Boat Wake Wash Decision Support System User's Manual. July 2013.

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Boat Wake Wash Decision Support System User's Manual

WRL Research Report 246
July 2013

W C Glamore, A M Badenhop and E K Davey

UNSW
THE UNIVERSITY OF NEW SOUTH WALES

Water Research Laboratory
University of New South Wales
School of Civil and Environmental Engineering

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1. Introduction

Over recent years community concern regarding the perceived impact of boat generated waves (or wake waves) on inland waterways has increased. At the same time, the popularity of recreational boating continues to increase and watersports, such as wakeboarding, have grown dramatically. To alleviate these concerns and improve waterway management the Water Research Laboratory (WRL) at the University of New South Wales have developed a standard methodology to assess the erosion susceptibility of a reach of a river and determine whether a selected vessel should be permitted to operate within the waterway.

The outcome of this study is a Boat Wake Wash Decision Support System (herein referred to as the DSS). The enclosed User's Manual aims to provide all the information required to apply this system in assessing a reach of river and in determining an appropriate, scientific based management strategy for the site. Additional background information, which details the development processes and underlying theory, can be found in "A Decision Support System to Assess the Impact of Boat Wake Wash on Riverbank Erosion" (Glamore and Badenhop, 2013).

The DSS discussed within this report assesses the susceptibility of a river bank to erode due to a wake wave or series of wake waves, by comparing the natural wind-wave energy with the vessel generated wave energy, the operating frequency of boats and the erosion potential of the bank. A basic description of the steps involved in the DSS is provided below.

The first step in applying the DSS is to determine the wind wave energy at the site using standard engineering methods and available data. The energy of the passing boat wave is then calculated based on previous field experiments conducted by WRL. The third step involves determining a bank erosion rating based on a series of field studies that incorporate individually weighted physical and biological features of the bank. Once these initial steps have been undertaken the wake wave energy is compared to the annual recurrence interval (ARI) of the wind wave energy. This comparison is undertaken for both the maximum generated wake wave and the total wave energy generated from a typical day involving multiple boat passes. The comparison of these wake wave energies with the ARI of the wind energy provides an indication of the likely impact of the boat waves on the shoreline. These results are then compared with the bank erosion index to determine the impact of the boat wake wave on the shoreline. The end result is one of three management categories: Allow, Manage/Monitor and Manage/Restrict.

An interactive spreadsheet has been developed to assist in applying the system at individual sites. A methodology for selecting sites is also provided and, based on the management outcomes, the timeframes between reassessment of a site is prescribed. Important issues such as wave attenuation, operating versus maximum wave conditions and wave duration time limits have all been included within the methodology. Note that while this system will provide an indication of the current state of the river bank, the system has not been designed to assess the ecological health of the river.

1.1 Report Outline

This report has been divided into 5 sections. Following this brief introduction, Section 2 provides a detailed description of the theoretical steps required to apply the DSS at a selected site. Section 3 provides the necessary information required to undertake the field assessment tasks including checklists and field tips. Section 4 details the step-by-step procedures for using the interactive EXCEL spreadsheet. Finally, Section 5 describes the information required to complete the study and how this information may be obtained.

To assist in understanding how to apply the DSS at a selected site three (3) appendices have been provided and should be consulted throughout reading this User's Manual. Appendix A is a draft field sheet that is recommended for use when undertaking the field assessment tasks. Appendix B contains a series of photos of previously assessed and rated field sites with detailed descriptions of relevant indicators. These photos should be consulted prior to undertaking the field assessment and may also be of assistance in the field as a general guide. Appendix C is to be used in conjunction with Section 4 of this manual as it is a pictorial guide to the steps undertaken in using the interactive spreadsheet.

2. Decision Support System Methodology

This section outlines the theoretical steps taken to determine the management strategy of a reach of river using the DSS. The user is not required to be able to complete these calculations by themselves, rather they can be completed using the interactive spreadsheet. For additional information regarding the calculations or theory behind the DSS assessment the reader is suggested to consult Glamore and Badenhop (2013).

2.1 Assessment Steps

The DSS methodology is summarised as a flow chart in Figure 1.

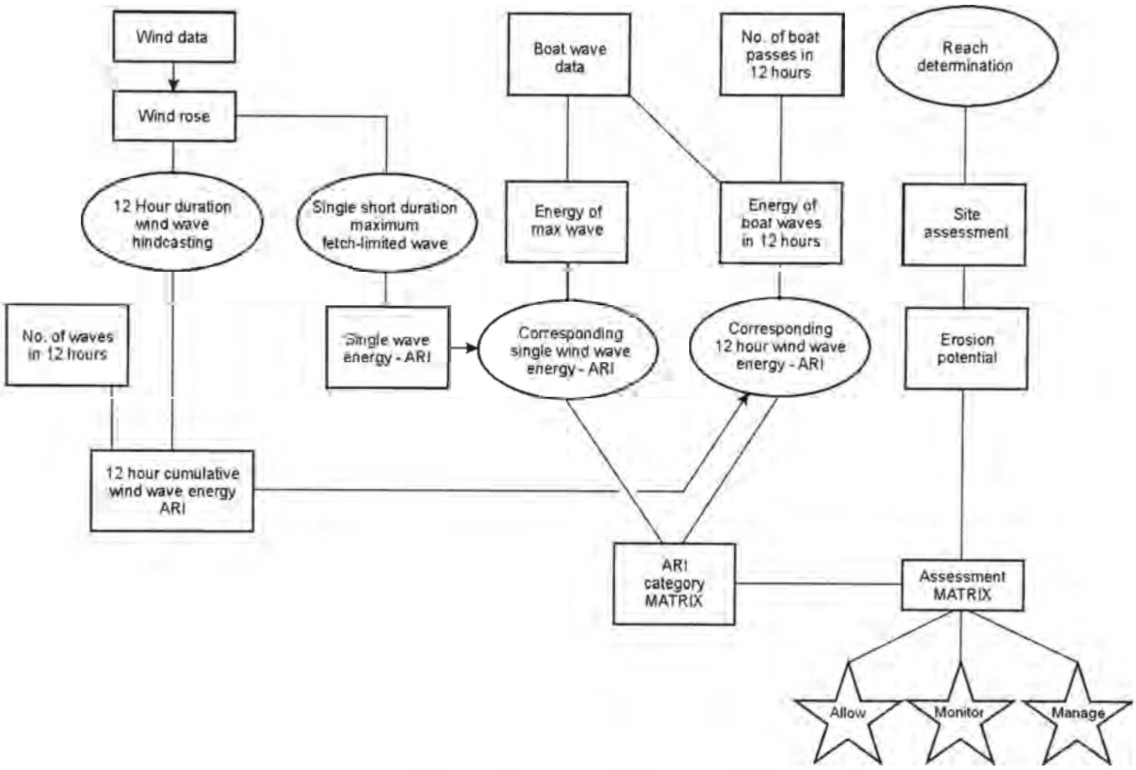


Figure 1: Flow Diagram of Decision Support System

The four major steps involved in assessing a selected site include:

- Step 1: Calculation of Wind Wave Climate
- Step 2: Calculation of Boat Wake Waves
- Step 3: Calculate Site Erosion Potential
- Step 4: Determine Site Rating.

The assessment tasks for each step are described in the following sections.

2.1.1 *Step 1: Calculation of Wind Wave Climate.*

This step outlines the tasks required to undertake the wind wave assessments. Importantly, this assessment recognises that both a single wave *and* the cumulative energy from a series of waves over a duration of time may cause erosion. Many of the steps described below are incorporated within the DSS spreadsheet (Step 1). Figure 2, which details the methodology for selecting sites, and Figure 3, which depicts the methodology for calculating fetch lengths, are useful in further understanding the assessment tasks below.

1. Manually divide the area to be assessed into 500 m sections and randomly select 30% of these sections (as per Figure 2).
2. For each section, manually calculate the fetch lengths of the 16 (or 8 depending on wind data available) compass directions (as per Figure 3).
3. Using the local wind rose, complete wave hindcasting for both the fetch-limited single wave and extended duration waves for each wind speed in each direction (see Section 4.1 for further information on wind data analysis).
4. Calculate the wind wave energy of the fetch-limited waves and determine the corresponding ARI's of the fetch-limited energy of a single wave.
5. Calculate the total wind wave energy at the site over the chosen daily duration of time boats are likely to be used (typically 8 hours) and determine the ARI's of the total wind wave energy for each adjusted wind speed and direction.

