Advances in Archaeological Practice (2024), **12**, 233–244
doi:10.1017/aap.2024.21

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HOW-TO SERIES

Community Coastal Zone Assessment Surveys: Methods and Experiences from Scotland

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Abstract

Community Coastal Zone Assessment Surveys (CCZASs) conducted on the Scottish coast aim to characterize and assess the significance, condition, and vulnerability of coastal archaeology and to prioritize assets most at risk. Two key differences from earlier coastal zone assessment survey methods are the use of coastline vulnerability models to target fieldwork and the involvement of the public in the surveys. This article details the methodology used to plan for, carry out, and disseminate results of the surveys, including the following: evaluating and targeting coastlines in a GIS framework to focus new coastal surveys in areas most susceptible to erosion, using SCAPE's coastal archaeology recording mobile application as our survey tool, managing data through SCAPE's Sites at Risk portal, involving local volunteers, and disseminating findings and data flow into regional and national historic environment databases. We discuss results and reflections from surveys of the Highland, Moray, and Aberdeenshire coastlines conducted in 2022 and conclude with general principles applicable beyond Scotland.

Resumen

Community Coastal Zone Assessment Surveys (CCZASs; Estudios de evaluación de las Zonas Costera Comunitarias), realizados en la costa escocesa tienen como objetivo caracterizar y evaluar la importancia, la condición, y la vulnerabilidad de la arqueología costera y priorizar los activos en mayor riesgo. Una diferencia clave con respecto a los métodos anteriores de evaluación de zonas costeras es el uso de modelos de vulnerabilidad costera para orientar el trabajo del campo y la participación del público en las encuestas. Este documento detalla la metodología utilizada para planificar, implementar, and difundir los resultados de los estudios, incluyendo: evaluación y orientación de las costas en un marco SIG para centrar nuevos estudios costera en áreas más susceptibles a la erosión, usando la aplicación móvil de registro de arqueología costera de SCAPE como nuestra herramienta del estudio; gestionando datos a través del portal Sitios en Riesgo de SCAPE; involucrando a voluntarios locales; y difusión de hallazgos y flujo de datos a bases de datos ambientales históricos regionales y nacionales. Nosotros discutimos los resultados y las reflexiones de los estudios de las costas de Highland, Moray, y Aberdeenshire, realizados en 2022 y concluimos con principios generales aplicables más allá de Escocia.

Keywords: Scotland's coastal heritage; coastal erosion; coastal heritage survey; community involvement; coastline susceptibility model; coastline change model; climate change

Palabras clave: Patrimonio costero de Escocia; la erosión costera; estudio del patrimonio costero; participación de la comunidad; modelo de susceptibilidad costera; modelo de cambio de costa; cambio climático

Scotland's resource-rich and accessible coasts have been the favored place for settlement throughout the human history of the region and are home to tens of thousands of tangible cultural heritage sites. Located in the dynamic coastal and intertidal zone, many of these are eroding (Figure 1; Hambly 2017a). This is nothing new, but climate change and relative sea-level rise are accelerating rates of erosion (Hansom et al. 2017), which will inevitably lead to an increased loss of valuable

Figure 1. Examples of the range of heritage at risk on the Scottish coast investigated in community projects by SCAPE: (a) Iron Age broch in Shetland; (b) nineteenth-century fishing boat graveyard near Inverness; (c) eighteenth-century lime kiln in Angus; (d) World War 2 pillbox in Aberdeenshire.

archaeological and heritage sites (Johnson et al. 2015; Murphy et al. 2009; Rick and Fitzpatrick 2012) and provides an imperative for action by all nations with a coastline.

Cultural heritage resource managers have always dealt with the natural decay and attrition of sites and monuments and have long recognized that coastal processes are the most severe natural agent of change to the historic environment (Cassar 2005). In 1996, Scotland's national cultural heritage management agency, Historic Scotland (now Historic Environment Scotland), took the strategic lead to build a baseline understanding of the significance, condition, and vulnerability of the vast range of heritage sites in the coastal zone by commissioning a series of Coastal Zone Assessment Surveys (CZASs). Between 1996 and 2010 professional archaeologists supported by coastal geomorphologists conducted 28 CZASs that covered approximately 35% of Scotland's coast and recorded 11,500 individual heritage sites. In the early 2000s, SCAPE, a research team based at the University of St. Andrews, developed approaches to prioritizing coastal heritage assets recorded in the Historic Scotland–sponsored surveys and involving communities in rescue action (Dawson 2010, 2013, 2015; Dawson et al. 2020). These efforts are widely cited as an example of a citizen science approach in the growing body of literature on responses to climate change impacts on cultural heritage (e.g., Fatorić and Seekamp 2017; Heilen et al. 2018; Hollesen 2022; Rockman et al. 2016). This approach evolved with the growing awareness of the amplification effects of climate change on the large number of heritage sites in Scotland threatened by natural coastal processes and the realization that it was impossible to save all these sites; therefore, it was necessary to prioritize conservation actions to address the most archaeologically significant sites most at risk and most valued by communities (Dawson 2010, 2013; Fatorić and Seekamp 2019).

