Alasdair Moore joined the Lost Gardens of Heligan team, as Head of Gardens and Estate, in 2018 after over 30 years of experience in horticulture. This new position allowed Alasdair to realise his dream of creating a large-scale source of wildflower seed through the Heligan Wildflower Project.

Alastdair tells us about the project...

The Heligan Wildflower Project successfully established a large meadow with cornfield annuals in 2019, which has flowered every year since. It has provided an unforgettable visitor experience, ample food for pollinators and an opportunity for additional business income.

" **Cornwall's biggest industry is tourism... let's make Cornwall the most beautiful, wildflower laden, glorious place to visit in the country!** *"*

Alasdair Moore, Head of Gardens and Estate, The Lost Gardens of Heligan.

We set up the project with the aim to:

- Increase pollinator numbers and biodiversity by seeding Valentines (a 15-acre field) with cornfield annuals.

- Develop a large wildflower display as part of the 2019 summer family program focused on pollinators (bees and butterflies).

- Explore the commercial possibilities of harvesting the wildflowers for seed.

- Work with the National Wildflower Centre, now based at the Eden Project, Cornwall.

Image © Alasdair Moore 2022. Since 2019, Valentine's meadow has been blooming with cornfield annual flowers providing a unique visitor experience at the Lost Gardens of Heligan.

What we did

The site: First, we choose our site – the Valentines' field. Traditionally, this had been used as a hay meadow with some light grazing, but over previous years had been planted with flax and used to keep pigs. Our first job was to prepare the ground for sowing. The options were to either spray off the grass cover or to deep plough. The Heligan team decided to deep plough. Whilst this had implications in terms of carbon release, we felt it the better option given the main aim of promoting pollinator populations, as spraying could potentially detrimentally affect the very creatures we were trying to support.

In order to have the wildflowers ready for our school holiday summer program, the flowering needed to take place from July to August, rather than during the natural flowering period of May to June. This meant that we had to sow the seed in April rather than in February-March. Valentines was ploughed and rolled in early April and seeded in late April, using a local contractor and a seed drill.

We worked closely with Richard Scott, Director of the National Wildflower Centre, (now based at the Eden Project in Cornwall), who provided invaluable advice, without which, this would have been much more difficult to achieve.

The seed: The seed mix was bought from the National Wildflower Centre. It consisted predominantly of poppy seed in reference to the commemorations of the First World War that had been taking place

at Heligan for the previous four years. This was particularly expensive as it had been treated to increase its germination.

It was six weeks from the sowing date, before there was a period of meaningful rainfall. This meant that despite their quick germination, many of the seedlings initially died from a lack of moisture, and when the rains did arrive, a substantial portion of the surviving plants were stunted. Despite this, the top third of Valentines (where the pigs had been stationed) grew exceptionally well and this, therefore, was the area opened to the public.

Initially, the idea had been to cut a path right through the wildflower field, but due to the fact that many of the plants were stunted, we decided to change to more limited access. Taking up about 20% of the field, we cut a narrow meandering path which was roped along its length with supporting posts below the flowers' height. Every so often, additional 'lay-bys' were created.

Weight	Species	Price	Total
50kg	Poppy (seed treated) *(Papaver rhoeas)*	£140/kg	£7,000
12kg	Cornflower *(Centaurea cyanus)*	£90/kg	£1,080
10kg	Corn marigold *(Glebionis segetum)*	£90/kg	£900
5kg	Corn chamomile *(Anthemis arvensis)*	£90/kg	£450
10kg	Corn cockle *(Agrostemma githago)*	£40/kg	£400
	Total		£9,830
	Total excluding treated Poppy seed		£2,830

Table 1. Species in the Heligan Wildflower Project year 1. Prices excluding VAT.

Straw bales were placed in these to allow visitors to sit down and enjoy the view. We also cut a number of cul-de-sacs leading off from the main path, extending into the field like fingers. These provided places for individuals to take a selfie / Instagram moment, excluding other visitors from the shot. We set up interpretation boards at a few points, explaining the importance of pollinators and what to look out for.

In mid-Sept, with Richard Scott's help, we harvested the field with a combine harvester. The crop yielded approximately 153kg of seed. Richard Scott estimated that a similar amount of seed would have been scattered throughout Valentine's during this process, essentially re-seeding the meadow for free. We saw a mini re-flowering of the field following the harvest - rather less dramatic than earlier, but still beautiful.

Valentine's was then power-harrowed in October. The residual seed bank produced another good show in 2020, this time between May and June, with another approximate £153kg of seed being harvested (see Economic section below for more details).

In 2021 we had a very dry spring. This resulted in a reduction in the diversity of flowers in the dis play compared to the previous two years. The meadow was dominated by Corn marigold with just a light scattering of Cornflowers, Corn camomile, Corn cockle and the odd Poppy. As a result, we decided not to harvest in 2021 and left the bountiful harvest of seed as food for the finches and other wild birds.

We took this opportunity to review our Heligan Wildflower Project strategy and as a result, are now looking to create annual and perennial wildflower displays in the future. These will provide even more benefits to biodiversity, increase carbon storage and provide important seeds for conservation projects.

> **" I loved seeing a safe space for pollinators. It made me happy and was so beautiful. "**
>
> An anonymous visitor to the wildflower meadow at the Lost Gardens of Heligan

The benefits

Economic

Producing c.153kg of seed per year with a profit of £11.6K in the first year and a potential £14.3K in the second year from selling seed wholesale and retail (see Economic section below for more details).

