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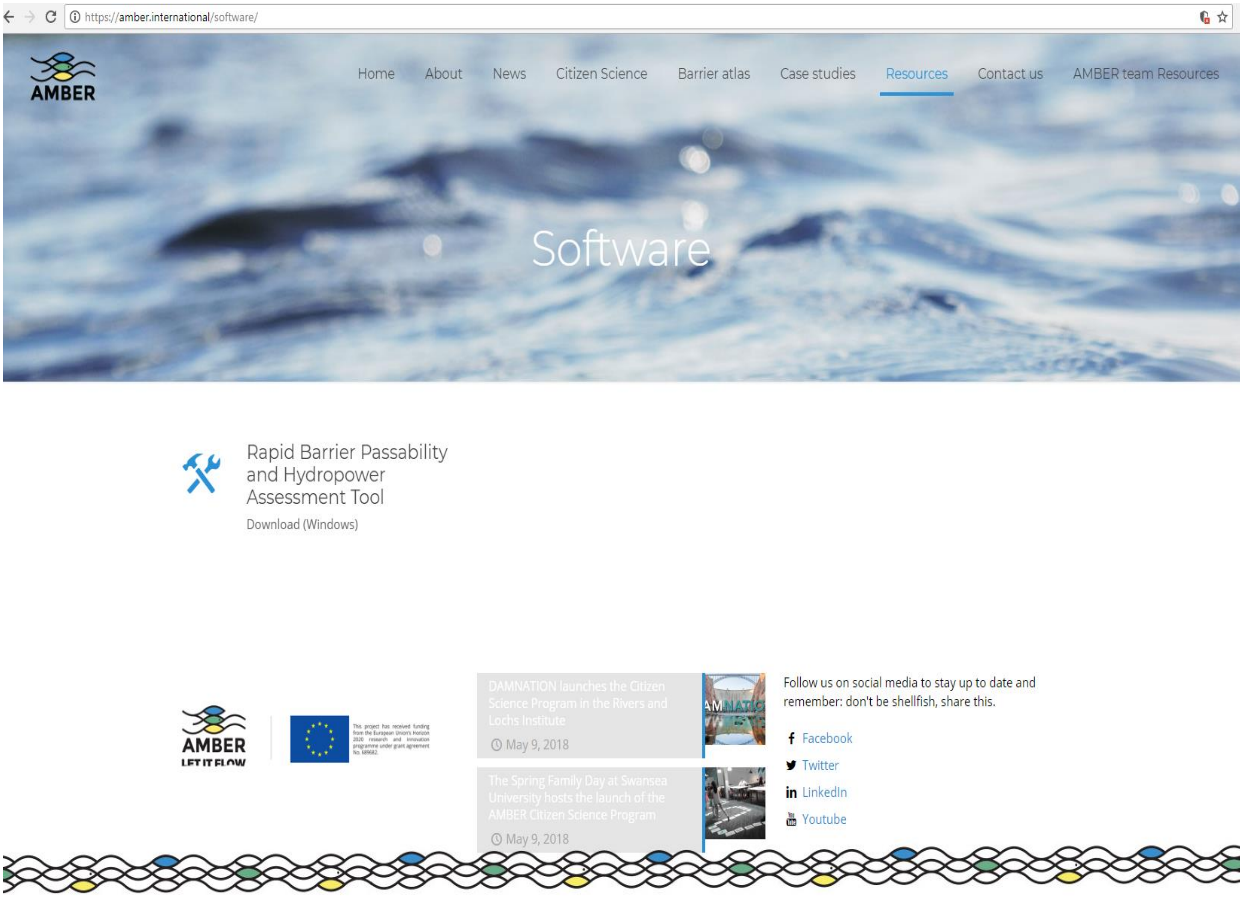
D.2.3 Rapid Barrier Passability and Hydropower Assessment Tool - Guidance Notes

This is version 1.0 of the Rapid Barrier Passability and Hydropower Assessment Tool - Guidance Notes. This document is a deliverable of the AMBER project.