Briefly, Dawson's method involved digitizing and standardizing field survey records from the CZASs, assigning a heritage value and a vulnerability class to each record, and combining the two to identify those sites with the highest archaeological value at the highest risk of erosion.[1] The output

https://doi.org/10.1017/aap.2024.21 Published online by Cambridge University Press

of this exercise—a prioritized list of coastal archaeological sites at the greatest risk of erosion—was an important step that enabled heritage managers to focus efforts on the most vulnerable sites within the areas surveyed and provided the impetus for Scotland's Coastal Heritage at Risk Project. This project recruited volunteers in local communities in a national program of field surveys to update and assess information about sites identified as priorities in Dawson's desk-based analysis (Hambly 2017b).

This article details the workflow in SCAPE's current program of community surveys that extend systematic tangible heritage surveys to the 65% of coastline that has not previously been investigated. Because the approach and methods are a culmination of 25 years of coastal heritage research and community-based practice, what follows will be of use more generally as a model than as a recipe. There are also legal, practical, and cultural factors in Scotland that make our approach possible. National and regional historic environment records are publicly accessible, and the data are freely available. Since 2003 there has been a "right to roam," meaning that anyone is free to explore all Scottish land, if done so in a responsible manner. There is an existing culture of volunteering and interest in natural and cultural heritage. In 2015, more than 17,000 members of the public volunteered their time in Scotland's historic environment sector (Volunteer Scotland 2016). Therefore, the conditions in Scotland are favorable for active public participation in walkover coastal heritage surveys. These conditions may not be present in other countries. Nevertheless, our approach has inspired others and been adapted to different situations, notably in the United States by the Florida Public Archaeology Network in their Heritage Monitoring Scouts Florida program and the Maine Midden Minders program (Dawson et al. 2020).

Community Coastal Zone Assessment Surveys

Community Coastal Zone Assessment Surveys (CCZAS) depart from Historic Scotland's original coastal heritage survey methodology in three key respects: (1) the use of coastline susceptibility and future change models to target fieldwork; (2) the involvement of local communities in the surveys; and (3) the dissemination of results, previously achieved through printed reports including maps linked to gazetteers and now done by publishing and sharing the data immediately, supported by a summary report that includes an assessment of site priority. The first difference reflects computing advances in modeling coastal vulnerability and change. It is no longer necessary to walk the entire coast, and efforts can be focused on areas where heritage is most likely to be at risk from erosion. The third change is due to technical improvements in data flow between researchers and data repositories and the ability to make data easily available. The second change—public involvement in the surveys—perhaps represents the biggest paradigm shift in the systematic collection of new coastal heritage data. SCAPE has always involved local communities in rescue and conservation action at eroding sites, but Scotland's Coastal Heritage at Risk Project clearly demonstrated the added value of the local knowledge that volunteers bring to the quality of survey records (Hambly 2017a). When captured in the heritage record, this knowledge also informs how we perceive site value, which is a factor in site prioritization.

The stages of CCZASs are summarized in Figure 2. In what follows, we outline the methods used to plan and undertake these surveys and illustrate how they enhance the success of our research, the experiences of volunteers, and the work of our societal partners in Local Authority Heritage Services and Historic Environment Scotland. We conclude with general principles that will be of relevance beyond Scotland.

How We Use of Models of Coastline Change and Susceptibility to Erosion to Target Fieldwork

We combined outputs from two national models—a coastal erosion susceptibility model (Fitton et al. 2016) and projections of future rates of change and landward coastal retreat (Dynamic Coast Phase 2; Hurst et al. 2021)—to target surveys to the most vulnerable coasts.

The coastal erosion susceptibility model (CESM) divides the whole coast into 50 m resolution grid cells. It combines physical characteristics of the coastline, including ground and rock head elevation, wave exposure, and proximity to the open coast, to create an underlying physical susceptibility model.