Profit

Wildflowers

Environment

Creating 15 acres of wildflowers for pollinators and other beneficial insects and delivering a variety of other ecosystem services. Providing enough seed for another 5.4 acres per year (at a high sowing rate 7g/m^2).

Planet

Engagement

Providing a unique visitor attraction available to our 350,000 yearly visitors, and providing opportunities for local community engagement.

People

Engagement

The meadow was incredibly beautiful, and visitors were delighted. The effects of the initial drought on the bottom two-thirds of Valentine's field became negligible as the plants still flowered and were far enough away that nobody noticed they were knee-high rather than waist-high! Those that flowered in the top third of the field, surrounding the meandering path for visitors, looked spectacular. The poppies were not so evident, but it wasn't noticeable as the other flowers grew so well.

Preliminary user experience data collected in 2021 indicated that the wildflower meadow was influential in attracting and potentially re-attracting visitors and the extent to which it enhanced their experience whilst visiting Heligan, 30% of visitors to the meadow said that it was partially the reason for them visiting the Lost Gardens of Heligan, 79% would visit again to see the meadow, and 90%would recommend visiting the meadow to someone else.

Environment

We created 15 acres of wildflower meadow, harvesting approximately 153kg of seed per year (2019-2020). We provided enough seed to sow an additional 5.4 acres of cornfield annuals each year (at a high sowing rate of $7g/m^2$).

Over two years, therefore, we estimated that we had created a total of 25.8 acres of wildflower habitat - the equivalent of over ten rugby pitches.

Research tells us that the pollinating work of wild bees is worth over £2.4K per hectare of the crop,[1] and we know that protecting and creating new flower-rich habitats is key to ensuring our invaluable pollinators thrive. Not only do wildflowers provide nectar and pollen for pollinators, they also support biodiversity, capture carbon and enhance other natural capital ecosystem services such as water and air quality.

Economic

The seed harvest was professionally cleaned and separated at Emorsgate in 2019, and on-site by South West Seeds in 2020. The majority of the seed was sold back to the National Wildflower Centre. The rest was kept to retail to visitors in our shop, and over 10kg was donated to farmers wanting to establish annual meadows on their farms in Cornwall and the Isles of Scilly.

With a yearly amount of harvested seed of approximately 153kg, and bulk wholesale prices between £60/kg and £100/kg, this meant, at the highest, we had a wholesale estimate of £15,300 worth of seed. Added to this, was retail income from the sale of some of the 27kg of our seed that went into seed packs in our shop (selling at £2.95 for a 7g packet, with a multi-buy discount). In total, our gross income for 2019 was estimated to be around £17,749.

In 2020, we were affected by the Covid-19 pandemic.This limited our cash flow so we made an arrangement with The National Wildflower Centre to exchange our wholesale seed for their services of ground preparation and harvesting.

We paid for on-site seed cleaning by South West Seeds (£500). This meant that we didn't realise the previous year's profits. We did, however, retain our retail seed sales, which provided invaluable income during a challenging year for the business.

Table 2 shows the overall cost of the process in the first year and estimated for the second year if we had followed the same model as the first year (excluding the price of the poppy seed as this was largely unsuccessful). See our business case - Wildflowers: a case for engagement, environment, and economics for more detailed information.
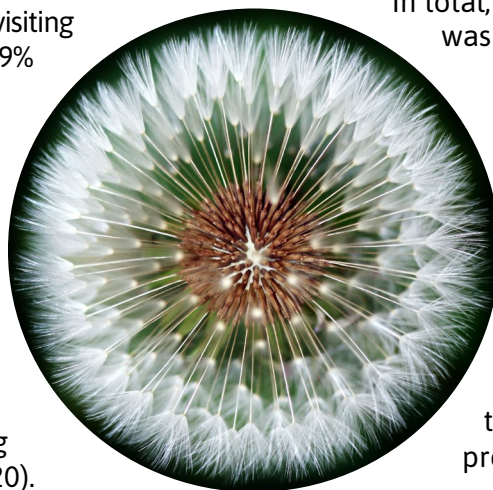
	2019	2020*	2021**
Costs	£6,184	£3,421	£0
Gross income	£17,749	£17,749	£0
Net income	£11,565	£14,327	£0
Yield	153kg	153kg	0kg

Table 2. Overall costs, income and yield from 2019-2020 from the Heligan Wildflower Project.

* 2020 estimate, based on 2019 model
** No harvest during 2021

In conclusion

- For us at Heligan, the initial investment was worthwhile alone simply for delivering a spectacular display of wildflowers for our visitors and providing an opportunity to engage them with our pollinator conservation message.

- However, also being able to pilot a business model for wildflower seed production and show that this can generate a net income of between £11,000 and £14,000 per year, was great news! We have shown that this is an opportunity for a genuinely profitable enterprise, both by selling seed wholesale, to the National Wildflower Centre, and retail, directly to our visitors under the Heligan brand.

- The fact that visitors to the Lost Gardens of Heligan can now experience our stunning wildflower display and then purchase wildflower seed grown from our Valentine's field, is proving to be a very attractive proposition that would seems to be attracting greater numbers of visitors.

- Our success at growing annuals has given us the confidence to consider growing perennial wildflowers as well. In this way, we can provide permanent habitats and food for pollinators and provide more seed for conservation projects across Cornwall and the Isles of Scilly.