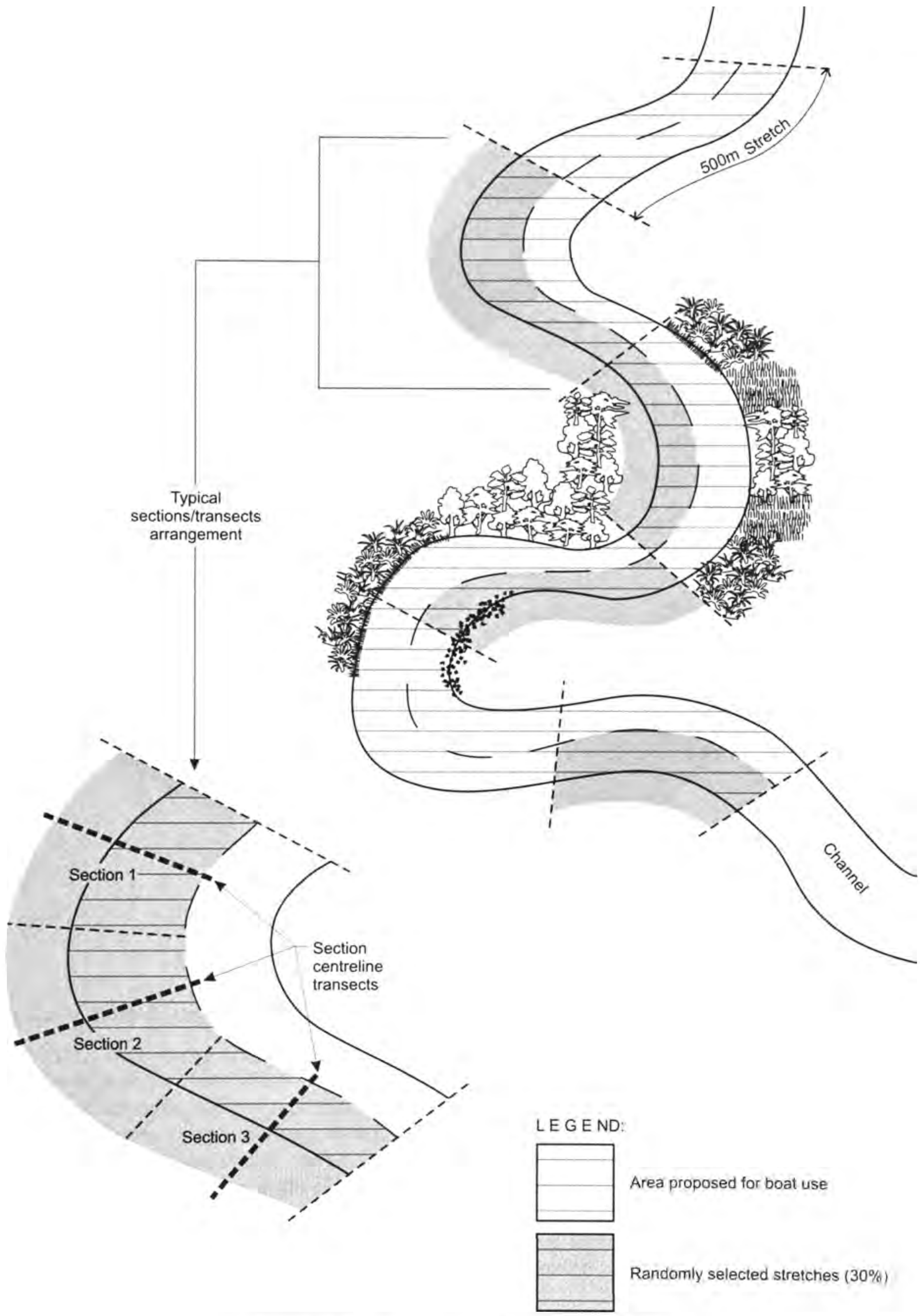


Figure 2: Erosion Potential Assessment Area

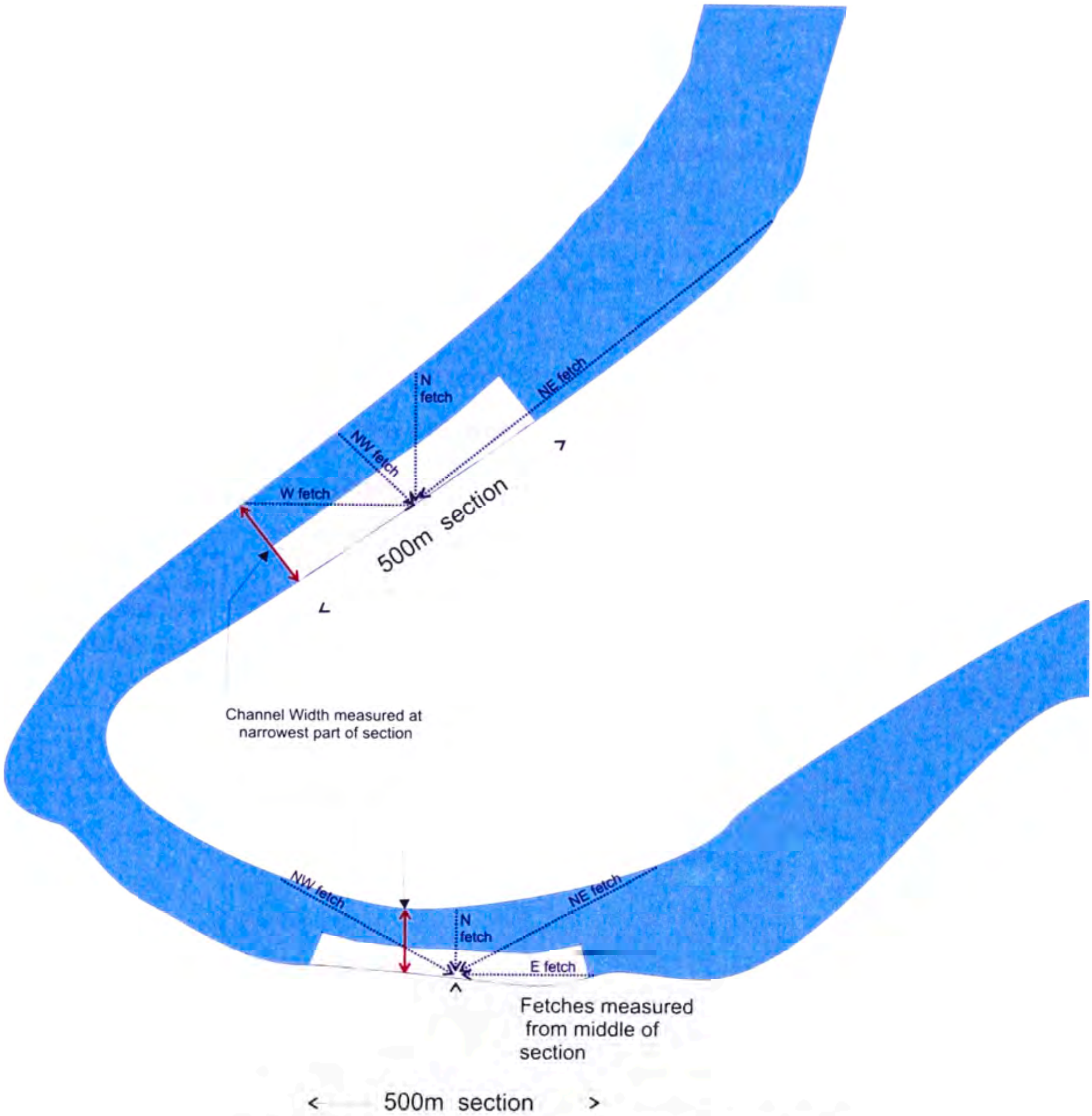


Figure 3: Measurement of Fetches and Channel Width

2.1.2 Step 2: Calculate Boat Wake Waves

This step determines the equivalent ARI of the boat wake wave (for both maximum and extended duration boat wake waves). Previously collected field data is used to estimate the energy of the boat wake waves for both waterski and wakeboarding vessels. The majority of this information is incorporated within the DSS spreadsheet (Step 2). Importantly, wave attenuation is included within the calculations as the attenuation of the waves with distance from the vessel depends on the width of the waterway.

1. Calculate the energy of the maximum boat wake wave. Compare the energy to the calculated energy of single wind waves and determine the equivalent wind wave energy ARI of the boat wake wave.

2. Calculate the energy of boat waves over the chosen daily duration. Compare the energy to the calculated energy of wind waves over the chosen daily duration and determine the equivalent wind wave energy ARI of the boat wake waves.
3. Calculate the energy of the maximum boat wake wave attenuated at the shoreline. Compare the energy to the calculated energy of single wind waves and determine the equivalent wind wave energy ARI of the boat wake wave.
4. Calculate the energy of boat waves attenuated at the shoreline over the chosen daily duration. Compare the energy to the calculated energy of wind waves over a chosen daily duration and determine the equivalent wind wave energy ARI of the boat wake waves.
5. Compare the two equivalent ARI's, with and without wave attenuation to the rating system in Table 1 to determine the boat wake wave category from A to E.

Table 1: Comparison of ARI for Wind and Boat Waves

	Equivalent ARI of Boat Wake Wave Energy over an extended period (typically 8 - 12 hours)					
Equivalent ARI for Maximum Boat Wave Energy	**<1**	**1-2**	**2-5**	**5-10**	**10-20**	**>20**
<1	A	A	B	C	C	C
1-2	A	B	B	C	C	D
2-5	A	B	C	C	D	D
5-10	B	B	C	C	D	D
10-20	B	C	C	D	D	E
>20	B	C	C	D	E	E

2.1.3 Step 3: Calculate Site Erosion Potential

This step determines the potential of a selected site to erode based on its physical properties. Within this step it is important to follow the methodology set out for determining the sampling procedure as outlined below and in Figure 2.

1. Divide each of the 500 m stretches previously selected in Step 1 into three sections. Within each of the these sections define a 10 m wide transect in the middle of the section. As per Figure 2, each of these three transects will undergo a site assessment.
2. Conduct a site assessment of each of the transects using the Erosion Potential rating system. Section 3 of this manual provides methods, tips and the techniques required to

undertake this field assessment. Average the results of the three transects to determine an Erosion Potential score for the stretch.

2.1.4 Step 4: Determine Site Rating

This step determines the final rating of the 500 m stretch based on the above analysis. When using the DSS spreadsheet most of these tasks are automatically calculated.

1. For each section examined, compare the ARI category with and without attenuation to the erosion potential category to determine the final rating as shown in Table 2. If the final ratings differ because of wave attenuation, the critical boat distance from the shoreline should be noted and included in any boating management plan.
2. To determine the final rating for the entire stretch of river investigated compare the final ratings of each of the transects. The rating for the entire assessment area is the lowest of values from all of the stretches (i.e. if all of the sections are rated 'Allow', except for one which is rated 'Manage/Restrict' the final rating for the site will be 'Manage/Restrict'). Sensitivity analysis can be undertaken for a range of parameters including boat passes or duration assessment.

Table 2: Final Rating Matrix

	Erosion Potential				
ARI Rating	**Highly Resistant**	**Moderately Resistant**	**Mildly Resistant**	**Moderately Erosive**	**Highly Erosive**
A	ALLOW	ALLOW	ALLOW	MANAGE/ MONITOR	MANAGE/ RESTRICT
B	ALLOW	ALLOW	MANAGE/ MONITOR	MANAGE/ MONITOR	MANAGE/ RESTRICT
C	ALLOW	MANAGE/ MONITOR	MANAGE/ MONITOR	MANAGE/ RESTRICT	MANAGE/ RESTRICT
D	MANAGE/ MONITOR	MANAGE/ MONITOR	MANAGE/ MONITOR	MANAGE/ RESTRICT	MANAGE/ RESTRICT
E	MANAGE/ MONITOR	MANAGE/ RESTRICT	MANAGE/ RESTRICT	MANAGE/ RESTRICT	MANAGE/ RESTRICT

3. Field Assessment of the Erosion Potential

This section details the tasks required to calculate the erosion potential of the site. Since these tasks are undertaken onsite from a vessel, a range of information is provided to assist in the field work preparation and assessment.

3.1 Preparing for Field Work

Prior to going into the field, you will need to complete the following steps:

1. Determine the extent of the river that you wish to assess.
2. Using topographic maps or GIS, divide this area into 500 m stretches and randomly select 30% of these stretches for assessment. A diagram demonstrating this process is given in Figure 2. For each stretch selected, three 10 m transects will be assessed at roughly even intervals along the stretch.

You will need the following items to complete your survey:

DSS FIELD CHECKLIST

☐ Maps marked with selected stretches	☐ Clipboard, Pens
☐ GPS	☐ Field notebook
☐ Digital Camera, spare batteries	☐ Boat (+ Driver)
☐ DSS Field Sheets (1 per transect)	☐ Two people to do assessments

The boat selected should allow the assessors to get as close as possible to the shoreline for inspection.

3.2 Completing Assessments

DSS Field Sheets for recording the assessment of each transect are given in Appendix A. At each transect, you must:

1. Agree with your assessment partner as to the extent of the transect. It is important to define the exact extent of each 10 m transect prior to starting the assessment. This will reduce bias and improve survey accuracy.
2. Take a GPS reading of the location.
3. Take at least two photos of the transect which displays the transect from the water line up past the verge.
4. Complete the DSS Field Sheet. A separate sheet should be completed for each transect. A sample field sheet is provided in Appendix A.

3.3 Tips for Completing Assessments

A detailed description of the indicators can be found in (Glamore and Badenhop, 2013). Prior to undertaking a field assessment this document should be consulted. To further assist in assessing the erosion potential indicators of a site, a series of labelled photos have been provided in Appendix B. In addition, to assist in clarifying the lateral extents of each transect a description of the assessment zones is provided in Figure 4.

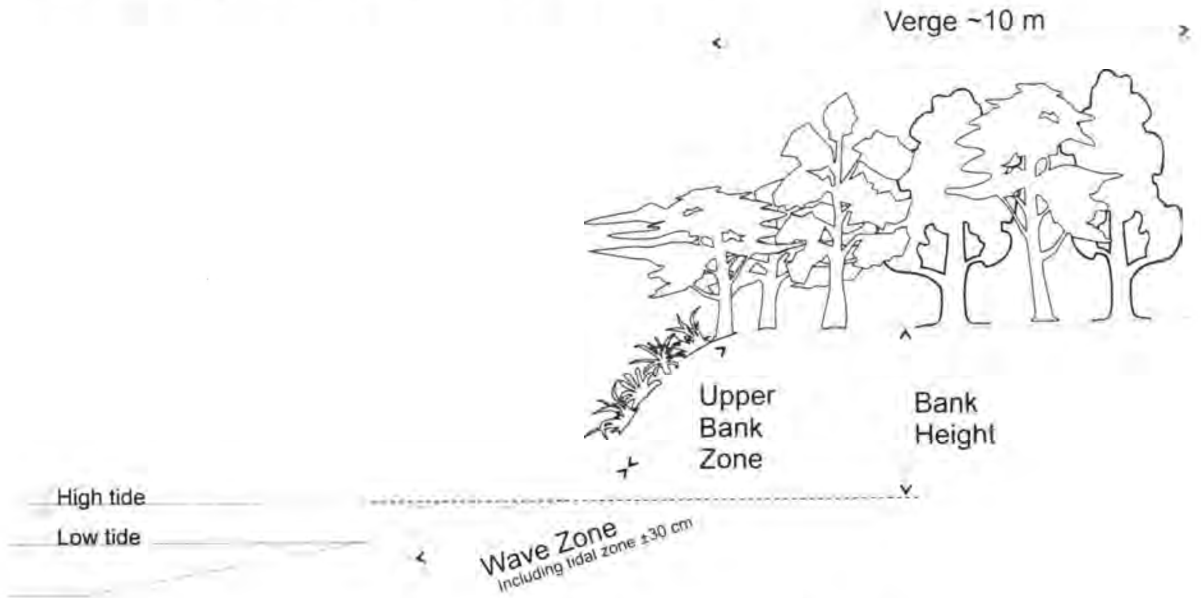


Figure 4: Erosion Potential Assessment Zones

Table 3 includes a series of additional tips for each indicator which may assist in completing the field assessment.