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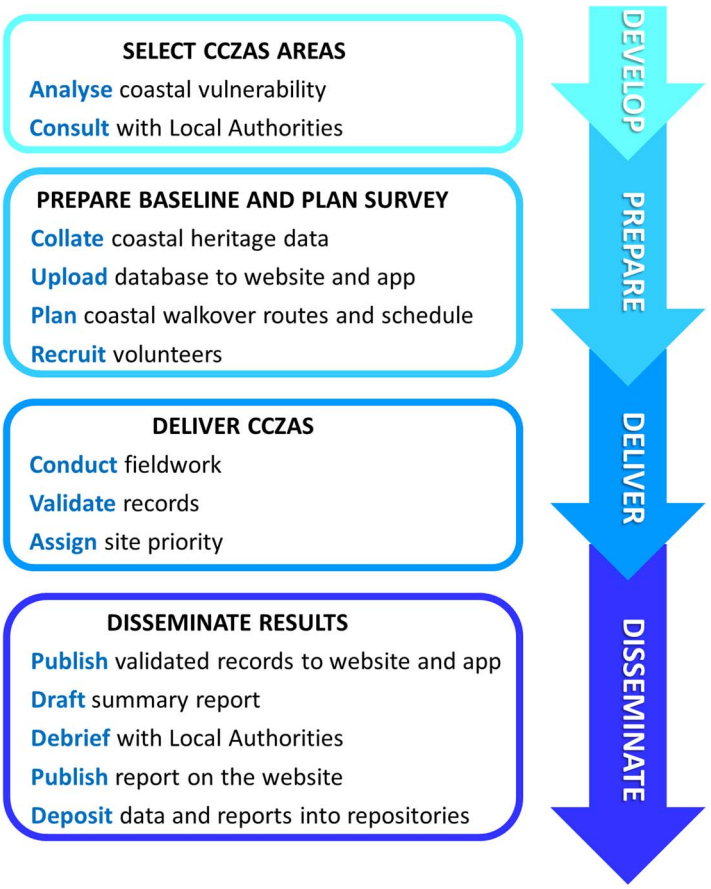

Figure 2. Flow of CCZASs.

The addition of coastline defense and accretion information creates the final CESM model. Each grid cell is given a value of susceptibility from 0 (very low) to 100 (very high).

The Dynamic Coast Phase 2 (DC2) model focuses only on soft low-lying coasts, which account for around 20% of Scotland's coastline. At 10 m intervals, DC2 uses historic rates of change and applies a modified Bruun rule—an equation that predicts the response of sandy shorelines to relative sea-level rise—to calculate future rates of change and total projected erosion distance for each decade up to 2100 (Hurst et al. 2021). For our purposes we used the 2030 Rate of Change (RATE_2030) data as most closely representing the rate of change now and in the near future and so of most use to our partner cultural heritage resource managers.

The following steps set out the method we used to integrate the models in Esri ArcMap Desktop version 10.6. Adapting the method to other geographic information system (GIS) programs is straightforward.

First, we created a grid of cell size 0.5 km × 0.5 km (0.25 km^2) to cover the entirety of Scotland's coastline. Then we ranked the CESM and DC2 model outputs into groups based on the level of coastal susceptibility or the severity of erosion rates, respectively (Table 1).[2] Separate layers for each group were created, using the Select by Attributes tool and displayed within the GIS.

New fields—CESM_Rank, DC2_Rank, and Ranking—were added to the attribute table of the 0.5 km coastal grid cells. We then used the Select by Location tool to select cells that spatially intersected with each CESM or DC2 ranked layer and the Field Calculator tool to assign the relevant rank value to the selected records within the coastal grid attribute table. This step was conducted sequentially from the lowest to the highest rank for each model to ensure that the highest-ranked layer that intersected with any given grid cell was the final rank assigned to each grid cell. For example,

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Table 1. CESM and DC2 Modeling Results Assigned to Ranking Groups.

CESM	Ranking	DC2 Rate 2030 (m/yr)	Ranking
No data	1	No data	5
0–40 (very low to low susceptibility)	2	No change/accretion (≥0)	10
40–60 (moderate susceptibility)	3	Low to moderate rate of erosion (0 to −1.09)	15
60–80 (high susceptibility)	4	High rate of erosion (−1.09 to −2.06)	20
80–100 (very high susceptibility)	5	Very high rate of erosion (< −2.06)	25

a grid cell that intersects with a CESM rank of low to very low susceptibility and a DC2 rank of a low to moderate rate of erosion will have an overall rank as moderate. We then calculated the overall Ranking field using the Field Calculator to sum the CESM_rank and the DC2_Rank values and visualized the results according to a color gradient from dark red for coastal grid cells at very high susceptibility to/ rate of erosion to dark green for cells with low susceptibility to/ rate of erosion. Figure 3 shows the ranking matrix; a detailed flow chart outlining the GIS workflow is provided in Supplemental Figure 1.