- Our Heligan Wildflower Project has provided multiple benefits - for pollinators, the wider environment, our visitors and local community, and our business. We hope it inspires other businesses to grow wildflowers.

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[1] Kleijn et al., (2015), Nature Communications, 6, 7414. This is a US study but provides a proxy for this ecosystem service. This paper combines USA and European results on the contribution of wild pollinators to a range of crops. $3251 per ha converted to £2480 per ha using the exchange rate a time of writing.

> **In all my thirty years of horticulture, it [the Heligan Wildflower Project] is unquestionably my favourite project. Regardless of age group or background, everyone was moved by what they saw.**

Alasdair Moore,
Head of Gardens and Estate, the Lost Gardens of Heligan.

Citation: Twiston-Davis, G., Abrahams, R., (2022). *The Heligan Wildflower Project: Potential opportunities and benefits of wildflower seed production in Cornwall and the Isles of Scilly.* This SWEEP resource was produced from the Policy for Pollinators project, part of the South West Environment and Economic Prosperity (SWEEP) programme.

SWEEP is a partnership between the University of Exeter, the University of Plymouth and Plymouth Marine Laboratory. Funded by NERC, it brings together experts and stakeholders to solve key challenges faced by those working with our natural resources.

Sylvawood Seeds Impact Case Study
Boosting local business in the South West, that enhances biodiversity and delivers health and wellbeing benefits.

What was the need?
Exeter-based [Sylvawood Seeds](#) was established in early 2002 by Matt O'Connell. His vision was to develop a high quality, UK sourced, seed business. With the UK having lost 97% of lowland meadows since World War II, a key driver for the business is to expand planting of wildflower areas helping to boost biodiversity, support greater wildlife and deliver health and wellbeing benefits. Matt was keen for his products and services to embody these ambitions and for this to be reflected in his business messaging.

How did SWEEP help?
Matt worked closely with two of the SWEEP teams. The SWEEP Pollinator team provided expertise to ensure Matt's seed mixes were balanced to deliver optimal flower growth to boost biodiversity and attract plentiful bumblebees, butterflies and birds.

The SWEEP Investing in nature for health team reviewed a wealth of academic and non-academic literature and worked with Sylvawood Seeds to develop a bespoke report to meet its needs. This report enabled Matt to communicate more clearly and confidently about the growing evidence linking wildflower seeds with wild flowers, increased biodiversity, greater wildlife, enhanced pollination, and improvements in human physical and mental health and wellbeing.

Outcomes and impact
Enhancing knowledge, changing perceptions and attitudes
SWEEP provided Matt with a greater evidence-based knowledge about optimal seed mixes, and associated health and wellbeing and biodiversity benefits, which boosted his ability to improve his seed mixes and deliver on his vision. It has also boosted Matt's confidence in talking about his products and services with his customers.

*'SWEEP's advice and expertise has been invaluable. This has allowed me to adapt and diversify some of my wildflower seed mixes which has helped to strengthen my business. SWEEP's involvement adds credibility to what I do and has increased my confidence and success in talking about, and selling, my products to customers'. **Matt O'Connell, Owner of Sylvawood Seeds.***

Operational efficiencies and boosting business
<u>Stronger business communications</u> – backed by science, SWEEP has lent academic credibility to Slyvawood Seed's messaging and the brand is rapidly gaining popularity. Business communications have been strengthened including pitches, informal conversations and website content. SWEEP developed a new section for [Sylvawood Seed's website](#) linking the business's USPs to key evidence that supports the connection between wildflowers, health and wellbeing, biodiversity and wildlife benefits. This has helped to attract new business.
<u>Attracting business support</u> – Slyvawood Seeds secured c£5k in-kind support from UKRI for business development support, and has benefited from an association with the University of Exeter's MSc Business Analytic students.
<u>Business expansion</u> – SWEEP has played an important role in the growth and development of Slyvawood Seeds business over the last two years helping to set the business apart from its competitors. It has contributed to:
- **The growth of overall business sales** – which is forecast to increase by 20% by the end of 2022, representing a 38% increase in revenue from sales.

- **A three year partnership deal with the RSPB** - this is already increasing seed sales (both in-store and online catalogue) from 8000 packs in 2021, to 50,000+ packs in 2022. It is anticipated this will rise to 75,000-100,000 packs in 2023.
- **A new deal with the National Trust (NT)** – currently stocking Sylvawood seeds in 50 of its shops with the expectation that this will rise to 80 NT shops nationally.

'Working with SWEEP has helped me forge new business deals, such as our three year partnership with the RSPB. Being endorsed by a charity of this standing, and having the RSPB logo to our packaging, has been a real game changer'. **Matt O'Connell.**

Business diversification – SWEEP's input has informed Matt's strategic thinking, inspiring him to take his business into new areas, securing further customers. These include new ideas for product (such as developing sensory grass seed mixes that could create therapeutic landscapes) and customer segments (such as farm shops, hospitality businesses, health trusts, spas, hospitals and the farmers to support the new Environmental Land Management Schemes).

One recent new example is Sylvawood Seeds collaboration with Lambeth Council community group. Mental wellbeing is key to the work of this group and Matt's wildflower seeds now form part of the food parcels being given out to children/families as well as the gardening project being run for children and young people.