D2.3 RAPID BARRIER PASSABILITY AND HYDROPOWER ASSESSMENT TOOL WEBSITE SCREENSHOT

This deliverable is a software deliverable available via the AMBER website at: https://amber.international/software/



The following document is the accompanying Guidance document for the software.

DISCLAIMER

The opinion stated in this report reflects the opinion of the authors and not the opinion of the European Commission.

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Executive summary

This document is a deliverable of the AMBER project and has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement No 689682.

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Contents

RAPID BARRIER PASSABILITY AND HYDROPOWER ASSESSMENT TOOL

1 THE PURPOSE AND BACKGROUND OF THE TOOL

Due to limited resources, precise enumeration of the impact of individual or multiple barriers on river connectivity using empirical telemetry techniques is generally only undertaken at large hydropower dams (e.g. Chanseau & Larinier 1998; Gowans *et al.* 2003; Rivinoja *et al.* 2006). Although these empirical studies provide valuable information on barrier passability they are generally very resource intensive and with some notable exceptions (e.g. Winter & Van Densen 2001; Ovidio *et al.* 2007; Lucas *et al.* 2009) they generally focus on salmonids and/or larger barriers. There is a need for a rapid coarse-scale passability assessment tool that can be implemented quickly and cheaply at catchment, national or international scales to facilitate prioritisation of restoration actions.

Around the world, numerous passability assessment protocols have been formulated to meet these requirements but these have generally been developed in an ad hoc fashion, resulting in major inefficiencies, and duplication of effort and frequent repetition of mistakes (Kemp & O'Hanley 2010; Kerr *et al.,* 2016). Within Europe, three key protocols exist that are well developed, widely accessible and are fully or partially available in English; the SNIFFER (UK), ICE (French) and ICF (Spanish) protocols (SNIFFER, 2010a, Baudoin *et al.,* 2014, Sola *et al.,* 2011, respectively). These protocols were tested and critically reviewed by Kerr *et al.* (2016). The French ICE protocol is the least subjective and produces passability scores for a greater number of species (*n* = 47), whilst requiring fewer physical measurements to be recorded than other fine-scale protocols (e.g. SNIFFER) (Kerr *et al.,* 2016). Recent work has also highlighted that the ICE protocol produces comparable passability scores to the finer scale SNIFFER protocol and is quicker and easier to complete (Barry *et al.,* 2018). The ICE protocol has been chosen as the protocol of choice for use by the AMBER consortium and for wider promotion as a European standard for barrier assessment.

One limitation of the ICE protocol is that passability scores are produced manually through a decision tree process, which can be time-consuming to complete, especially as this has to be repeated for each species assessed. The Rapid Barrier Passability and Hydropower Assessment Tool presented in this chapter (hereafter referred to as the Barrier Assessment Tool) automates the process, rapidly calculating the passability scores and any reasons for limited connectivity for all species at the click of a button based on a few simple input parameters. Scores produced range from 0 – 1: 0 (total barrier), 0.33 (high-impact partial barrier), 0.66 (medium impact partial barrier), 1 (low-impact passable barrier). In addition to generating ICE passability scores, the tool estimates the hydropower potential (Watts) at the site through a simple assessment of discharge and head drop. As such, the tool produces data that can be used to populate barrier mitigation prioritisation tools (see Kerr *et al.,* 2016) and efficiently help with catchment level management decisions.

2 INSTRUCTIONS

2.1 Installation

The software was developed in MATLAB but functions as a standalone tool regardless of whether the user has a MATLAB licence. To run the software a MATLAB Compiler Runtime (MCR) package is required. This MCR is contained within the software installation file and will be automatically installed with the main software.

1. Download the software from the AMBER website (https://amber.international/software).

2. Run the MyAppInstaller_mcr.exe file. This will guide you through the process of installation and by default install the software within 'C:\\program files\University of Southampton\'. An option to install a desktop shortcut to the final application is available to the user.