We deliberately chose a low-resolution grid size of 0.5 km × 0.5 km to plan walkover surveys because this broadly identifies stretches of coastline that are, in part, modeled to be susceptible to erosion or eroding by 2030. Within any given grid square, there may be a more complex story of accretion and erosion. For example, a red grid cell should not be interpreted as suggesting that the entire 0.25 km^2 area is equally susceptible to coastal erosion. Instead, the red color indicates that the grid cell contains at least one transect modeled to be highly susceptible to coastal erosion. For more detailed resolution of the coastal susceptibility of erosion (50 m) or to view individual modeled transects of erosion rates (every 10 m), we refer users to the underlying models. An example of the combined ranking outcome for our 2022 survey area in Highland is shown in Figure 4.

Once we prepared the coastline vulnerability maps, we shared them with our regional cultural heritage resource agency partners as the basis of discussion to target walkover surveys.

How We Prepare the Heritage Baseline

In a GIS framework, we created a coastal buffer 500 m either side of mean high water and sent it to our national and relevant regional cultural heritage resource management organizations to extract all heritage records within their respective Historic Environment Records (HERs) that intersect the area. We requested heritage data from both national and regional sources to capture a complete picture of existing information to populate our baseline. We applied a buffer of 25 m to all point data to give each site a realistic footprint. We then selected all sites that intersected a refined coastal zone, 500 m seaward and 100 m landward of mean high-water springs. This zone was extended landward in areas where Dynamic Coast predicted erosion to be greater than 100 m by 2100.

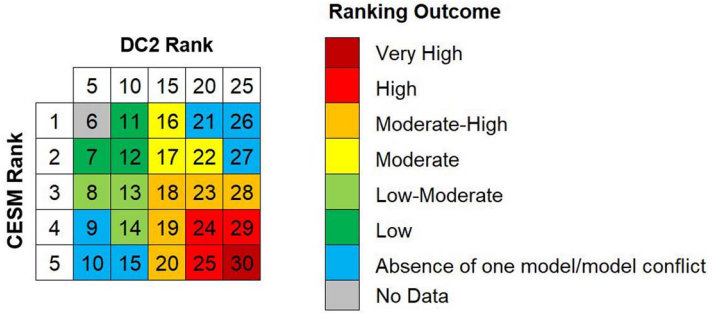

Figure 3. Matrix for combining the CESM and DC2 rank for each grid cell within the coastal survey area, with color coding.

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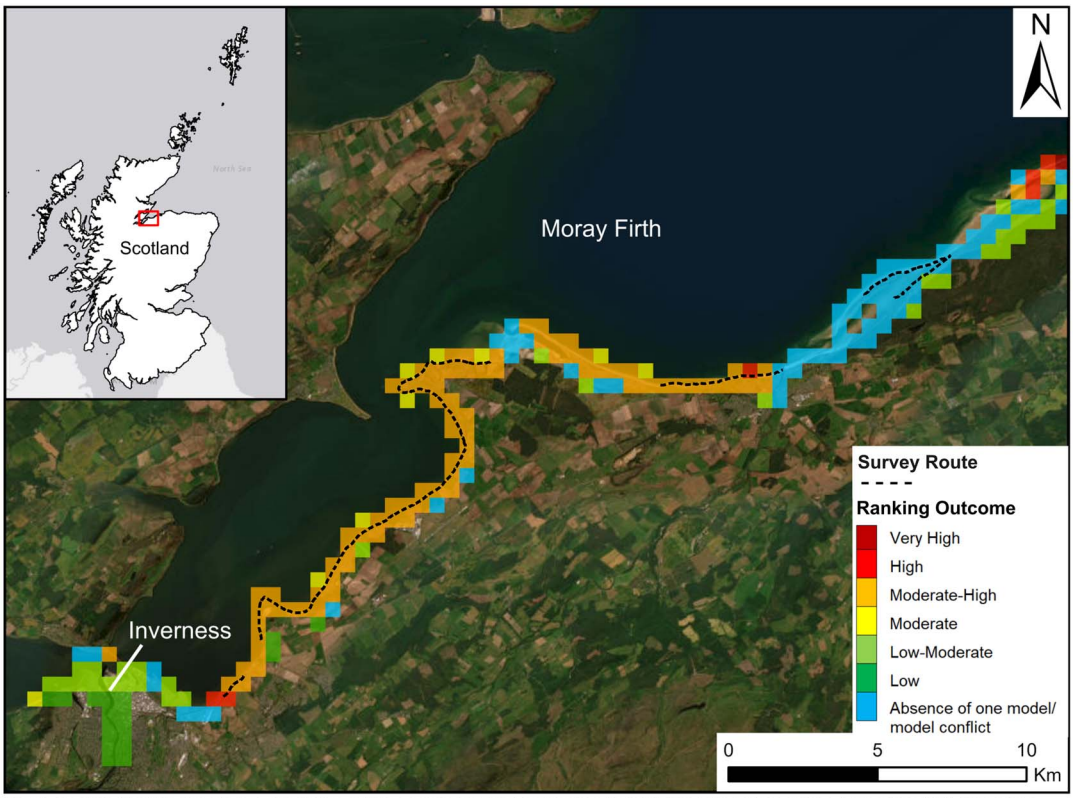