'SWEEP has opened up a whole new arena for me. The reputation and growth of my business has benefitted from the scientific evidence SWEEP has provided. Without this, I wouldn't now be communicating so confidently about how my seed mixes help to boost biodiversity and deliver health and wellbeing benefits or have started thinking more strategically about new product ideas such as sensory grasses'. **Matt O'Connell.**

Environmental enhancement and health and wellbeing

Increasing sales of Matt's wildflower seeds will lead to greater benefits for people and the environment. Evidence shows that planting and tending wildflowers, and spending time in wildflower areas, is linked to positive health and wellbeing. We also know that these wildflower areas offer high levels of biodiversity, supporting a great number of birds, insects and butterflies as well as delivering a raft of ecosystem services such as improved soil and air quality. Still in its first few years of trading, Matt calculates that his seed sales to date equate to 27ha of wildflower area.

The following case studies illustrate how and in what areas of DNPA activity, the SWEEP Habitat Classification and Change Detection tools (developed specifically for DNPA), as well as the THaW Mapping Toolbox and Change Detection tool, are being used to provide a more precise, cost-effective and timely understanding of the extent, state and change over time of natural capital assets and thereby informing more robust and sustainable decision making.

Impact Case Study 1: Peatland management and restoration work

What's the issue?

A vital habitat for many plants and threatened bird species, water quality, carbon sequestration, landscape and recreation and archeological interest, peat bogs are under significant threat. Research carried out by the University of Exeter found that just 1% of Dartmoor's peatland area is still intact, whilst much of the remainder has been severely damaged by drainage, cutting, drying and erosion.

The South West Peatland Partnership is tasked with restoring 1599 ha of degraded peatland on the South West's moors (Bodmin Moor, Dartmoor and Exmoor) - around 300ha of this is on Dartmoor.

How are SWEEP Habitat tools being used to address this issue, and what benefits are they providing both now and anticipated over the next few years?

- **To identify new areas for peatland restoration** – through their ability to measure peat depth, identify habitat type and monitor vegetation change over time, the SWEEP maps will be used to inform detailed peatland restoration and monitoring plans, and used to answer questions from Commoners around their future grazing management in relation to peatland.

  'The work has been extremely important and complementary to Naomi's previous work on the remote sensed depth of peat. It has added an extra dimension that would otherwise have been missing from a data set had it been generated elsewhere, or if we had relied on some nationally generated map'. Richard Knott, DNPA's Ecologist.

  'Working with the MOD as a landowner on Dartmoor, the SWEEP tools provide an opportunity to reveal priority areas not previously identified as part of the Peatland Partnership bid'. Richard Knott, DNPA's Ecologist.

- **To explore the value and limitations of using landscape scale remote sensing data** - such as that produced by SWEEP, for informing this kind of work, in comparison with traditional site scale surveys. Findings and recommendations to be shared to encourage wider uptake and further development of these kind of tools.

Impact Case Study 2: Natural capital mapping for carbon sequestration enhancement on DNPA land

What's the issue?

The planet's natural carbon cycles are designed to be kept in balance through its ecosystems such as forests, oceans, and soils sequestering carbon. But rising human-induced CO2 emissions has thrown nature significantly out of balance.

As Governments begin to understand and support the vital role of ecosystems in climate mitigation and adaptation strategies, a growing need and opportunity exists for land managers to understand their current

natural capital asset and value in terms of carbon capture (credits) and how this can be enhanced to provide a nature-based solution for reducing carbon emissions.

How are SWEEP Habitat tools being used to address this issue, and what benefits are they providing both now and anticipated over the next few years?

- SWEEP Habitat classification tool data are being used, along with Cranfield soils data, on some of DNPA's large land holdings (e.g. whole Haytor/ Holne Tor) to develop an effective sampling strategy to quantify (and value) the existing and potential for carbon capture in these areas. This is enabling a more accurate, timely and landscape-scale assessment than would otherwise have been possible and will help to inform effective future DNPA carbon sequestration strategies.
- It is anticipated the THaW dataset will also feed into this. For example, to determine tree height and stand density which, used alongside the farm carbon tool kit, can determine volumes and values of standing carbon. Additionally, calculate carbon storage values for woody boundaries (e.g. gorse and scrub) to inform what particular mix of species to plant in a boundary, and over what length, to accrete a quantified amount of carbon.
- Longer-term, it is hoped this ground-breaking work could lead to a publication of methodology and findings to benefit the whole national park (producing a full carbon audit), other areas of work e.g. Environment Net Gain, and wider beneficiaries such as farmers, as they seek to work collaboratively, across landscapes, taking advantage of developing carbon markets.

Impact Case Study 3: Informing Defra policy by strengthening the submission of DNPA's ELMs T&T work

What's the issue?

There are three new schemes that will reward environmental land management. These schemes are intended to support the rural economy while achieving the goals of the 25 Year Environment Plan and a commitment to net zero emissions by 2050.

Between January 2020 and November 2021, DNPA were invited to input to Defra's Environmental Land Management Scheme (ELMs) via a Test and Trial (T&T) by exploring a 'payment by results' approach which could operate on commons as well as home farms.

An advisory team of farmers and landowners guiding the T&T wanted to use a scorecard as a land management plan to deliver the whole of the ELM on a payment by results basis, looking to score based on the costs of delivering public goods and the value of these goods. Two iterations of the score card were developed and trialled on Duchy Dartmoor demonstration farms and sense checked against other farms Dartmoor, Exmoor & Bodmin.

How are SWEEP Habitat tools being used to address this issue, and what benefits are they providing both now and anticipated over the next few years?