3. Once installed double click the'Rapid_Barrier_Passability_and_Hydropower_assessment_ _Tool.exe' shortcut located on the desktop or find the executable file in the installation location.

2.2 Operation

1. Create a new Microsoft Excel (.xlsx) file for the data to be loaded into by pressing the "Create new file" button within the "Select file" panel. Alternatively, select an existing file to export the data into using the "Select existing file" button (**Figure 1**).

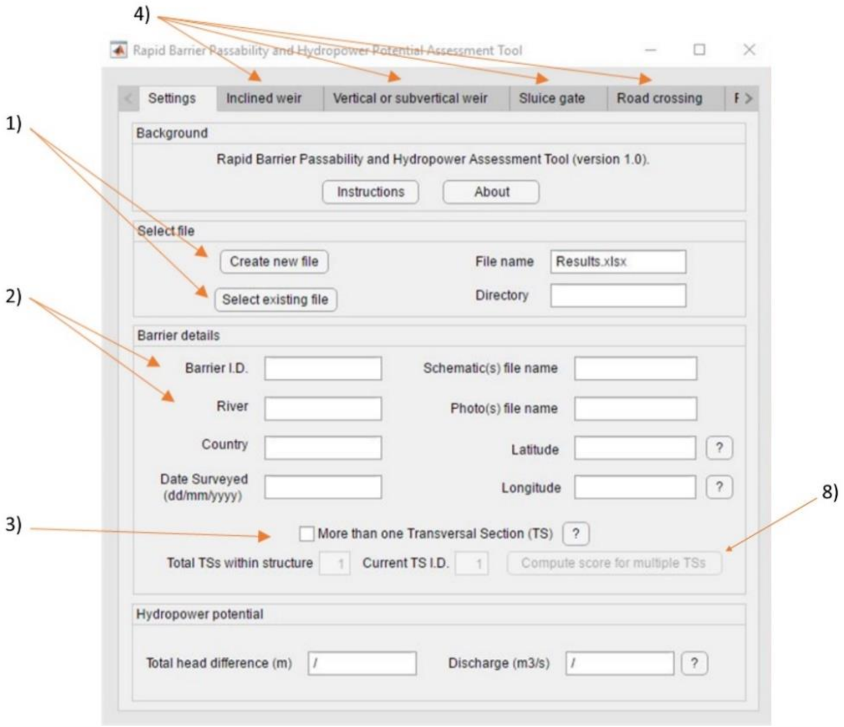

Figure 1. Settings tab of the Rapid Barrier Passability and Hydropower Assessment Tool.

2. Enter in all available barrier information within the "Barrier details" panel within the "Settings tab". A unique "Barrier I.D.", which can is defined by the user, is required for each barrier.

3. Identify if the barrier is made up of multiple Transversal Sections (TSs) or not and fill in the total number of TSs and TS I.D. as appropriate. For more information select the relevant "?" button in the "Barrier details" panel.

4. For each TS select the appropriate barrier type tab and fill in the required details.

5. Press the calculate button to calculate the passability score for that TS. Scores produced range from 0 – 1: 0 (total barrier), 0.33 (high-impact partial barrier), 0.66 (medium impact partial barrier), 1 (low-impact passable barrier).