Figure 4. Combined ranking outcome for Highland coastline, east of Inverness.[3]

We then screened out sites not relevant to the walkover surveys; for example, sites in urban areas such as listed buildings and memorials, findspots, relocated sites that record the original location of an object no longer there, and other poorly located sites such as shipwrecks. Sites and artifact scatters encountered during the surveys that may link to a screened-out record, such as intertidal wrecks, can be checked against the relevant database and relinked after the survey. We summarized and edited the remaining site descriptions to make them as user friendly as possible when in the field. Our database structure keeps a close match to that of the source HERs to facilitate integration of our records into the national and regional databases and has hyperlinks to the source data. Finally, we uploaded the cleaned database to the interactive map portal on the SCAPE website and SCAPE's Coastal Archaeology Recording app. These baseline heritage records are initially colored green to show they have not yet been visited and verified in the field.

Involving Volunteers

The objectives of the walkover survey are to visit and verify known heritage sites collated in the baseline, identify and record new sites located on vulnerable coasts, and assess the condition and vulnerability of all the sites.

A mixed team of professionals and locally recruited volunteers conduct the surveys to achieve consistent data that will be informed by local knowledge. We aim to attract volunteers who are representative of the communities in which they live and always contact heritage and history groups because they often hold valuable local archives. We publicize the surveys by giving in-person or online talks using press releases and social media. Wherever possible, we try and meet and interview those who are interested in contributing but are unable to take part in fieldwork. We plan surveys to be as

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accessible and manageable as possible, covering 4–8 km per walk, with clearly communicated information about parking, expected terrain, and facilities. Surveys are conducted two to three hours either side of low tide to maximize intertidal site visibility and to make the walks easier and safer.

We use SCAPE's Coastal Archaeology Recording app as our primary recording tool in the field (Figure 5). This is the third iteration of SCAPE's Coastal Archaeology Recording app, which was created in 2012. Mobile phones are ideally suited to collecting the spatial data, photographic record, and descriptive text needed for rapid archaeological surveys, and this app has proved to be a relatively straightforward and cost-effective recording tool that reduces barriers to involvement. We manage access to the app through registration, which enables us to (1) keep a record of users, (2) communicate important health and safety information and set out rights and responsibilities, and (3) explain how we use the data submitted.

We aim for the surveys to be enjoyable, social, and learning experiences for everyone. Volunteers gain both practice in using the app and confidence in recognizing heritage features while creating survey records based on their observations. We keep them informed about results and additional surveys and fieldwork opportunities. In this way involvement extends beyond the first survey, and we retain and build our network of experienced volunteers.

Managing the Data and Disseminating the Results

We check and validate every record submitted to ensure they meet the standard to be accepted by HERs; that is, they need to be consistent with national heritage thesauri and period definitions. We verify and add additional information to records where necessary. As part of the validation process, we assign a priority following Dawson's approach and based on our assessment and discussions in the field.

We validate and manage heritage data through a bespoke Sites at Risk plug-in, consisting of a series of linked databases, embedded in our WordPress website (Figure 6). The validated record updates the