- The SWEEP Habitat tool/ map was vital in enabling the proportion of different habitat cover on each land holding to be calculated. This was a key piece of information in determining payment rates per ha. Payment rates were calculated by multiplying the score allocated to each habitat type (in accordance with the estimated cost of delivering public goods on them) by the amount of that particular type of habitat cover on the farm. Calculating this for each of the different habitat types, provides a total payment for the holding. Thus, SWEEP Habitat maps were submitted to Defra along with the second iteration of the scorecard.
- One of the issues identified early in the T&T was the challenge of regularly, affordably and consistently mapping the Dartmoor landscape. SWEEP maps made this possible at a very low cost. This meant habitat

maps could easily be generated for every farm and common involved, as well as using other data sets to show information related to the scorecard, such as heritage assets.

- A clear majority of the farmers/ commoners and landowners involved in the T&T felt that using the SWEEP maps would help them in the future to use the scorecard and identify where to locate different habitats on the farm.
- Furthermore, 16 out of 17 trial home farms felt the maps would help them monitor habitat change over time. Participants were entirely positive about the potential to use the SWEEP maps to pre-populate some of the scorecard answers but 100% of participants felt that they would only want to use that approach if data could be easily corrected where necessary.
- Following this work it was recommended that the SWEEP tool and maps were hosted on a suitable platform so farmers can access easily – not just for monitoring purposes but for reporting and decision making. It was also suggested that farmers could help ground truth the data whilst they self-monitor thier payments.

Impact Case Study 4: Strengthening the delivery of current DNPA projects and new proposals

What's the issue?

DNPA covers an area of 86,186 acres and is currently managed in line with the strategic Dartmoor Partnership plan 2021-26. This has an ambition to manage better for climate change; the next generation; for nature and natural beauty; for cultural heritage; for people; for farming and forestry and for business and communities.

To do things 'better' DNPA is keen to be at the forefront on new technologies and data that can inform more timely, accurate and cost-efficient decisions for land management practices that deliver greater environmental, community and economic benefits.

How are SWEEP Habitat tools being used to address this issue, and what benefits are they providing both now and anticipated over the next few years?

- The innovative and ground-breaking SWEEP tools help to meet this need, and are already being used to enhance the decision making and delivery on the ground. As Richard Knott, DNPA's ecologist attests:

    'SWEEP Habitat classification and ThaW baseline tools are now the primary landscape scale data for the National Park and SWEEP mapping is providing the mainstay of our habitat monitoring from now on. Both the Habitat and THaW datasets are being used on a daily basis – from advising event organisers on where to locate and manage Dartmoor runs to minimizing the impact on fragile habitats to Commons grazing advice'.

- One project already benefitting from SWEEP's Habitat maps is the Defra funded Dartmoor Farming in Protected Landscapes Programme (FiPL) DNPA is delivering. The maps are used on a weekly basis both to help farmers understand their opportunities for nature enhancement and for the project management team to assess the wider landscape habitat context of land holding when enquiries are received from potential applicants.
- The SWEEP tools have already been used to successfully leverage funding in association with DNPA, for example the £X Landscape Recovery Scheme project for East Dartmoor, with the Devon Wildlife Trust and University of Exeter. The results of the Habitat Classification tool were used to quantify a baseline for priority habitat in the landscape project area.
- The SWEEP tools will be the primary source for habitat mapping during the proposed 6 years of delivery for the current (>£5.5m) Heritage Lottery Fund bid. This will work with land managers over three of Dartmoor's river catchments, piloting approaches to nature enhancement that respond to post Brexit agri environment schmes, green finance markets and changing societal views/needs from farming. The mapping tools will initially to support land managers' understanding of what they have and opportunities/planning and then to

monitor and report on progress. The confidence scores in the tool will guide our citizen science work, engagement with volunteers with targeted ground truthing surveys.

What's the issue?

Certain species of birds are used as an indicator of the general quality of the environment because birds sit near the top of the food chain. Monitoring the populations of these species and understanding the types and quality of habitat they need to survive and thrive is key for management and restoration projects. This RSPB study is one such survey.

How are SWEEP Habitat tools being used to address this issue, and what benefits are they providing both now and anticipated over the next few years?

- The SWEEP Habitat tools have provided important additional layers of data to the RSPB study which is examining the factors that are influencing changes in Whinchat, Tree Pipit and Cuckoo distribution between the late 1970's and present, especially in relation to habitat.
- Adding to the already collected 'fine-scale' vegetation information, the SWEEP tools provide 'landscape composition' variables for the final study analysis which help identify key habitats and features preferred by the indicator bird species e.g. bracken. The SWEEP data has provided information that RSPB wasn't able to obtain through fieldwork and at a level of detail that wasn't possible through other existing remotely sensed datasets (e.g. the Land Cover Map, which focuses on coarser land cover categories).
- Thus it will play a key role in increasing the robustness and accuracy of this RSPB's study, and any future conservation work it informs.

are considerably more accurate.

(A) Supporting robust policy implementation and evaluation

THaW provides an accurate and easy method for monitoring the impact of this work in the WEZ overtime. We will use the tool to understand changes in the woodland overtime, in relation to planned interventions, which allows us to know how effective our policy has been to bring woodlands back into management.

Into the future with THaW …

As the THaW tools continue to be refined, we anticipate benefitting from it further in relation to woodlands back into active management. For example, the THaW change detection tool will enable the NDBR to be able to better understand, and monitor over time, the impact of thinning interventions in existing plantations; a key element of successful active woodland management.