Table 3: Tips for Field Assessments of Erosion Potential

Indicator	Tips
Valley Setting:	• Confinement of the valley is most likely to be the same for the entire reach unless there is a sudden change from confined valley into a floodplain • Each section may, however, be either completely or partially armoured. If this is true, this criteria takes precedent over the level of confinement.
Longitudinal continuity of bank vegetation over the WHOLE STRETCH:	• As this indicator is a rating of the continuity of vegetation over the whole stretch, it should only be completed after assessing the entire section. • The assessors need to observe the continuity in between transects
Verge cover (10 m from top of bank):	• Verge cover needs to be trees (is rated as <10% if only grasses) • Complete cover would require at least two lines of trees (not just one line at the top of the bank) • See Figure 4: Erosion Potential Assessment Zones
Upper Bank Cover:	• Mentally divide the transect bank into three to determine whether the vegetation covers more than one third or two thirds of the transect • See Figure 4: Erosion Potential Assessment Zones
Wave Zone Cover:	• See Figure 4: Erosion Potential Assessment Zones
Native canopy species regeneration (< 1 m tall):	• Must be native species

Indicator	Tips
Native understorey regeneration:	• Must be native species
Dominant Wave Zone Cover Type:	• Must be more than 50%
Upper Bank Slope:	• Slope above the wave zone (rise/run) • See Figure 5 for a comparison of bank slopes
Channel width:	• Can be measured off topographic maps or GIS if uncertain
Bank Height	• Only necessary if slope near-vertical
Bank Sediment Type:	• Cohesive bank – sediment clumped together and typically very clayey. No individual grains visible. • Complex bank will contain mix of sands and clays. May show some layering. • Non-cohesive bank – very sandy with no clay observable. Separation of grains can be seen.
Erosion above the Wave Zone:	• Used for general signs of erosion such as bare bank that cannot be easily classified.
Slumping:	• Failure of the bank where one section appears to have slid over another. May be indicated by a concave section of the bank or by the waste sediment seen further down the bank.
Undercutting in the Wave Zone:	• Notches cut into the bank in the wave zone area, threatening the bank above it.
Desnagging:	• Need to ask local waterway authorities or Council
Excavation:	• From observation
Extraction:	• Need to ask local waterway authorities or Council
Stock access:	• Look for fences, but ensure fences still look stable • Check for cow trails down to the water and signs of trampling • Tall shrubs growing on the bank or close to the water typically indicates no stock access.
Brief Description of Site	• Document type of veg, slope, if the site looks good or bad, natural or unnatural • Include a basic sketch if possible showing basic site features

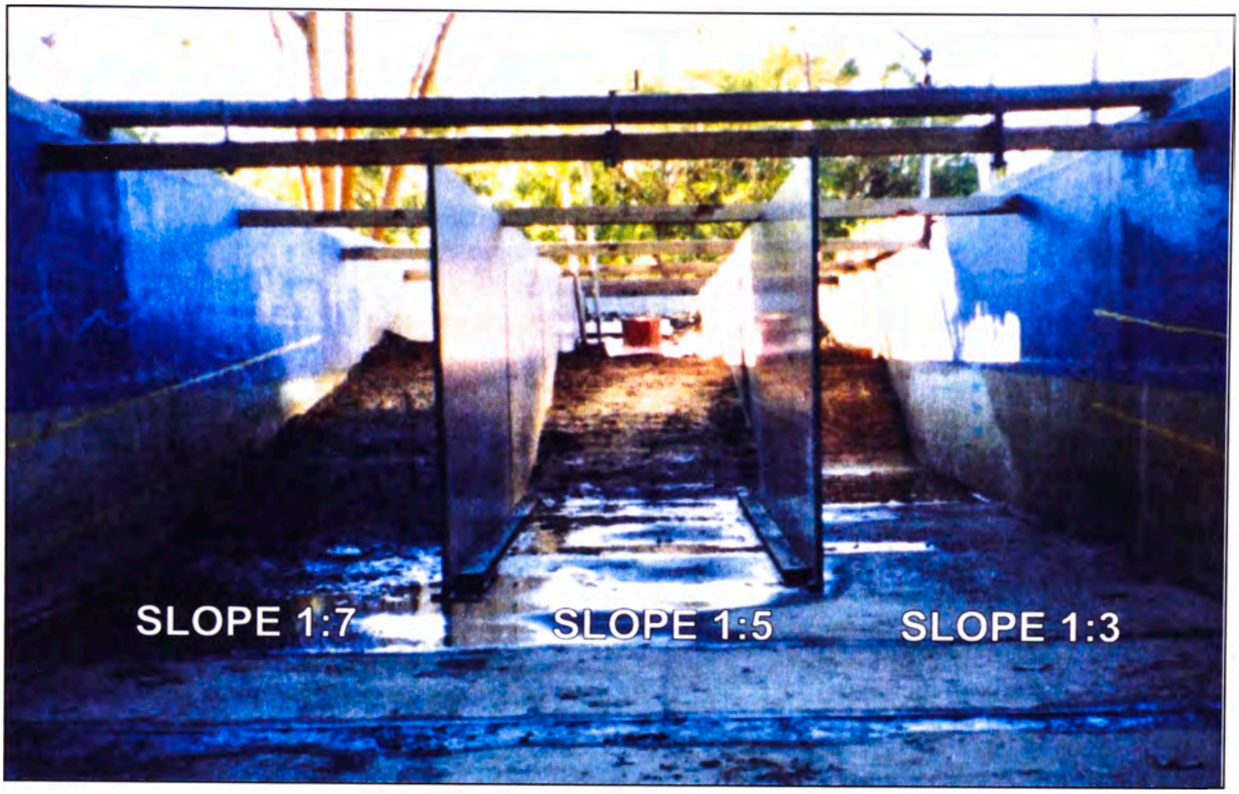


Figure 5: Bank Slopes Comparison

4. Using the Interactive Spreadsheet

All of the collected data and analysis have been incorporated into a single decision support system. The system has been developed within a Microsoft EXCEL spreadsheet format to allow easy manipulation of the variables. Further, to allow for widespread use of the system many of the complex steps of wave analysis have been incorporated within the spreadsheet and do not require hands-on processing. This section outlines the step-by-step process required to use the system and thereby determine whether vessels should be permitted on a selected stretch of a waterway.

4.1 Wind Data Format

Wind data is assumed to be in the format of a local wind rose providing frequency occurrences of wind speed and direction as shown in Table 4. Note that this data is usually provided as 10 minute duration at 10 m height. The interactive spreadsheet provides space for 6 wind speed brackets and 16 wind directions. If you have more brackets, you will need to condense the data into smaller brackets. For each wind speed bracket, the upper limit of the wind speed is used (e.g. for 1-5 km/h, the wind speed bracket entered is 5 km/h (1.39 m/s)). Most wind roses will have a final wind speed bracket that is simply all wind greater than a certain value (in the example >40 km/h). An upper value therefore needs to be chosen for this bracket that does not either overestimate or underestimate the wind wave climate too much, e.g. 45 km/h may be reasonable.

If, such as in the example shown in Table 4, there is only 8 wind directions given (instead of 16), simply leave the other directions blank. If local wind data is available in raw form, it is simplest to convert this data into a wind rose/frequency distribution and simply use the same steps described above.

Table 4: Example Provided Wind Data Format

	Wind Direction								
Speed Range	N	NE	E	SE	S	SW	W	NW	Total
1-5 km/h	0.9	1.7	1.7	1.2	1.4	1.2	0.6	0.5	9.3
6-10 km/h	1.4	3.1	2.8	2.3	2.4	1.9	1.2	0.8	15.8
11-15 km/h	1.0	2.0	2.0	1.9	2.0	1.4	1.1	0.7	12.0
16-20 km/h	0.6	0.8	1.1	1.3	1.2	0.8	0.9	0.5	7.2
21-25 km/h	0.5	0.5	0.7	1.1	1.1	0.8	1.1	0.6	6.5
26-30 km/h	0.3	0.1	0.2	0.5	0.5	0.5	1.0	0.5	3.5
31-35 km/h	0.1	0.0	0.0	0.1	0.2	0.2	0.5	0.2	1.3
35-40 km/h	0.0	0.0	0.0	0.1	0.1	0.1	0.3	0.2	0.8
>40 km/h	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.2	0.9

Note: 42.6% calms

4.2 Basic Data Input Steps

The spreadsheet has been designed for use on each stretch, which includes 3 transects. Data fields that need to be entered are coloured in white. Buttons, located in the top right hand corner of each worksheet are used to navigate between pages.

As some of the data will be identical for each of the stretches, a base spreadsheet should be set up incorporating the wind wave and boat data for the reach. This spreadsheet can then be edited and saved for each individual stretch.

The steps outlined below can be followed to create a base template file for each reach. To assist in understanding these steps labelled images of the spreadsheet pages, with individual steps highlighted, are shown in Appendix C.

Steps to Create a Base Template File for Each Reach:

1. Open the DSS.xls spreadsheet.
2. Save as a new copy RiverNameBase.xls.
3. Click Enter Data. This will take you to the Wind Wave Calculations tab. It is assumed that frequency occurrences (e.g. a wind rose) have been already calculated for your data.
4. Enter in the chosen time period under Extended Duration for calculating cumulative effects of waves over a day. This is typically 8 hours but may range between 6 to 12 hours. This must be in minutes.
5. Enter in the upper values of the wind speed brackets your data has been divided into in m/s.
6. Enter in the number of years of wind data.
7. Enter in the per cent occurrence of the wind for the different wind speed brackets. (Note that if you only have wind speeds for the 8 directions, the other directions should simply be left blank).
8. Go to Step 2.
9. Choose from the dropdown menu the boat type and associated boat operating condition.
10. Enter in the number of boat passes.
11. Go to Step 3.
12. For each transect, enter in the Valley Setting and Stage Variability.
13. Save the file.

Steps to Completing a Stretch Analysis Using the Interactive Spreadsheet:

1. Open the RiverNameBase.xls spreadsheet.
2. Save as a new copy with RiverName-StretchA.xls.
3. Click Enter Data.
4. Enter the fetch lengths for the stretch.
5. Go to Step 2. As you click on this button, ARI's of the wind wave data will be calculated.
6. Enter "Distance of Boat from Shore". For a starting value, use half the width of the river at the narrowest part of the stretch.
7. Go to Step 3.
8. Enter in all of the data from the Field Assessment Sheets using the drop-down boxes for each transect. You may wish to record the Erosion Potential rating for each transect.
9. After rating the third transect, click Determine Rating.
10. Record the final rating, taking care to observe whether the boat distance from the shore needs to be maintained.

Should there be uncertainty about the boat conditions being investigated, click "Change Boat Operation". You may wish to investigate the impact of changing the number of boat passes, boat type, operation or the distance from the shoreline. The results of these permutations will need to be recorded in a separate spreadsheet.

The user will need to keep a record of the results of each analysis for each stretch. This record will be used to determine the rating for the entire section of river under analysis. The management strategy for the entire stretch is based on the worse rating for the entire section of river.

5. Data Requirements

The data required for use of the DSS is summarised in Table 5.

Table 5: Data Required for Assessment using the Decision Support System

Assessment Component	Data required	Scale (Units)
Wind Waves	Fetch length from topographic maps, aerial photographs or GIS. This is taken from the middle of the section.	Each section (metres)
	Wind rose or local wind data. This data can be typically obtained from the Bureau of Meteorology	One dataset for whole reach (frequency occurrences)
Boat Wake Waves	Distance of boat from shoreline. This is taken to be half the width of the river at its narrowest point in the section and should be measured off topographic maps or GIS.	Each section (metres)
	Daily duration over which boats are likely to operate (usually between 6-12 hours).	Whole reach or each section (minutes)
	Boat pass frequency	Whole reach or each section
Bank Erosion Potential	Channel width from topographic map / aerial photographs/GIS	Section (metres)
	Regulation and extraction information	Whole reach
	Bank Erosion Site Assessment undertaken by users	Each transect (as per rating sheets)

It is important to note that not all information may be available for every category. Data which is critical to the study includes:

- Long term wind records (typically greater than 20 years)
- Fetch Lengths
- Channel Widths.

If other information including boat pass frequency and daily durations is not available these parameters could be sensitivity tested using the DSS. For instance, there may not be sufficient information regarding boat pass frequency at the site. In this case, boat pass frequency data should be collected as per the methods stated in (Glamore and Badenhop, 2013). If boat pass information cannot be obtained, sensitivity analyses could be undertaken by manipulating the number of boat passes within the DSS. The outcomes of these tests could then be compared to determine if frequency of boat passes has an impact on the resultant management strategy.