6. Export the data to your selected excel file by pressing the export button within the relevant tab **(Figure 2).**

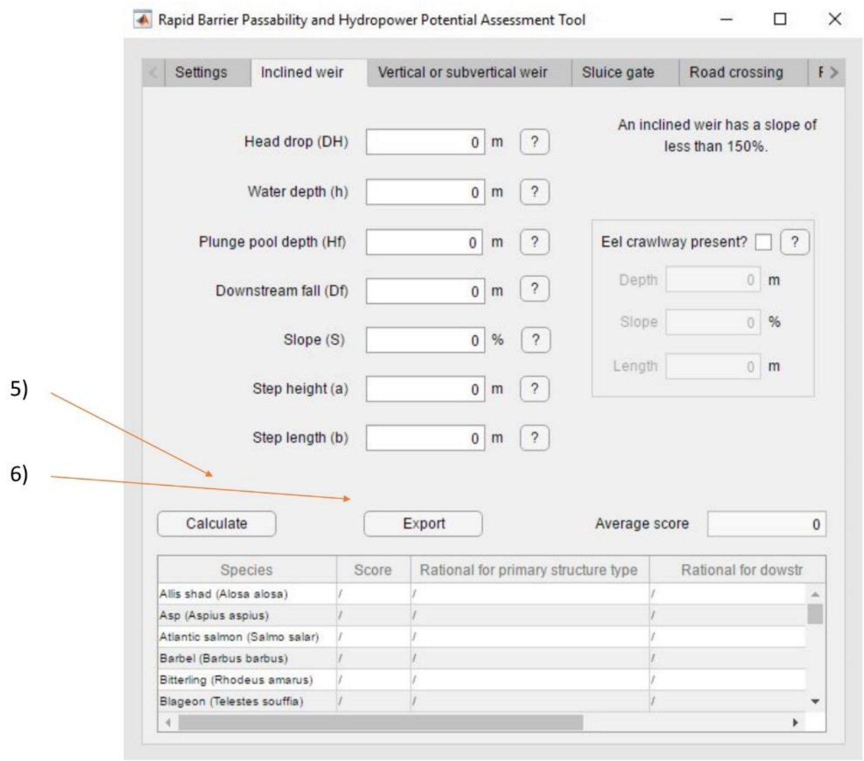

Figure 2. Inclined weir tab of the Rapid Barrier Passability and Hydropower Assessment Tool.

7. Repeat the process until passability scores are logged for each TS.

8. If the barrier consists of more than one TS make sure the correct barrier I.D. is entered within the settings tab and then press the "Compute score for multiple TSs" button. This will generate the passability score for each species for the whole barrier and output it into the selected Excel spreadsheet.

9. Clear all previously logged details, and repeat for next barrier. Additional data is logged on the next available line within the export file. Or a new file can be created.

10. Periodically backup the Excel file to ensure overwriting errors cause no loss of data.

3 EQUIPMENT NEEDED

An example of the equipment that may be needed to collect the relevant barrier measurements is provided in **Figure 3**. Note: Velocity measurements are only required under certain flow conditions for road/rail crossings (e.g. culverts) so this device is not always needed.

Figure 3. Suggested equipment for data collection using the Rapid Barrier Passability and Hydropower Assessment Tool. Image sourced and modified from Baudoin *et al.,* 2014.

4 PREPARATION FOR FIELDWORK

4.1 Permits/certificates

In the UK, the Barrier Assessment Tool does not require equipment or procedures subject to legal qualifications or permits for their use. Please check this is the situation in the region you plan to undertake the work. However, collecting the data required by the tool may involve access to private lands, depending on the purpose of the study and the site selection for sample collection. The right of the public to roam across private land exists in only a few jurisdictions (e.g. Scotland), while in most countries is a contentious issue that has often led to court action. To prevent inconvenient encounters with landowners or legal issues, check the local regulations and fill in the relevant forms to obtain permission to access private lands.

4.2 Safety

Obtaining barrier data may mean going into the river and onto the barrier and can be dangerous in some circumstances. In particular, users may be working in remote locations whilst accessing flowing water. Health and safety issues relating to collecting barrier data are the responsibility of each individual person intended to use the Barrier Assessment Tool. Acknowledging and undertaking a formal risk assessment of the hazards involved in working in/near flowing water and means by which they can be minimized is important in preventing accidents and ensuring the safety of the users collecting the data. This encompasses following the recommended precautions with regards weather, heat, dehydration, wading, and working at height etc. paying special attention to the hazards and risks that may occur in the vicinity of the barrier. Personnel, with their line managers, should assess their suitability for the task, e.g. inability to swim increases the risk in the event of suddenly plunging into the water.