The survey work as part of the current CRF project in North Devon, provides an opportunity to provide valuable ground truthing data for the THaW tools, which will help to strengthen their predictive capacity, thus enhancing its application and value.

Impact case study 2: Detecting canopy loss in rapid response catchment areas

Summary

As part of its woodland responsibilities the NDBR, in conjunction with the Environment Agency (EA), monitors areas at risk of large sediment loss due to felling. The THaW tool was used in a recent consultation on a draft woodland management plan in two steep rapid response catchments in North Devon. This enabled NDBR to provide more timely and accurate advice to the land manager, avoiding the need for a site visit. With its 3-month time lag mapping outputs, the THaW mapping tool is also being used to instigate a more pro-active identification of woodland canopy loss in areas where felling activities could result in significant soil erosion.

What's the issue and why does it matter

The NDBR has many areas of steep sided woodland that, if inappropriately felled, would most likely lead to significant and damaging soil loss. There is a need to be able to more quickly identify areas of existing clear fell that could be of concern, and better advise land owners on new management plans, so that remedial action can be taken to reducing soil damage, avoid financial and environmental costs.

How is the THaW tool helping and what impact is it generating

The THaW mapping tool was used in conjunction with a management plan consultation on two steep rapid response catchments in North Devon before it was implemented. Unlike traditional approaches involving site visits (that require time and money) and the assessment of aerial photographs (that often provide coarse and inaccurate data), THaW mapping outputs allow for a quick and accurate desk-based determination of canopy height and, therefore, likely impact of felling.

Impact Case Study 3: Supporting the Forestry Commission across a range of its activities, including the detection of illegal tree felling.

What's the issue?

The Forestry Commission is responsible for protecting, expanding and promoting the sustainable management of woodlands, while increasing their value to society and the environment.

Being able to quickly and accurately assess its forest assets, and monitor changes in these over time, enables the Forestry Commission (FC) to develop robust strategies to deliver on its objectives and take swift and cost-effective action in response to issue that arise.

Traditionally the FC has relied on Google Earth aerial photographs, and undertaken multiple field visits to obtain this data. However, these methods are slow, labour intensive and costly, and often delivering low-quality data.

Why does this matter?

- 13% of the UK is forested land and in 2021 the UK forestry market was estimated to be worth £262.7m.
- To protect and enhance this land, the FC needs to undertake a range of activities effectively and efficiently. Accurate, cost-effective and quickly accessed data is key to this.
- One such activity is monitoring and reducing illegal felling – an issue that is on the increase with significant financial implication e.g. costs the FC money to monitor and respond to this/ loss of timber/ impact of this on natural capital goods and services e.g. carbon, soil etc

What benefits do the THaW tools offer the FC to tackle issues such as illegal felling?

In contrast to the traditional approaches to forest monitoring described above, the THaW mapping tool box brings numerous advantages - it autonomously and rapidly generates high spatial resolution baseline and canopy loss maps, across landscape extents, using 2m^2 LiDAR data and Spaceborne Synthetic Aperture Radar (SAR) data. This produces significantly more detailed, extensive and easy to use maps vs established methods.

As a result, the THaW tools are increasingly being used by FC staff for the following benefits:

- ✓ **Quickly identifying the area of deforestation** - that could be linked to illegal felling activity, enabling swift and accurate deployment of a FC field officer.
- ✓ **Increased confidence in the presence of alleged illegal felling activity** - by providing robust mapping evidence of deforestation over time. This is particularly important where deforestation has occurred little and often, and where evidence (felled timber) has been removed from the site.
- ✓ **A quicker, and more accurate, understanding of the timeline of change** - i.e. by generating a series of canopy loss maps it's possible to determine what felling has occurred, where, and over what period of time.
- ✓ **Increased confidence in taking alleged illegal felling cases to prosecution** - especially where previously a lack of written or photographic evidence would mean a case couldn't proceed.
- ✓ **Delivering cost-savings** - for site visits that require two people (with travel, accommodation and site survey costs) vs one person undertaking a desk study of the THaW images. These savings are realised either by reducing or eliminating the need for initial site visits, or by increasing the efficiency of visits. The increased accuracy and higher spatial resolution of THaW data (vs existing aerial photographs) offers FC staff a more comprehensive site specific picture in advance of any visit. This enables staff to be more prepared, which in turn reduces the time required at the site, increases the efficiency of site visit work, and follow up work.
  - ➢ No. of alleged illegal felling (AIF) cases - between 2019-21, there was an average of c.750 cases of AIFs in the UK; a sharp rise from an average of c.260 AIFs in the 3 years before that. AIFs in the South West are currently between 125-150 pa.
  - ➢ Cost-savings – out of 150 AIFs pa in the South West, it is likely that 30% of these sites would no longer require a visit where THAW was used instead to verify felling. This represents a day's salary cost-saving for two people over 45 sites, allowing focus instead on the creating woodlands effort. These cost-savings are likely to increase going forward.
- ✓ **The potential to be pro-active** – identifying sites of possible illegal felling rather than waiting to be alerted. Although the better approach, this raises concerns about levels of work and a mismatch with current FC resource. However, THaW proves the potential to be able to do this, and as such may help to strengthen cases for further investment in FC resource.
- ✓ **Economic savings** –
  - ➢ Providing a more accurate understanding of biodiversity loss and change arising from unauthorised tree removal. Also enable the tracking of ecosystem services loss, as a result of tree loss – by aggregation and extrapolation of data from more detailed surveys to quantify habitats and ecosystem services.
  - ➢ By being more pro-active, THaW could help secure natural capital goods and ecosystem services savings that would otherwise have been lost due to illegal tree felling e.g. carbon sequestration, soil and water quality.
- ✓ **Supporting wider FC operations** - The THaW tools are also being increasingly being used to support more effective operations across a range of FC's work. Specific examples include detecting indicative change in hedgerows and inspecting and monitoring thinning activities