6. References

Glamore, W.C. and Badenhop, A.M. (2013) *A Decision Support System to Assess the Impact of Boat Wake Wash on Riverbank Erosion*. WRL Research Report 245

APPENDIX A: DSS Field Sheet

DSS FIELD SHEET

Date:	**Stretch:**
Time:	**Section (1,2 or 3):**
Assessing Personnel:	**GPS Waypoint:** **or E:** **N:** AMG/MGA (circle correct one)
Photo Numbers:	

River Type

Valley Setting:	☐ Confined ☐ Partly Confined ☐ Laterally Unconfined	☐ Completely Armoured ☐ Partially armoured

Vegetation (Not required if completely Confined or Armoured)

Longitudinal continuity of bank vegetation over WHOLE STRETCH:	☐ < 10 % ☐ 10-30 %	☐ 31-60 % ☐ > 60 %
Verge cover (10 m from top of bank):	☐ < 10 % ☐ 10-30 %	☐ 31-60 % ☐ > 60 %
Upper Bank Cover:	☐ < 10 % ☐ 10-30 %	☐ 31-60 % ☐ > 60 %
Wave Zone Cover:	☐ < 10 % ☐ 10-30 %	☐ 31-60 % ☐ > 60 %
Native canopy species regeneration (< 1 m tall):	☐ None	☐ Scattered ☐ Abundant
Native understorey regeneration:	☐ None	☐ Scattered ☐ Abundant
Dominant Wave Zone Cover Type:	☐ Bare (vertical slope) ☐ Bare (1:3 – 1:6 slope) ☐ Bare (≤1:7 slope) ☐ Rocks	☐ Grasses ☐ Reeds ☐ Trees/Tree roots ☐ Mangroves

Channel Features

Upper Bank Slope:	☐ Near Vertical ☐ ~1:3	☐ ~1:5 ☐ <1:7
Channel width:	☐ <36 ☐ 36-120	☐ >120
Bank Height	☐ > 3 m ☐ 1-3 m	☐ < 1 m

Erosion

Bank Sediment Type:	☐ Bedrock/Boulders/Cobbles/ Armouring ☐ Cohesive	☐ Complex (sand & clay) ☐ Non-Cohesive
Erosion above the Wave Zone:	☐ Absent ☐ < 10 % banks	☐ 10-30 % banks ☐ > 30 % banks
Slumping:	☐ Absent ☐ < 10 % banks	☐ 10-30 % banks ☐ > 30 % banks
Undercutting in the Wave Zone:	☐ Absent ☐ < 10 % banks	☐ 10-30 % banks ☐ > 30 % banks

Land use

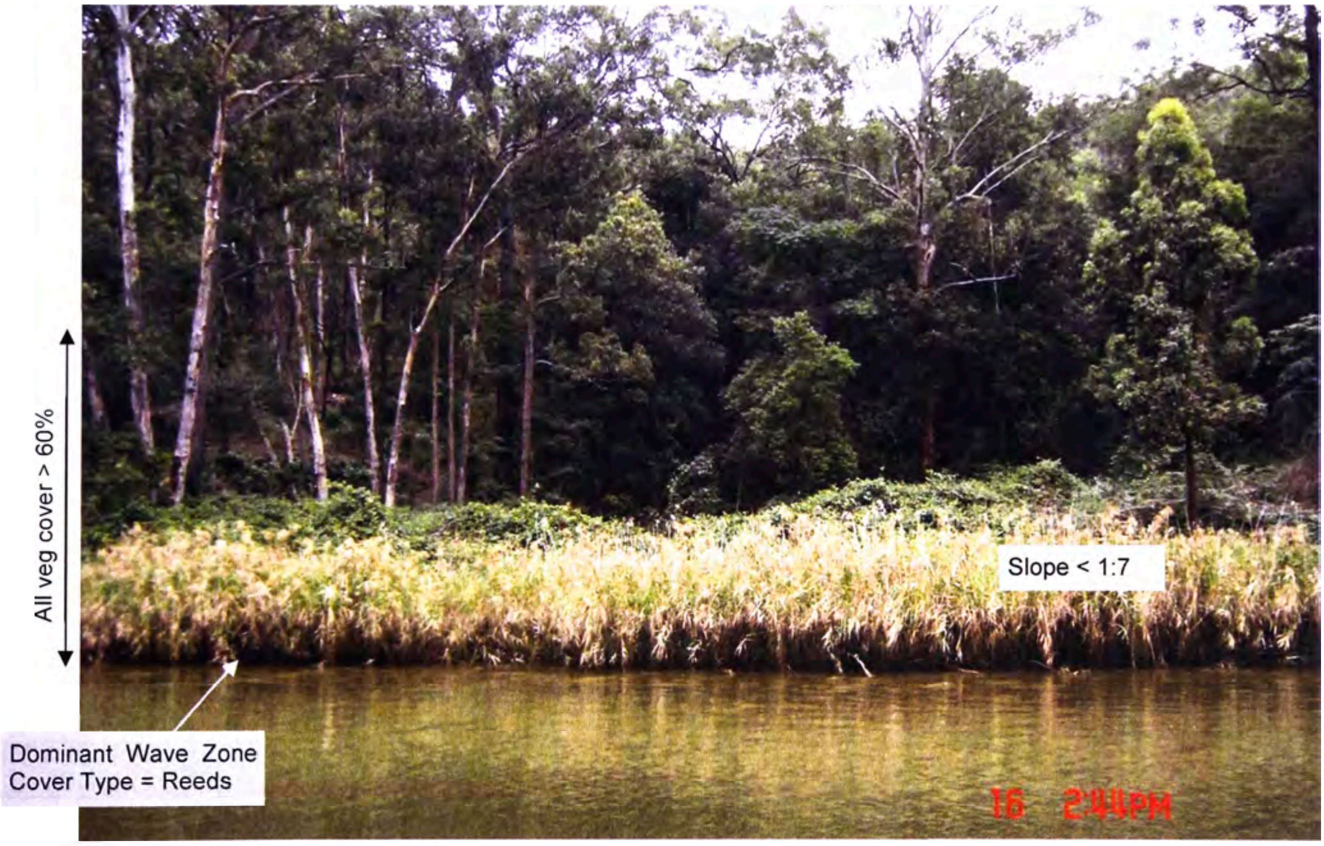
Desnagging:	☐ None	☐ Conducted in last previous year
Excavation:	☐ Present	☐ Absent
Extraction:	☐ None	☐ Water ☐ Sediment
Stock access:	☐ Absent	☐ Present