Channel dimensions tend to be restricted at barriers causing increases in flow speed. In addition, the purpose of many structures is to maintain upstream water levels, which inherently results in a head-drop between up and downstream water levels. As such working a height is often a key consideration when assessing the risks involved in collecting data at river barriers. Individuals undertaking fieldwork should also be aware of the temperature, precipitation and the risk of high flow and flash flooding during fieldwork.

When working in polluted waters, follow the corresponding guidelines to protect yourself from contact with the water to avoid exposure to dangerous chemicals or microbes. Always, when possible, work with someone to reduce accident risk, particularly in remote locations or those associated with a higher risk of accidents and ensure that others are aware of your schedule of fieldwork and study locations.

An example of equipment that may be required to safely collect data for the Barrier Assessment Tool is provided in **Figure 4**.

Figure 4. Example of equipment that may be required to safely collect data using the Rapid BarrierPassability and Hydropower Assessment Tool. Image sourced and modified from Baudoin *et al.,* 2014.

5 ADDITIONAL DATA COLLECTION REQUIREMENTS

The Barrier Assessment Tool is designed to be used as standalone software installed on a field laptop or tablet that enables users to record all relevant barrier data without the need for additional paper forms. However, it is advised that users also produce a detailed field sketch of the barrier and site containing, at minimum, the following information: Date, Time, Field operative names, North arrow, River name, Scale, Flow direction, Delineation of Traversal Sections, Flow conditions (low, medium, high) (**Figure 5**).