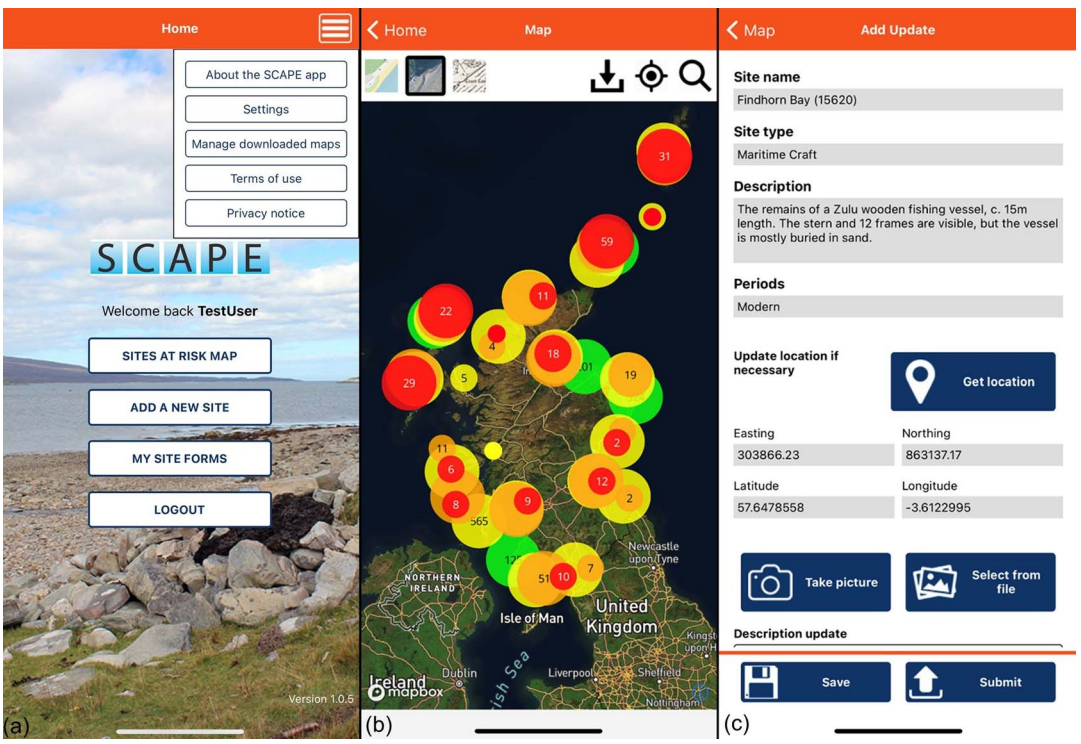

Figure 5. SCAPE Coastal Archaeology Recording application, Version 1.0.5.[4]

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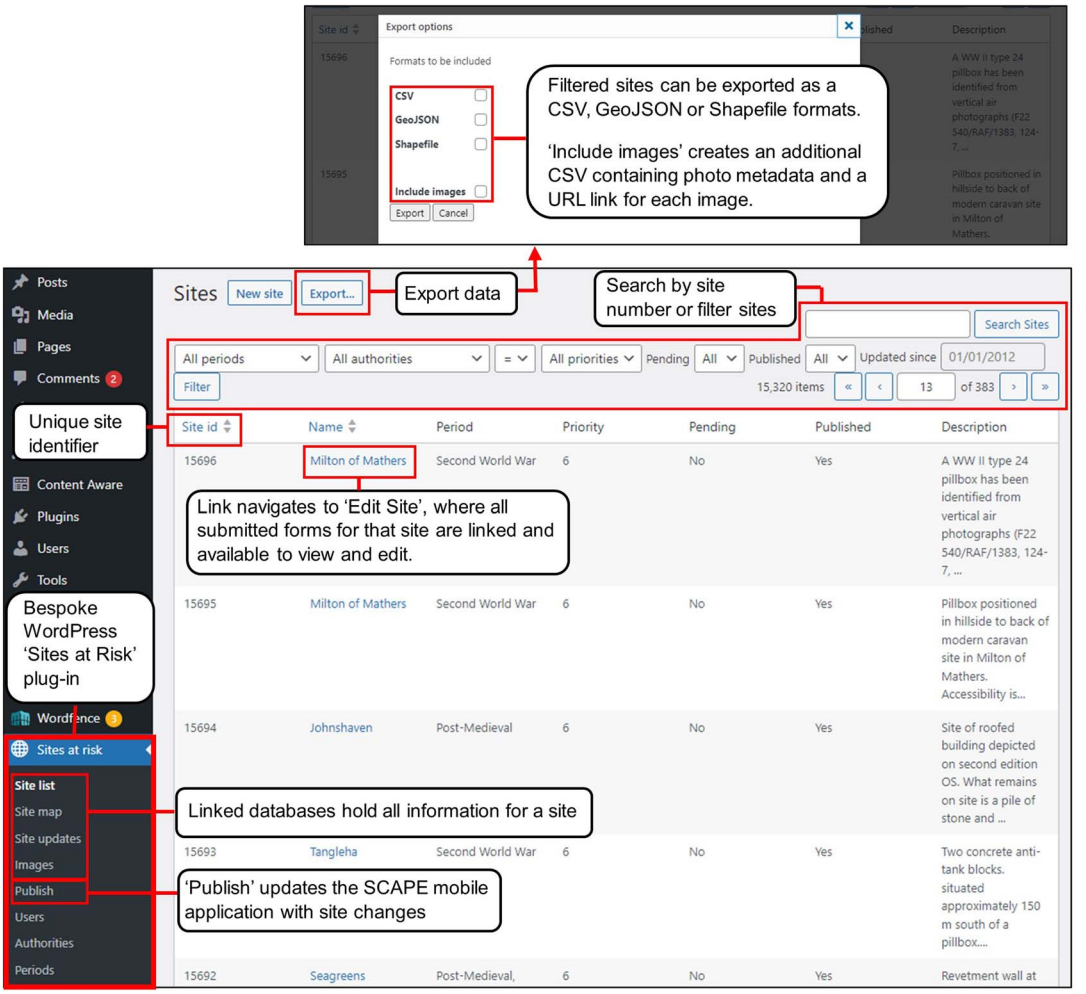