Examples of where ThaW maps have been used to evidence illegal felling activities:
Illegal feeling alerts are assessed on a case by case basis. The THaW tools and maps are already being used to benefit this work by enabling effective monitoring and assessment of deforestation activities that could constitute illegal felling. Many of these cases can't be mentioned as they are currently undergoing prosecution, but below are two examples of sites on Dartmoor where low levels of illegal felling have been tracked and evidenced using the THaW tools. These cases didn't progress to prosecution, but demonstrate how THaW clearly shows deforestation occurring under the radar that wouldn't otherwise have been detected.

These Images illustrate the automated detection of young woodland cover, lost or deforested, within a single calendar quarter (red areas) for two sites on Dartmoor. These cases provide evidence of non-permissive tree loss. These data are shown alongside the THaW baseline mapping product, and open-source aerial photography.

THAW Legend
- Below 1.3m (Fragmented - Scrub, Bushes or Misc e.g. fence/dry stone wall <10m2)
- Below 1.3m (Scrub, Bushes or Misc)
- Below 3m (Managed Hedgerow, Large Bushes)
- Below 15m (Trees)
- Above 15m (Large Trees)
- change in last 3 months
- change for selected period

THAW Legend
- Below 1.3m (Fragmented - Scrub, Bushes or Misc e.g. fence/dry stone wall <10m2)
- Below 1.3m (Scrub, Bushes or Misc)
- Below 3m (Managed Hedgerow, Large Bushes)
- 3m to 15m (Tree Canopy, Mature Hedgerow)
- Above 15m (Contiguous Tree Canopy)
- Above 15m (Individual Trees)
- Change in last 3 months
- Change for selected period

sweep

North Devon Biosphere Reserve and Forestry Commission Impact Case Studies

The following case studies illustrate how and in what areas of NDBR and FC activity, the SWEEP THaW Toolbox is being used to provide a more precise, cost-effective and timely understanding of the extent, state and change over time of tree, hedgerow and woodland natural capital assets, thereby informing more robust and sustainable decision making.

Impact Case Study 1: North Devon woodlands back into management

Summary

As part of the £1.47m of Community Renewal Funding (CRF) awarded to North Devon in November 2021, the THaW mapping tool is being used to support surveys on current woodland condition in order to identify neglected and undermanaged woodlands. This is helping to prioritise areas of woodland that can be brought back into active management or where new woodland can be created.

What's the issue and why does it matter

Running up to July 2022, £185k of the £1.47m CRF award will be spent on the North Devon Biosphere Reserve's (NDBR) woodlands. Accounting for 11.4% (26,400 Ha) of the terrestrial part of the Biosphere Reserve, these are a vitally important asset and as such, are a designated Woodland Enterprise Zone (WEZ). Regional strategy aims to deliver WEZ interventions that help to create a stronger woodland economy.

North Devon covers an area of 2500km2 which includes the whole of the Biosphere Reserve area. Within this, currently only around 40% of woodlands are in management. The aim is to bring back at least 20% of this into management by 2030; representing a 50% increase in active woodland management. Based on current figures from the forest policy framework 2017:2027, it is anticipated that this will result in a significant positive impact for the local economy, for example by –

- increasing timber production from approximately £16m to £24m
- safeguarding the existing 460 jobs in this sector and adding to this with an further estimated 230 jobs
- boosting ecosystem services from approximately £58.5m to £87.75m

How is the THaW tool helping and what impact is it generating?

(A) THaW creates a more robust woodland baseline that enables effective project delivery and boosts the local economy. In this way, the THaW mapping tool is being used to -

- <u>Identify and quantify woodlands not currently in management</u> - in conjunction with Forestry Commission data on licenses, felling, and management plans.

  The THaW tool offers various advantages. The National Forest Inventory only delivers maps at a scale of 0.5 ha, whereas THaW produces mapping outputs that can show individual trees. By offering improved granularity and an easy to read, clear, visual mapping output, THaW has the benefit of providing an enhanced picture of total tree cover, and therefore, the whole woodland opportunity. It also saves the user time, and therefore money, by replacing previous methods for undertaking this work that are less accurate and slower to use e.g. digitisation analysis of aerial photographs.

- <u>Identify failed plantations from the past 20 years</u> – the THaW mapping outputs are beginning to be cross-referenced against historic data to identify failed areas of planting. This is one of the specific aims of CRF WEZ funded projects and which aims to bring these areas back into productivity in the broader sense - both for timber production, as well as for enhancing biodiversity and delivering ecosystem services.

This work would previously have been undertaken using normal classification methods on optical imagery; analysis that often results in significant errors. In contrast, because THaW combines remote sensing SAR and LiDAR data to look at the physical structure of woodlands, it provides data outputs that are considerably more accurate.