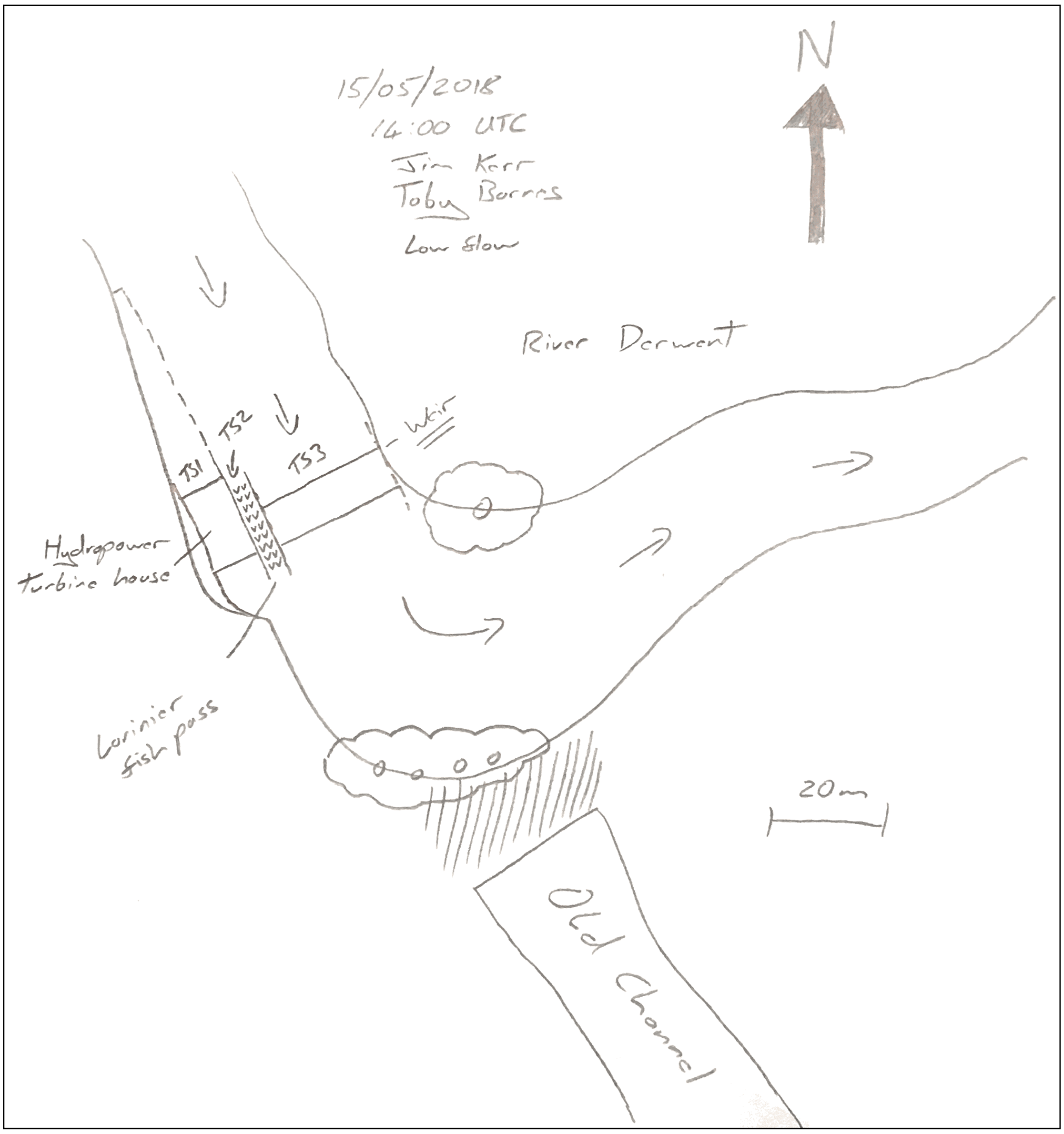

Figure 5. Example field sketch of the barrier and river system.

This field sketch can then be photographed onsite or scanned once offsite and the name and location of the image recorded within the software.

Several photos of the barrier should also be taken during the visit. At minimum, an upstream and downstream photo of the barrier should be taken if possible. Preferably, multiple shots focussing on key features of the barrier (e.g. crawl-ways) and individual TSs should be taken as well and appropriately stored. Photo file names can be logged within the software.

6 BACKGROUND INFORMATION NEEDED

It is recommended that the ICE protocol is undertaken under "hydrological conditions most common during the migratory period of the given species". However, high flow conditions can make barriers inaccessible, and even if the barrier is accessible, key features are often submerged making assessment difficult. These factors should be considered when planning a trip to assess passability for a species that typically migrates under high-flow conditions. If a broader multi-species assessment of a barrier is required then it is recommended that low flow summer conditions be targeted. As such, monitoring discharge and predicted rainfall at the site is essential when planning a trip to undertake a barrier assessment. Depending on the country, discharge values can often be obtained remotely through government webpages designed to provide flood warnings. For example, in the UK, frequently updated river level data is available from https://riverlevels.uk. Annual flow data may also be available from archive sites such as http://nrfa.ceh.ac.uk/.

Predicted rainfall can be obtained from international weather services such as https://www.yr.no/ or https://www.metoffice.gov.uk/.

It is recommended that users access and check whether such data is available for the region of interest to plan their site visit and maximise the chances of being able to safely collect data.

7 LOGISTICS

Before going to the field:

1. Ensure that the software is loaded onto an appropriate field computer and is functioning correctly.
2. Ensure that you have all the data collection and safety equipment required.
3. Check the forecast. If there is a high probability of excessive precipitation coinciding with or immediately prior to the planned sampling, it should be re-scheduled since this may result in rapidly changing flow conditions that increase the risk of working at the site.
4. Confirm that batteries are fully charged for electronic devices such as GPS. Carry spare ones in case they run out.
5. Carry any permits needed.
6. Schedule your time in advance and always add some extra time for any unexpected delays.