Figure 6. Administrator view of SCAPE website with Sites at Risk plug-in.[5]

Sites at Risk map on our website, and a summarized version, without images, is published to the mobile app.

Following validation, we export records in the CSV format and import them into Excel templates that mirror the fields used by our partner HERs. We share images via an Excel spreadsheet that contains image metadata, a URL link to each image, and an in-built VBA macro to allow our partners to bulk download and archive images. Each image filename includes the unique site ID and date of update. We send the data to our partners, accompanied by a concise report that highlights significant heritage sites, draws attention to areas experiencing notable or nuisance erosion, and includes recommendations for further investigation or management action. Recent reports for Highland, Moray, Aberdeenshire, South Ayrshire and Stronsay, Orkney, which use the new methodology, are available on the SCAPE website. We then schedule a debrief with our partners to discuss findings and any future action.

Outcomes of Recent Surveys

In 2022 we conducted 23 days of CCZASs in northeast Scotland covering approximately 140 km of coastline modeled to be at high or moderate risk of erosion by 2030 in the Highland, Moray, and Aberdeenshire council areas. Two SCAPE officers led the surveys, which involved more than

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Figure 7. (a) Volunteers taking part in CCZAS, Forvie National Nature Reserve, Aberdeenshire; (b) a volunteer using the recording app, Whinnyfold, Aberdeenshire.

50 local volunteers (Figure 7). We visited and updated records for 619 heritage sites, including 195 not previously documented.

Overall, the CCZASs have been successful in creating a comprehensive coastal heritage baseline in the areas surveyed while identifying the most archaeologically significant and vulnerable sites. The use of existing coastal susceptibility and erosion models has been effective in focusing surveys on heritage assets located on vulnerable coasts most urgently in need of assessment. Our observations in the field not only largely concur with modeled erosion trends but also provide empirical information about what is happening at a local level. The surveys identified localized areas of greater than expected erosion, as well as stretches of coastline that appear to be more resilient than models suggest. This on-the-ground information is very useful for local managers.

https://doi.org/10.1017/aap.2024.21 Published online by Cambridge University Press

Close cooperation with societal partners in the design and structure of data outputs means that heritage data produced by the surveys flow efficiently into national and regional HERs. In a departure from the original Historic Scotland surveys in which the report was the primary means of disseminating survey data through maps and directories, the role of the CCZAS report is to accompany the data by summarizing results, highlighting the heritage that is significant to a region, and proposing clear recommendations for further research and management actions. Our Local Authority partners have welcomed this format and are collaborating with us to implement some recommendations through community projects. The new approach has enabled a clear and timely pathway from field survey to management action.

Conclusion

In this article, we detailed the steps taken in a community-centered approach to new rapid coastal heritage surveys in Scotland. It is not prescriptive because the legal conditions of access to sites and heritage data, as well as societal attitudes and practical constraints to public involvement in archaeological fieldwork, differ across countries. However, it does provide the following general set of principles based on a great deal of experience that should be of value to researchers, managers, and community members anywhere with an interest in coastal heritage:

(1) Use existing information about coastline change and susceptibility to target field surveys.
(2) Work closely with national and regional cultural resource agencies.
(3) Involve volunteers from local communities in survey areas.
(4) Apply accessible technology, such as mobile phone apps, for data collection.
(5) Validate records so that they are ready (and more likely) to be accepted into national or regional historic environment records.
(6) Prioritize sites for research and monitoring and conservation action, thus creating a management resource rather than just a database.
(7) Disseminate results as widely as possible according to laws and regulations.