Brief Description of Site

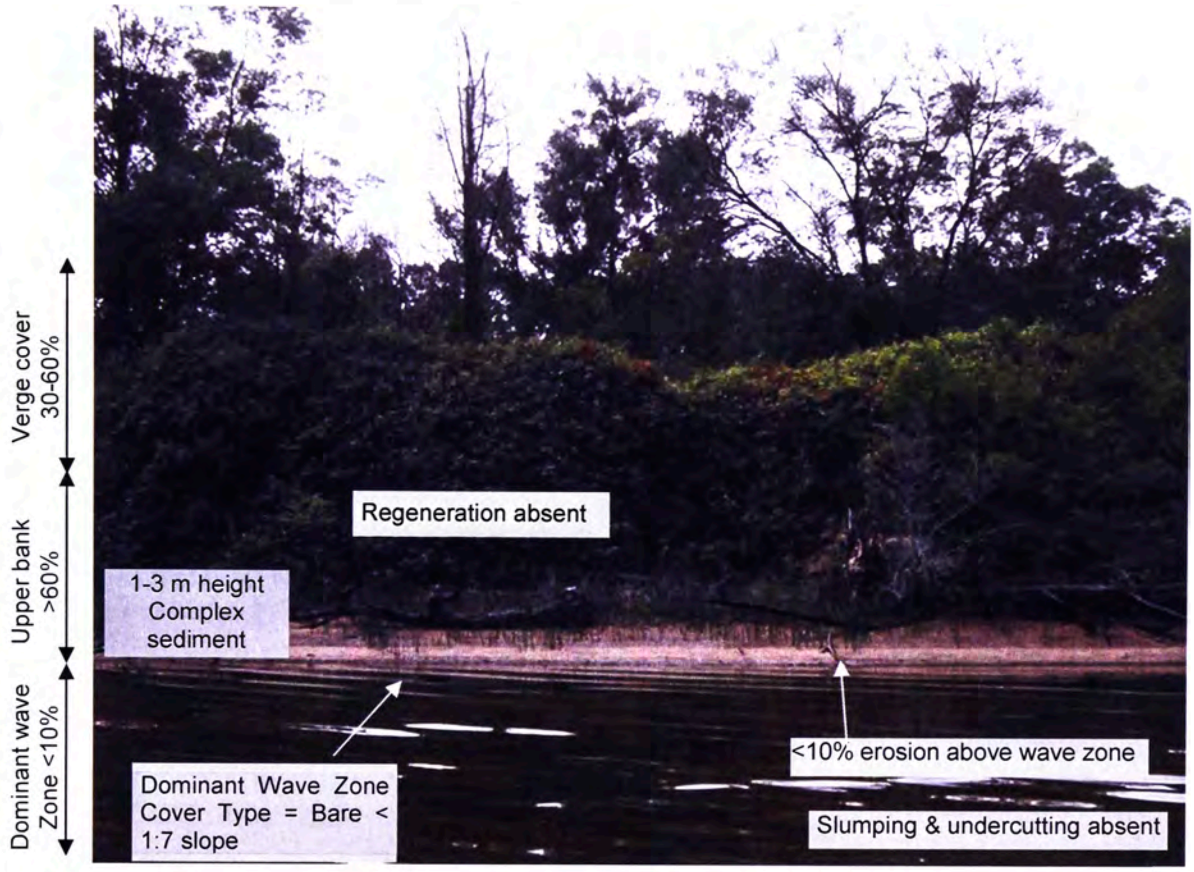
APPENDIX B: Field Assessment Examples

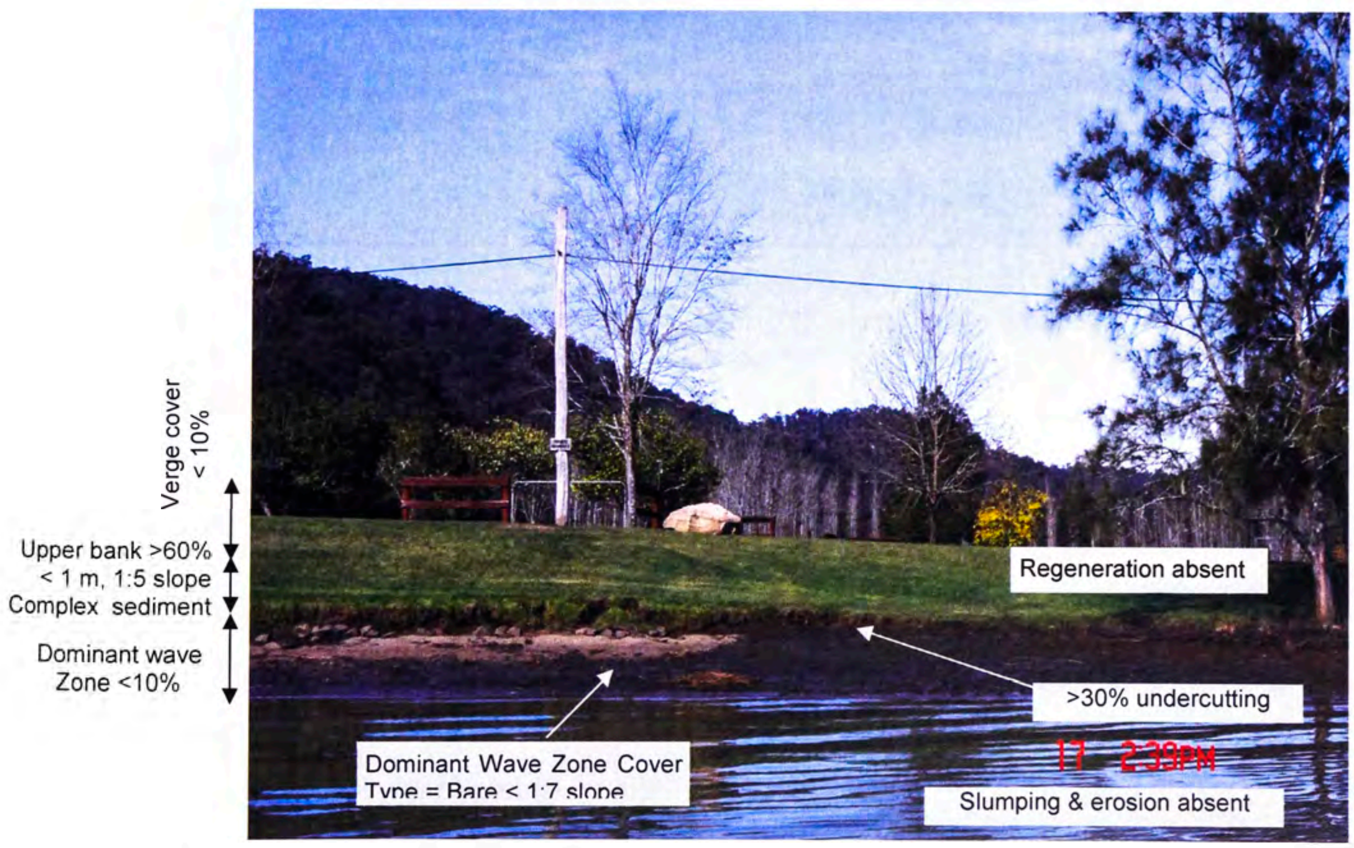
Highly Resistant – Completely Armoured

Highly Resistant – Excellent Vegetation

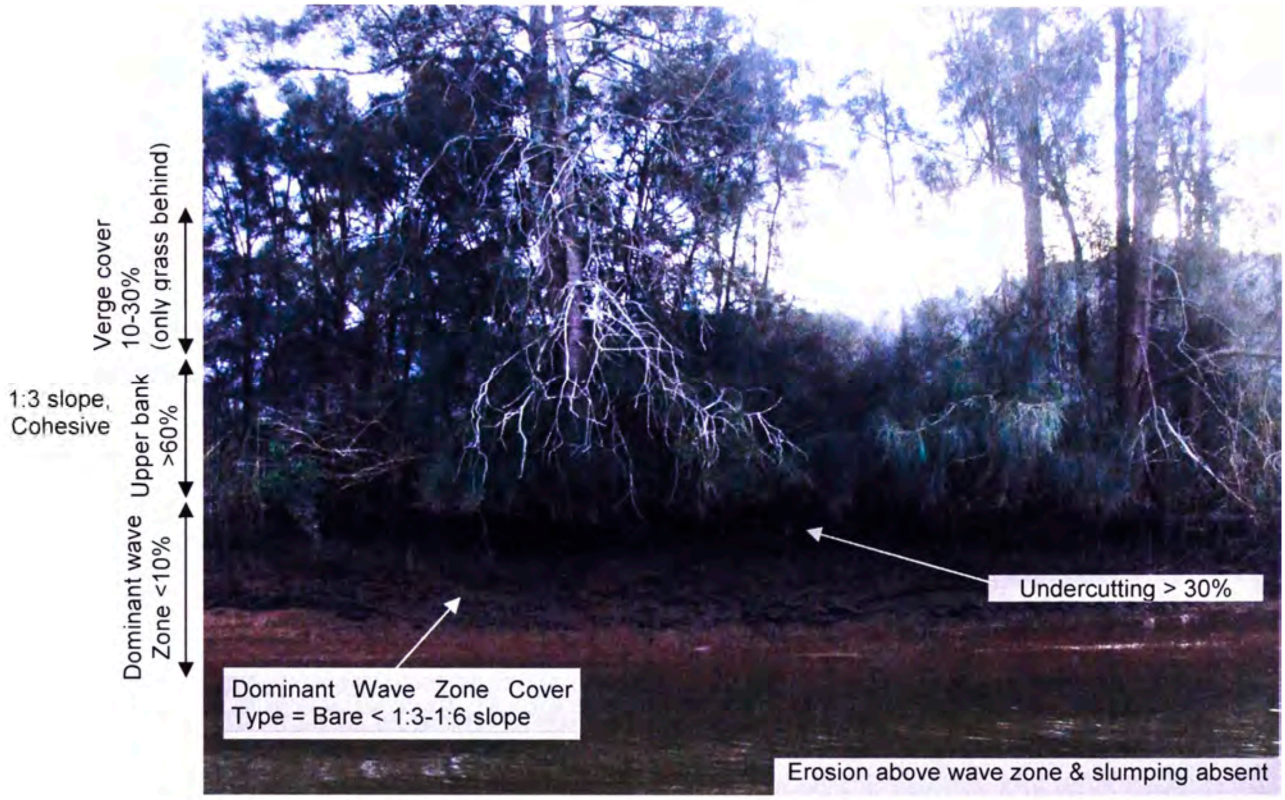