Once you are in the field:

1. From the bank, locate the barrier and undertake a preliminary assessment of the site; noting access points, escape routes and locations where equipment can be safely deployed (e.g. levelling equipment).
2. Be aware of safety risks and take appropriate preventive actions to avoid any issue.
3. Undertake field sketch of the site, delineate any lateral heterogeneity into separate labelled TSs, and classify the sections according to barrier type.
4. Carry out data collection according to the systematic collection protocol outlined above (Section 2.2, **Figure 1** and **Figure 2**).
5. Remember to take photographs and log all required metadata before leaving the site.

6. Before leaving site check that, all equipment and rubbish has been collected. Make sure all gates/access points are left as they were found.

7.1 Number of people

It is recommended that at least two people undertake data collection at a barrier. Many barrier sites are remote and assessing barriers can often be dangerous. Users should not attempt to assess a barrier alone. In addition, much of the equipment is also best operated by at least two operatives. More than two operatives may be required at particularly hazardous sites where increased bankside or boat support is needed.

8 TROUBLESHOOTING AND UNUSUAL SITUATIONS

The Barrier Assessment Tool covers five commonly occurring barrier types and the majority of structures encountered should fall within one of these categories. It may not be possible to assess anomalous barriers that do not fit into one of the five categories. Users must use their discretion to judge whether a barrier can be categorised into one of the five categories. Further guidance with this can be gained by reviewing the relevant section in the ICE protocol guidance document (Baudoin *et al.,* 2014). Barrier details (e.g. slope, head drop, length) for structures of unknown type should still be recorded. These details can be manually entered onto the excel data file.

Lateral heterogeneity along the width of the barrier is accounted for in the tool by delineating different TSs and calculating passability scores for each individual section. The final passability score for the entire barrier is considered equivalent to the TS with the highest passability score. To compute the barrier score for multiple TSs, calculate and export the score for each TS separately (numbering them appropriately), make sure the Barrier I.D. data entry field is correct and press the 'Compute score for multiple TSs' button. This outputs a new line of data in the output data file, with the TS I.D. listed as 'ALL' and the barrier type as 'Combined'.

The impact of complex structures that consist of multiple different barrier types longitudinally (one after the other) cannot be cumulatively assessed using the Barrier Assessment Tool but the passability of each individual barrier type should be calculated and exported. As long as the structure consists of less than five distinct longitudinal barrier types the overall passability score can be estimated manually (see p142 ICE protocol, Baudoin *et al.,* 2014).

Runtime errors that occur are identified by a single chime that sounds if the program encounters a problem and cannot complete the required operation. If the problem is not immediately obvious and solvable, users can troubleshoot the problem by opening the program in the 'Command Prompt' dialogue utility for Windows. This will display details of the error that is occurring. The location of the 'Command Prompt' utility varies depending on the version of Windows that the program is running on. If not immediately obvious where the utility is located, it can usually be found by searching for 'Command Prompt' within the start menu. Once open the user should open the Barrier Assessment Tool using the command prompt utility. This can be achieved by manually typing in the location of the Barrier Assessment Tool '.exe' file (or by dragging and dropping the program into the 'Command Prompt' dialogue box) and pressing return to open the program. Once open use the program as normal. Any errors that occur will be shown within the 'Command Prompt' dialogue box. This may help the user troubleshoot any problems. Alternatively, contact Dr Jim Kerr (j.kerr@soton.ac.uk) for support.

To enable further tool development, software bugs and faults should be reported to Dr Jim Kerr (j.kerr@soton.ac.uk)

9 SECURING DATA

It is recommended that the output spreadsheet from the software is periodically backed up to secure location. This is to ensure that the risk of data loss through overwriting errors is kept to a minimum.

It is recommended that 10% of data undergo a quality control process whereby the results are crossed checked back against the original ICE decision tree protocols. This can either be for 10% of the species for a single barrier or 10% of barriers assessed if multiple assessments are being undertaken. Any output errors that are identified should be reported to Dr Jim Kerr (j.kerr@soton.ac.uk).

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