It is well worth the effort because Community Coastal Zone Assessment Surveys provide an opportunity for members of the public with an interest in archaeology and local heritage to share their knowledge and enrich heritage records with local information. Participants enjoy and value learning about the history of their coasts, discovering new sites, and gaining skills in conducting archaeological surveys. The surveys have a lasting impact in encouraging community involvement in site monitoring and in projects that address management and research needs for priority sites. They present an example of how challenges posed by the accelerated loss of coastal heritage can be channeled into activities that offer solutions and benefit the public.

Acknowledgments. The SCAPE Trust is supported by Historic Environment Scotland (HES) and the University of St Andrews. We thank HES and our Local Authority partners for making heritage records freely available to us and for their valuable input in planning the surveys and assessing the results. Thank you to Alistair Rennie and James Fitton who generously shared Dynamic Coast data and CESM data with us and have encouraged and supported us for many years. Mike Arrowsmith wrote the SCAPE Sites at Risk plug-in and mobile app, and we are immensely grateful for his expertise and dedication in making continuous improvements and maintenance. Special thanks to our many volunteers and supporters who contributed their knowledge, time, and effort to this research. No permits were required for this research. All photographs are courtesy of SCAPE and used with permission.

Funding Statement. Historic Environment Scotland funds the current program of Community Coastal Zone Assessment Surveys through their Partnership Fund, grant number PF2022-1136.

Data Availability Statement. Sites at Risk data and summary reports for each CCZAS are available for download from the SCAPE website, https://scapetrust.org/sites-at-risk/.

Competing Interests. The authors declare none.

Supplemental Material. For supplemental material accompanying this article, visit https://doi.org/10.1017/aap.2024.21.
Supplemental Figure 1. GIS workflow to create a combined ranking for the Scottish coastline.

Notes

1. For consistency with the then-national framework of archaeological significance, heritage value was based on the following criteria applied when considering legal protection for archaeological sites in the United Kingdom: period, rarity, condition, group value, potential, fragility, and vulnerability. Heritage value was scored A to E, with A being most significant. The vulnerability class was arrived at by assessing the written description within the site record, with additional information calculated in a GIS environment including the sites' proximity to the coast edge, altitude, and correlation with eroding stretches of coast. Vulnerability was scored 1 to 5, with 1 being most vulnerable. The detailed methodology is set out in Dawson (2010), and a summary can be found in Dawson (2013).
2. Statistics were run on all DC2 RATE 2030 transect data. Positive values of change indicate accretion; negative values of change indicate erosion. The mean change is −0.12 m/yr with a standard deviation (SD) of 0.97. These values were used to rank the rates of erosion by severity. A low to moderate rate of erosion includes any erosion value within 1 SD of the mean. A high rate of erosion is any erosion value between 1 and 2 SD of the mean. A very high rate of erosion was calculated as any erosion value greater than 2 SD away from the mean.
3. The analysis identified almost all coastline between Inverness and Culbin as being at least of moderate priority for survey. The main exception is Culbin Sands, an area that is so dynamic that it was not possible to calculate reliable models of coastal change and so was excluded from the underlying DC2 projections. Areas showing model conflicts or missing data are always considered in the planning process for survey; in this instance, the Culbin coastline was included in the Highland survey.
4. (a) **Home**: Navigation to Sites at Risk map, adding a new site and viewing saved site forms. Options to view settings, terms of use, privacy information, and manage downloaded map tiles; (b) **Map**: The user can toggle satellite imagery, modern, or historic mapping for additional geographical or historical context. Option to download satellite image tiles, display GPS location, and search on Site Name or Site ID. Clicking a site navigates to the site record that displays site name, site type, period, and a short description. From this screen, the user can choose to add an update; (c) **Add Update**: The user can update location, add photographs, and input an updated description of site. Optional tick-box questions prompt additional information, such as the state of the tide at time of survey, the proximity of the site to the shore, and the type of erosion (if any) the site is experiencing.
5. The "Site list database includes all fields used to create the basic site record. The "Site updates" database contains additional information relating to the condition and management of the site. The "Images" and "Site updates" databases are linked to the primary site record though the unique site ID assigned to every record. Clicking a site name opens the submitted form where every linked database is available and every field is editable by moderators. Filtering functions allow the selection of data according to period, authority, assigned priority, date of site update, and whether the site is published or pending. An export function for each database provides a list of data and formats to export.

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Cite this article: Hambly, Joanna, Sarah Boyd, and Tom Dawson. 2024. Community Coastal Zone Assessment Surveys: Methods and Experiences from Scotland. *Advances in Archaeological Practice* **12**(3):233–244. https://doi.org/10.1017/aap.2024.21.