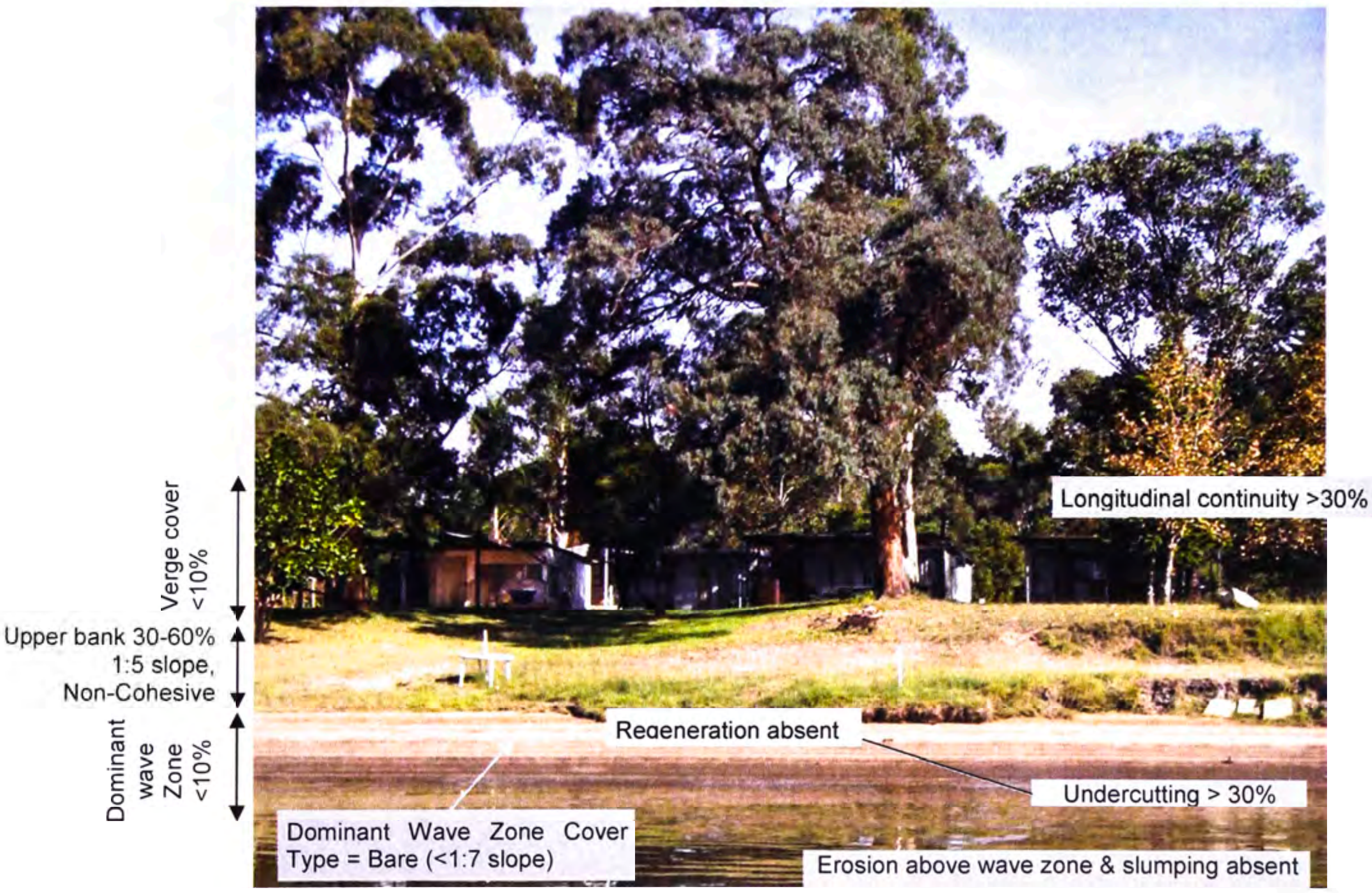
Moderately Resistant





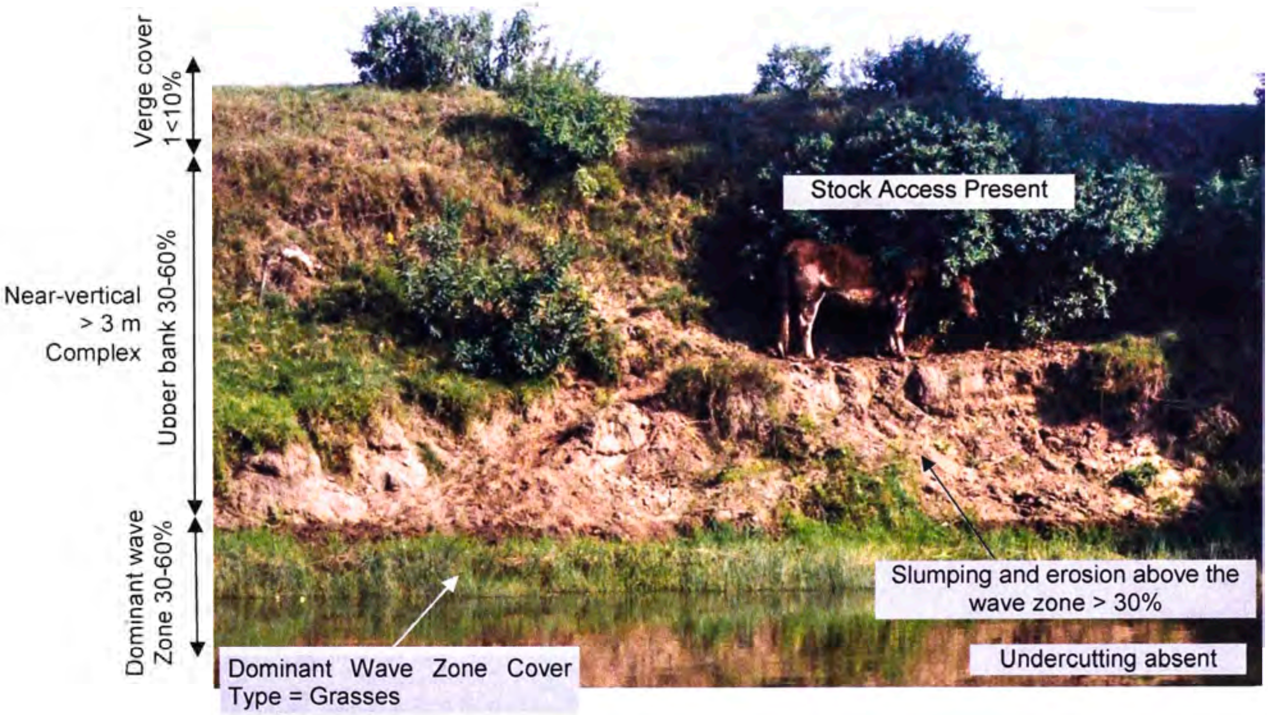
Mildly Resistant

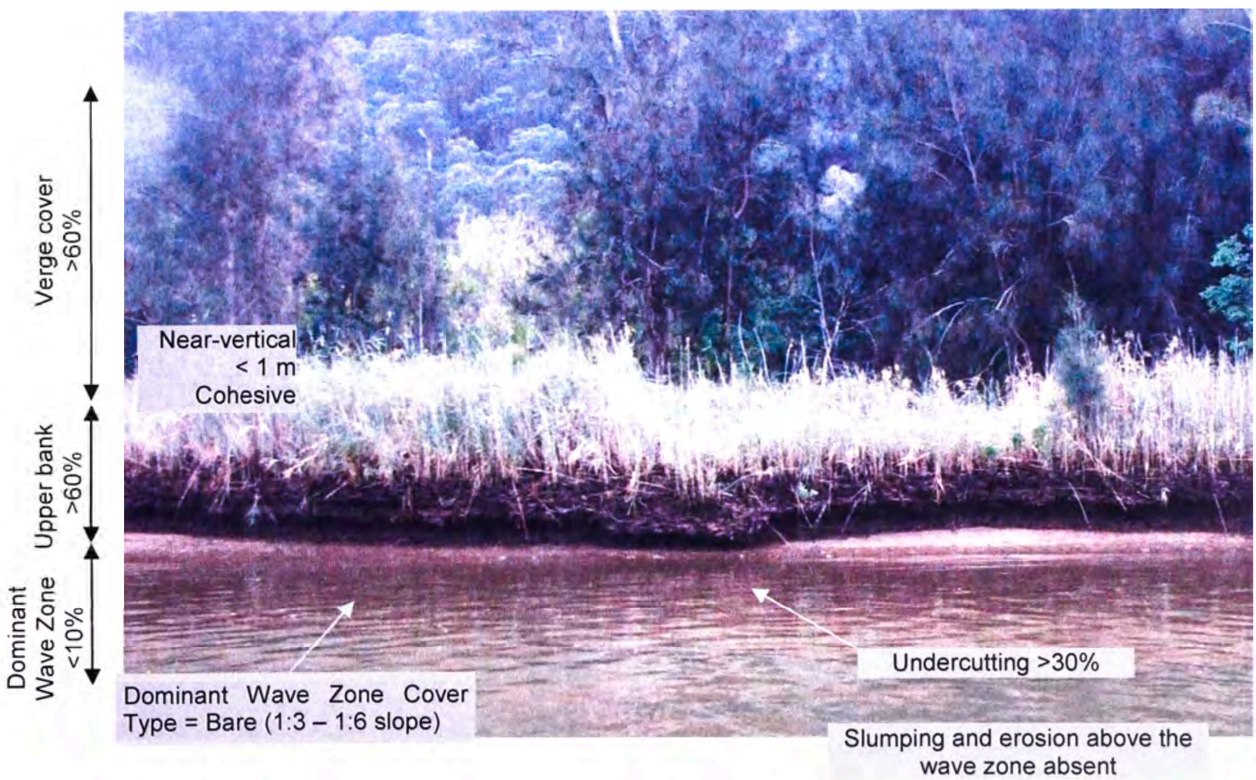




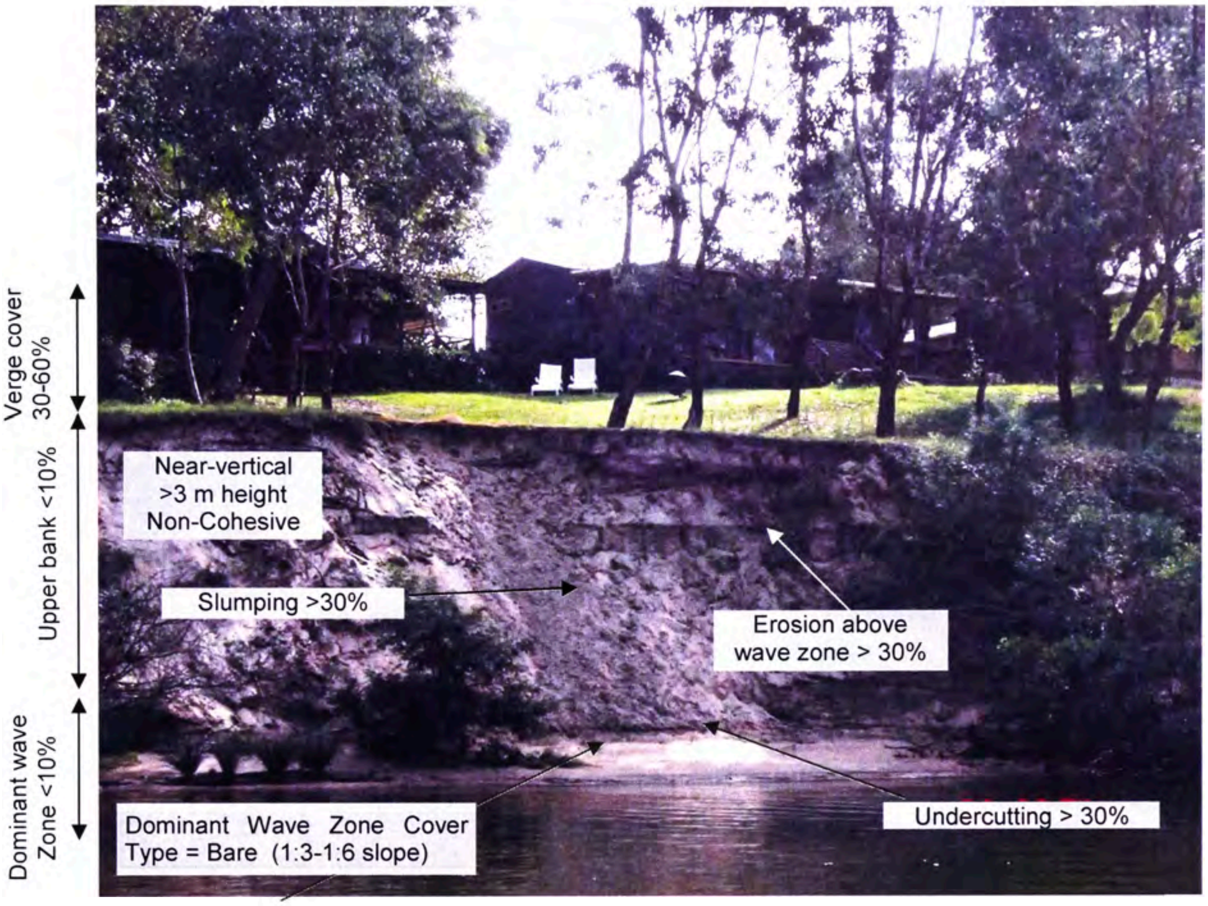
Mildly Resistant

Moderately Erosive

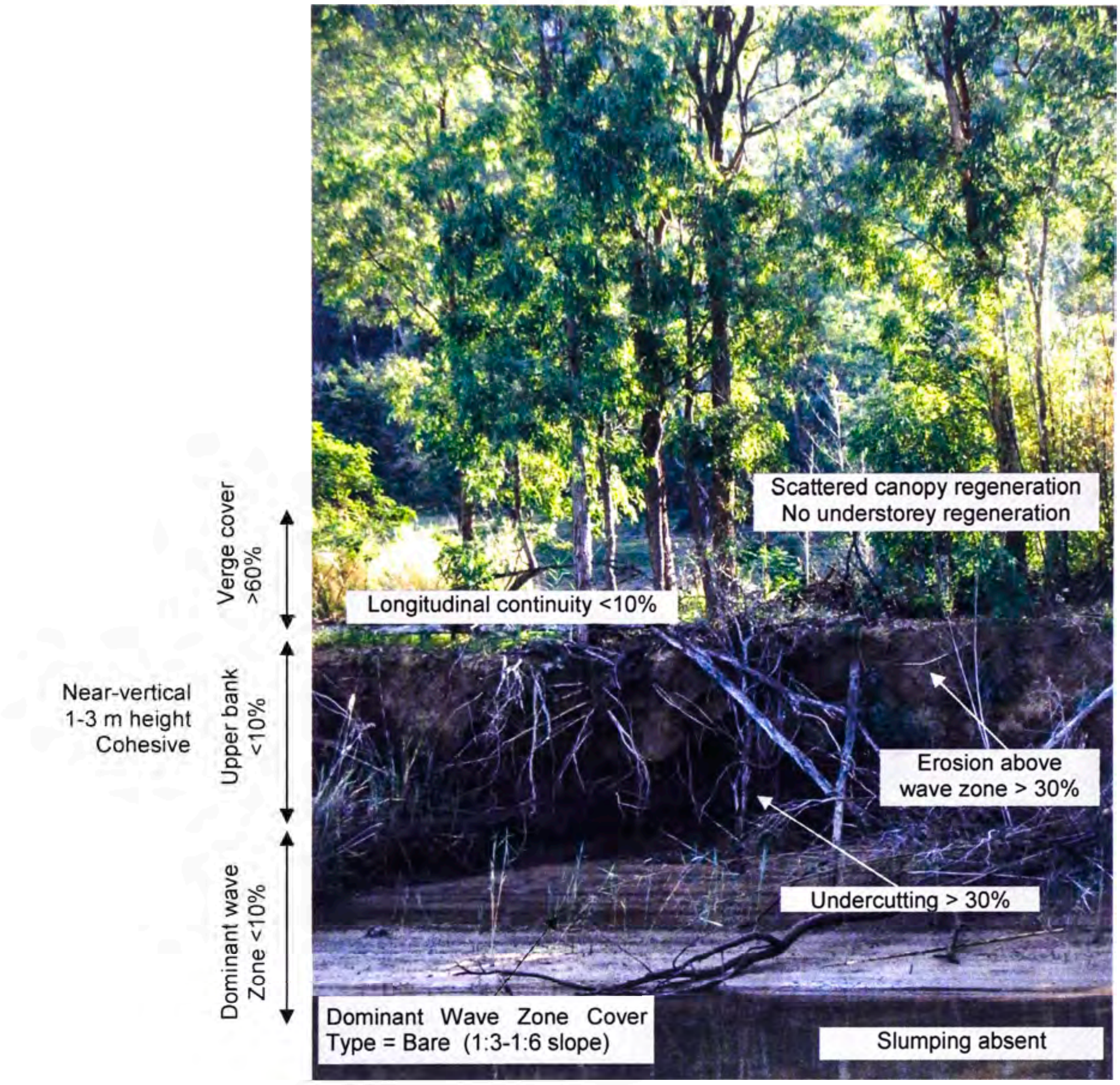