(B) Supporting robust policy implementation and evaluation

THaW provides an accurate and easy method for monitoring the impact of this work in the WEZ overtime. We will use the tool to understand changes in the woodland overtime, in relation to planned interventions, which allows us to know how effective our policy has been to bring woodlands back into management.

Into the future with THaW …

As the THaW tools continue to be refined, we anticipate benefitting from it further in relation to woodlands back into active management. For example, the THaW change detection tool will enable the NDBR to be able to better understand, and monitor over time, the impact of thinning interventions in existing plantations; a key element of successful active woodland management.

The survey work as part of the current CRF project in North Devon, provides an opportunity to provide valuable ground truthing data for the THaW tools, which will help to strengthen their predictive capacity, thus enhancing its application and value.

Impact case study 2: Detecting canopy loss in rapid response catchment areas

Summary

As part of its woodland responsibilities the NDBR, in conjunction with the Environment Agency (EA), monitors areas at risk of large sediment loss due to felling. The THaW tool was used in a recent consultation on a draft woodland management plan in two steep rapid response catchments in North Devon. This enabled NDBR to provide more timely and accurate advice to the land manager, avoiding the need for a site visit. With its 3-month time lag mapping outputs, the THaW mapping tool is also being used to instigate a more pro-active identification of woodland canopy loss in areas where felling activities could result in significant soil erosion.

What's the issue and why does it matter

The NDBR has many areas of steep sided woodland that, if inappropriately felled, would most likely lead to significant and damaging soil loss. There is a need to be able to more quickly identify areas of existing clear fell that could be of concern, and better advise land owners on new management plans, so that remedial action can be taken to reducing soil damage, avoid financial and environmental costs.

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Impact Case Study 3: Supporting the Forestry Commission across a range of its activities, including the detection of illegal tree felling.

What's the issue?

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Traditionally the FC has relied on Google Earth aerial photographs, and undertaken multiple field visits to obtain this data. However, these methods are slow, labour intensive and costly, and often delivering low-quality data.

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- To protect and enhance this land, the FC needs to undertake a range of activities effectively and efficiently. Accurate, cost-effective and quickly accessed data is key to this.
- One such activity is monitoring and reducing illegal felling – an issue that is on the increase with significant financial implication e.g. costs the FC money to monitor and respond to this/ loss of timber/ impact of this on natural capital goods and services e.g. carbon, soil etc

What benefits do the THaW tools offer the FC to tackle issues such as illegal felling?

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As a result, the THaW tools are increasingly being used by FC staff for the following benefits:

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- ✓ **Increased confidence in the presence of alleged illegal felling activity** - by providing robust mapping evidence of deforestation over time. This is particularly important where deforestation has occurred little and often, and where evidence (felled timber) has been removed from the site.
- ✓ **A quicker, and more accurate, understanding of the timeline of change** - i.e. by generating a series of canopy loss maps it's possible to determine what felling has occurred, where, and over what period of time.
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- ✓ **The potential to be pro-active** – identifying sites of possible illegal felling rather than waiting to be alerted. Although the better approach, this raises concerns about levels of work and a mismatch with current FC resource. However, THaW proves the potential to be able to do this, and as such may help to strengthen cases for further investment in FC resource.
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  - ➢ Providing a more accurate understanding of biodiversity loss and change arising from unauthorised tree removal. Also enable the tracking of ecosystem services loss, as a result of tree loss – by aggregation and extrapolation of data from more detailed surveys to quantify habitats and ecosystem services.
  - ➢ By being more pro-active, THaW could help secure natural capital goods and ecosystem services savings that would otherwise have been lost due to illegal tree felling e.g. carbon sequestration, soil and water quality.
- ✓ **Supporting wider FC operations** - The THaW tools are also being increasingly being used to support more effective operations across a range of FC's work. Specific examples include detecting indicative change in hedgerows and inspecting and monitoring thinning activities

Examples of where ThaW maps have been used to evidence illegal felling activities:
Illegal feeling alerts are assessed on a case by case basis. The THaW tools and maps are already being used to benefit this work by enabling effective monitoring and assessment of deforestation activities that could constitute illegal felling. Many of these cases can't be mentioned as they are currently undergoing prosecution, but below are two examples of sites on Dartmoor where low levels of illegal felling have been tracked and evidenced using the THaW tools. These cases didn't progress to prosecution, but demonstrate how THaW clearly shows deforestation occurring under the radar that wouldn't otherwise have been detected.

These Images illustrate the automated detection of young woodland cover, lost or deforested, within a single calendar quarter (red areas) for two sites on Dartmoor. These cases provide evidence of non-permissive tree loss. These data are shown alongside the THaW baseline mapping product, and open-source aerial photography.

THAW Legend
- Below 1.3m (Fragmented - Scrub, Bushes or Misc e.g. fence/dry stone wall <10m2)
- Below 1.3m (Scrub, Bushes or Misc)
- Below 3m (Managed Hedgerow, Large Bushes)
- Below 15m (Trees)
- Above 15m (Large Trees)
- change in last 3 months
- change for selected period

THAW Legend
- Below 1.3m (Fragmented - Scrub, Bushes or Misc e.g. fence/dry stone wall <10m2)
- Below 1.3m (Scrub, Bushes or Misc)
- Below 3m (Managed Hedgerow, Large Bushes)
- 3m to 15m (Tree Canopy, Mature Hedgerow)
- Above 15m (Contiguous Tree Canopy)
- Above 15m (Individual Trees)
- Change in last 3 months
- Change for selected period