Highly Erosive



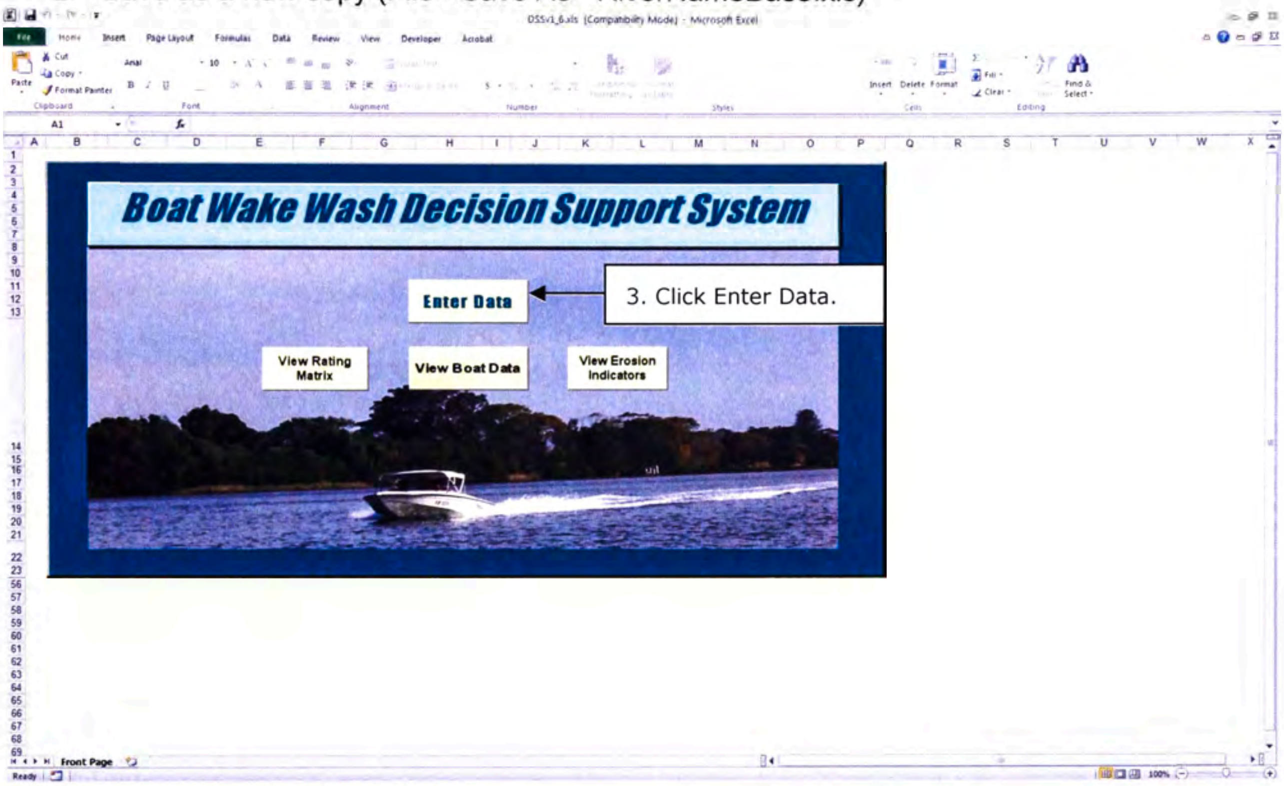
Highly Erosive

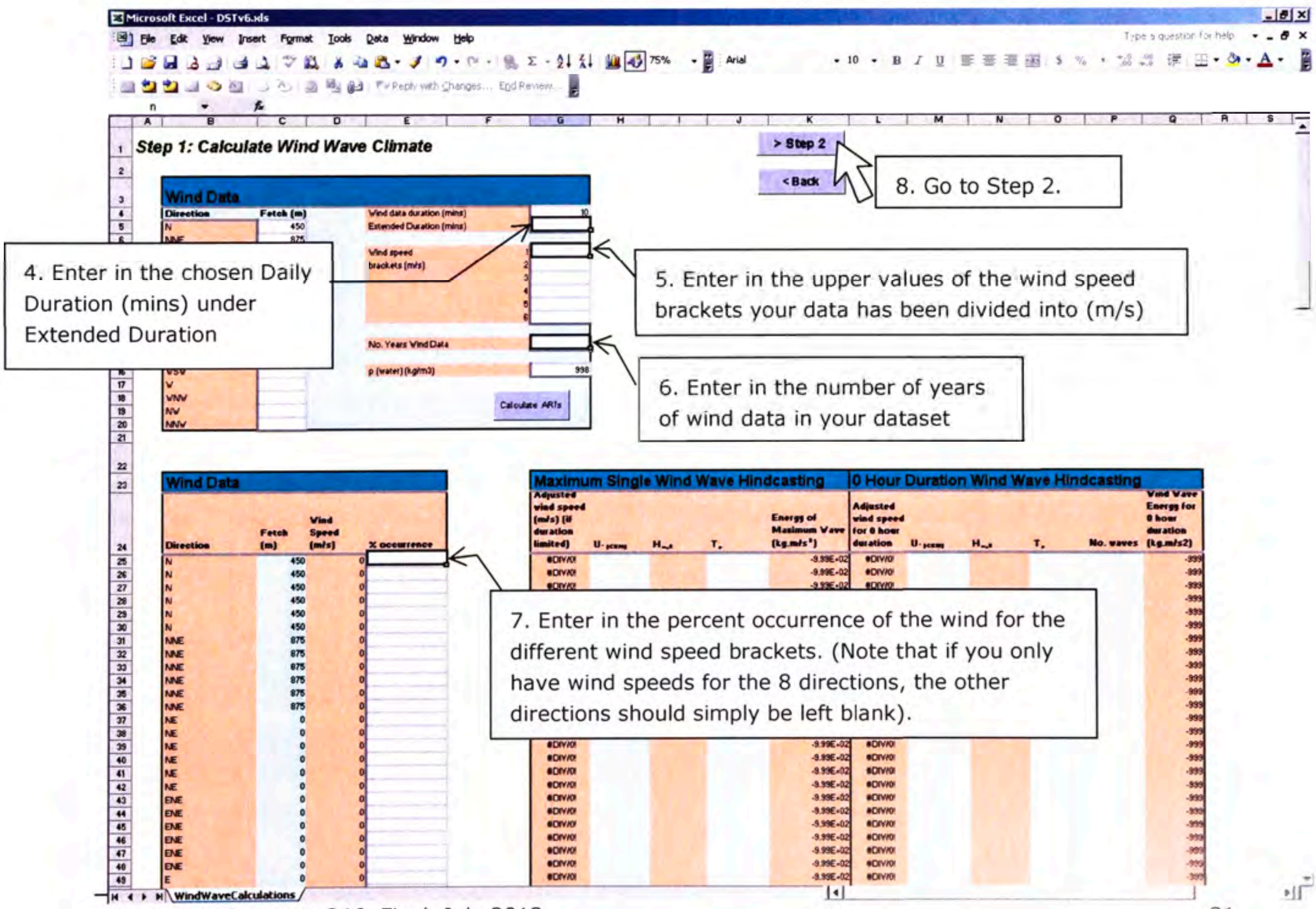


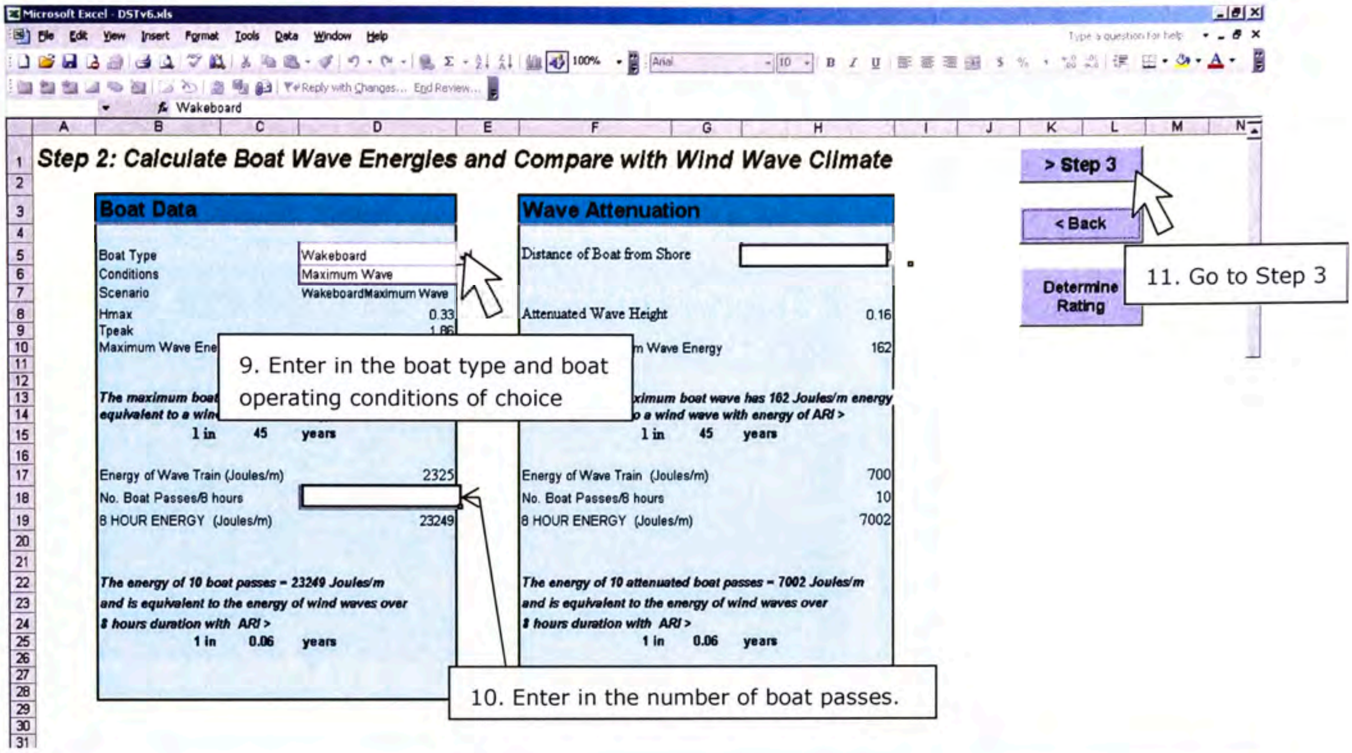
APPENDIX C: Using the Interactive Spreadsheet

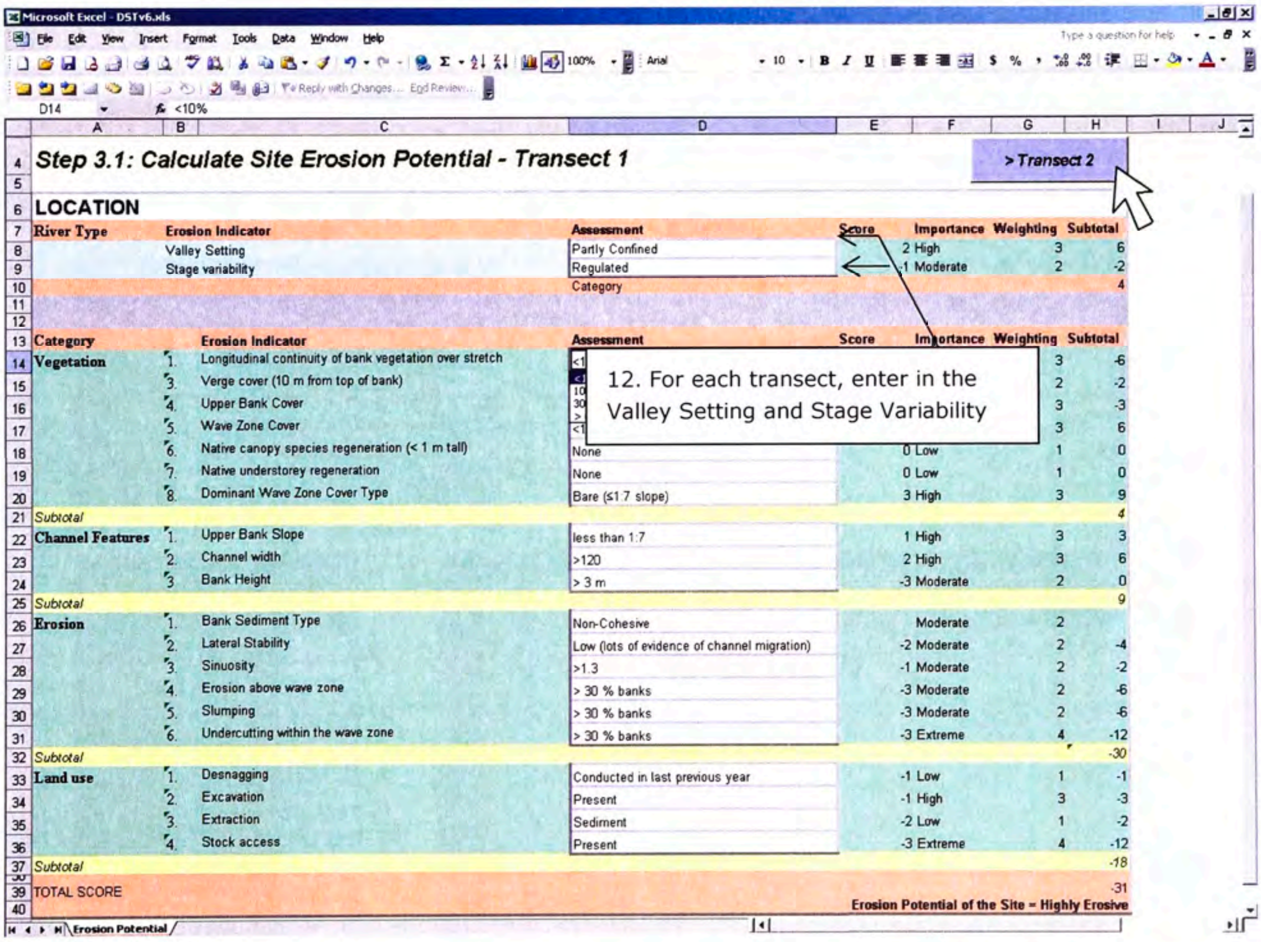
Creating a Base Template File for your Reach.

1. Open the DST.xls spreadsheet
2. Save as a new copy (File> Save As> RiverNameBase.xls)





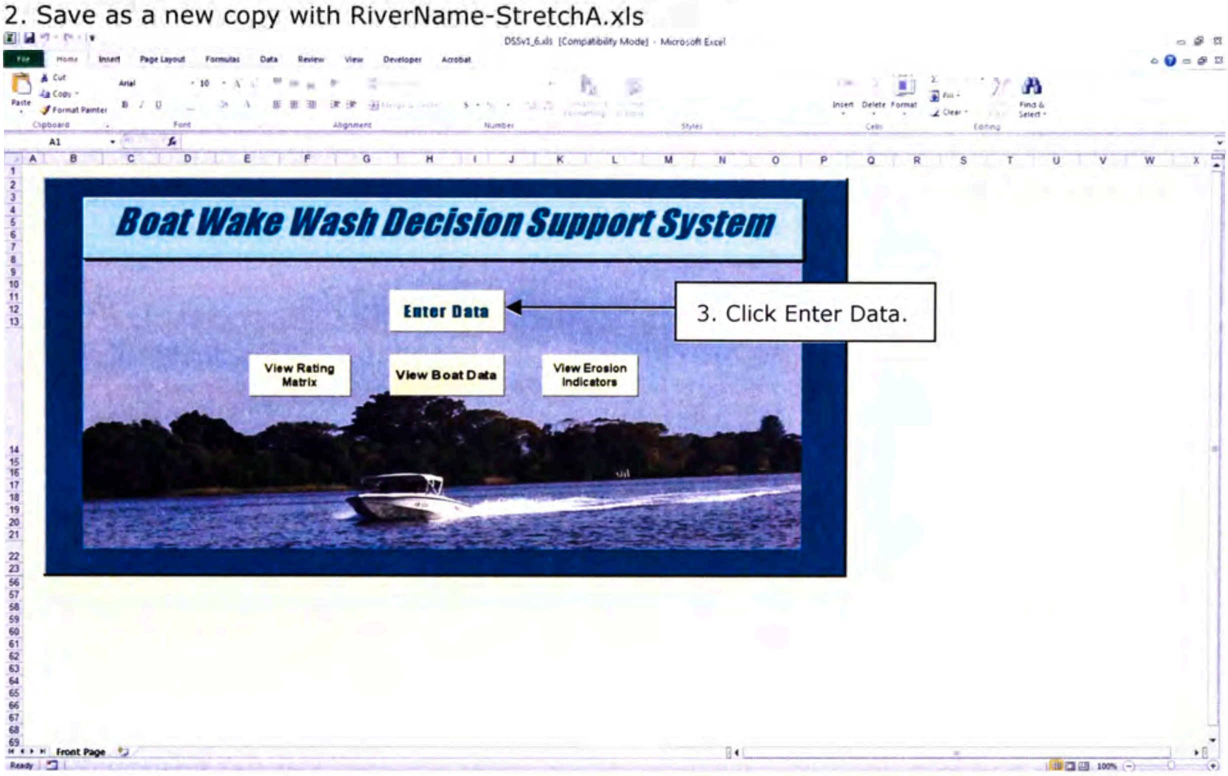


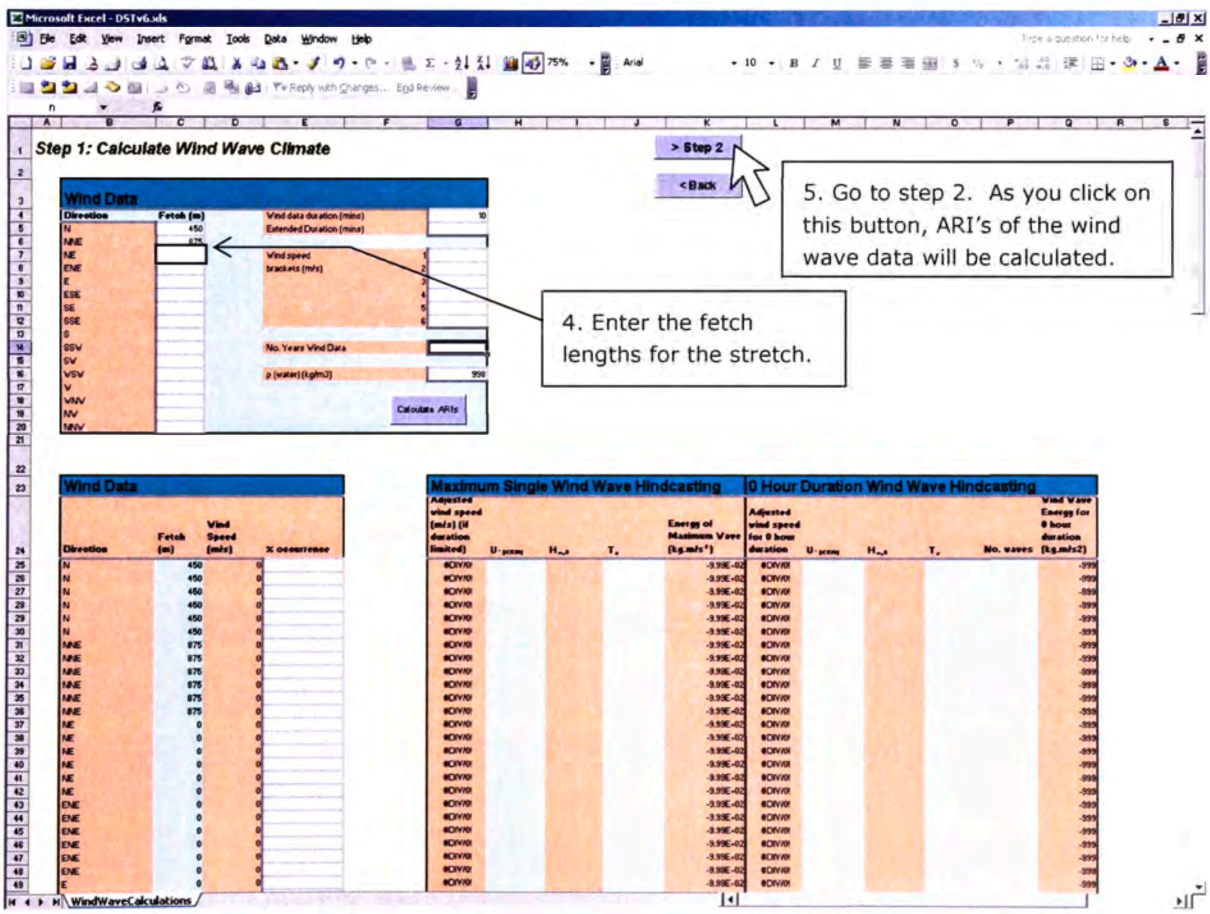


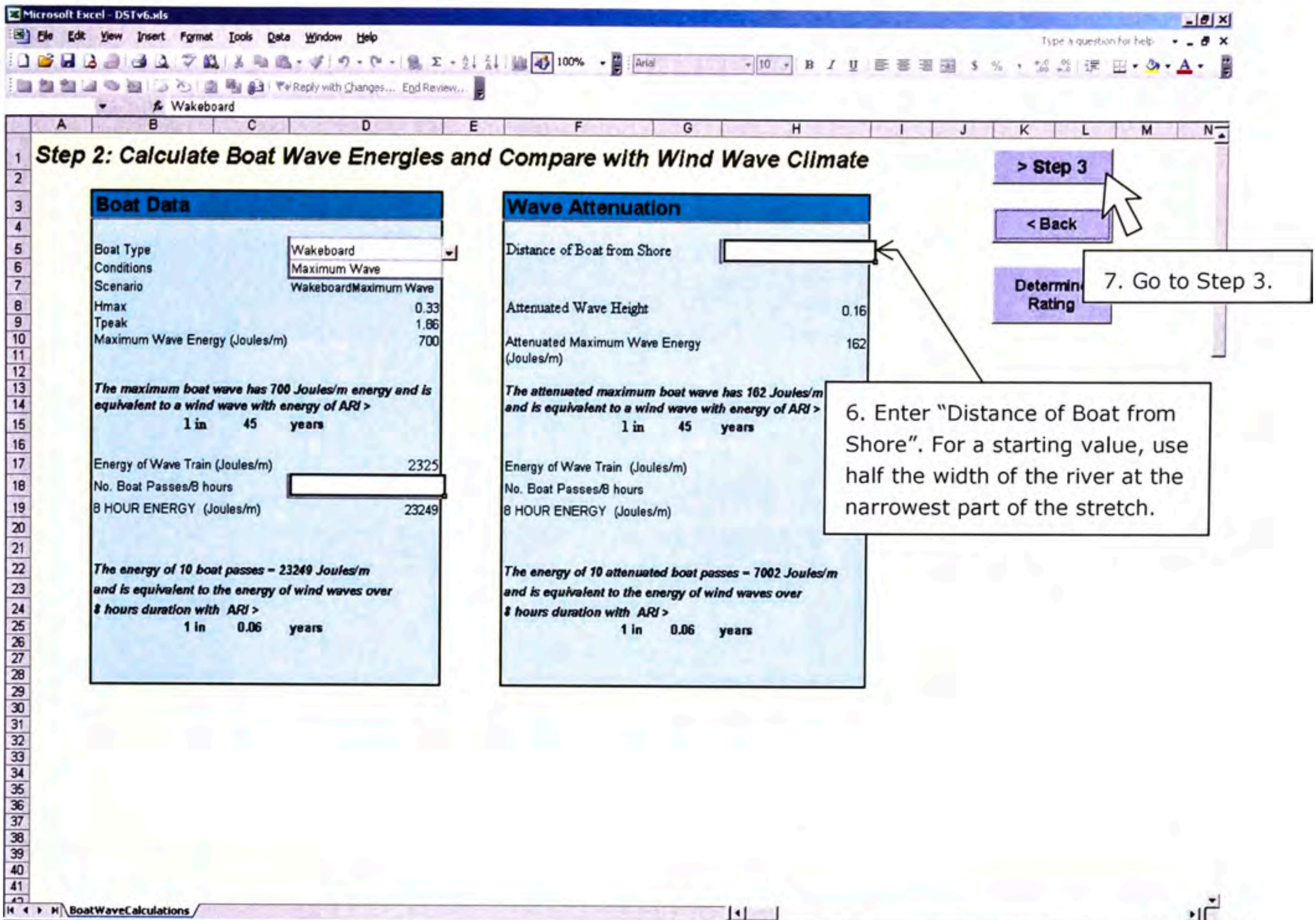
13. Save the file.

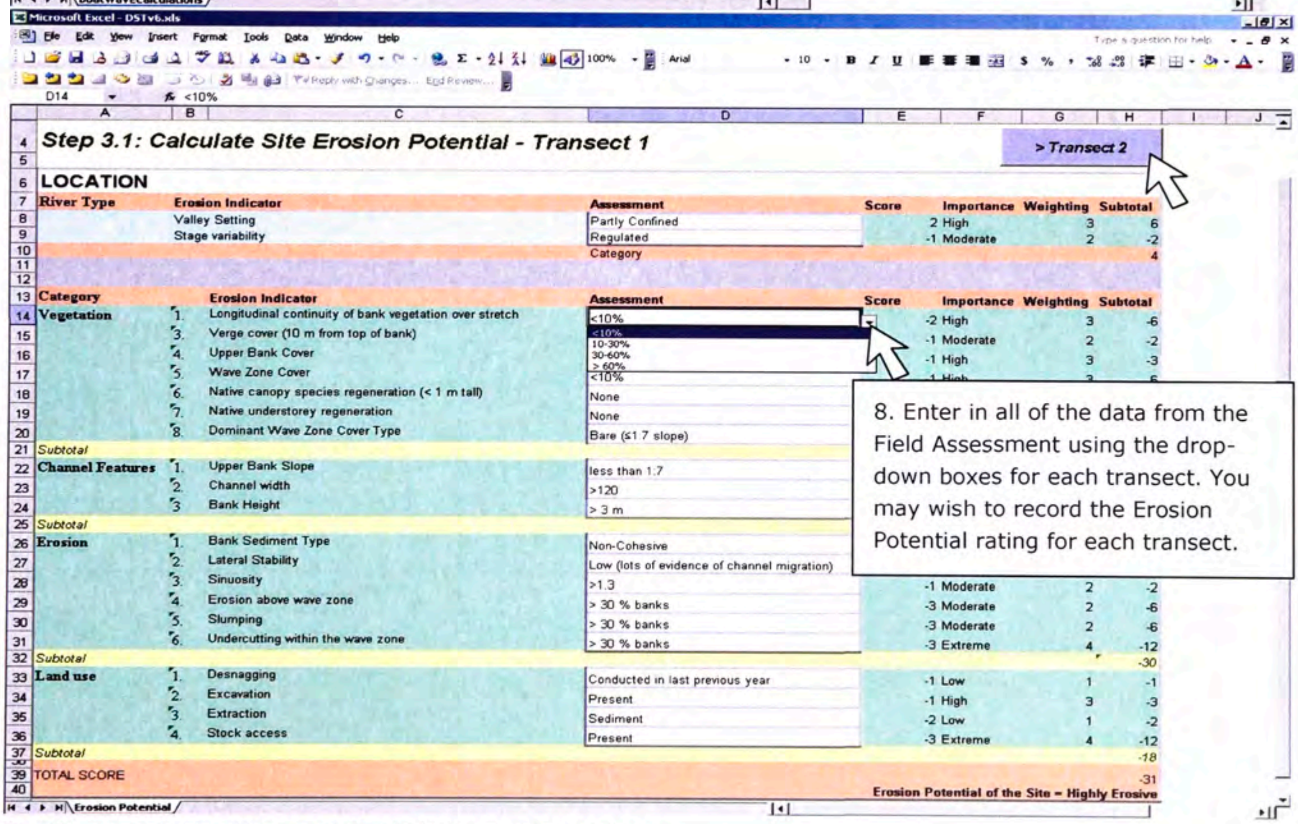
Steps to Completing a Reach Analysis

1. Open the RiverNameBase.xls spreadsheet
2. Save as a new copy with RiverName-StretchA.xls

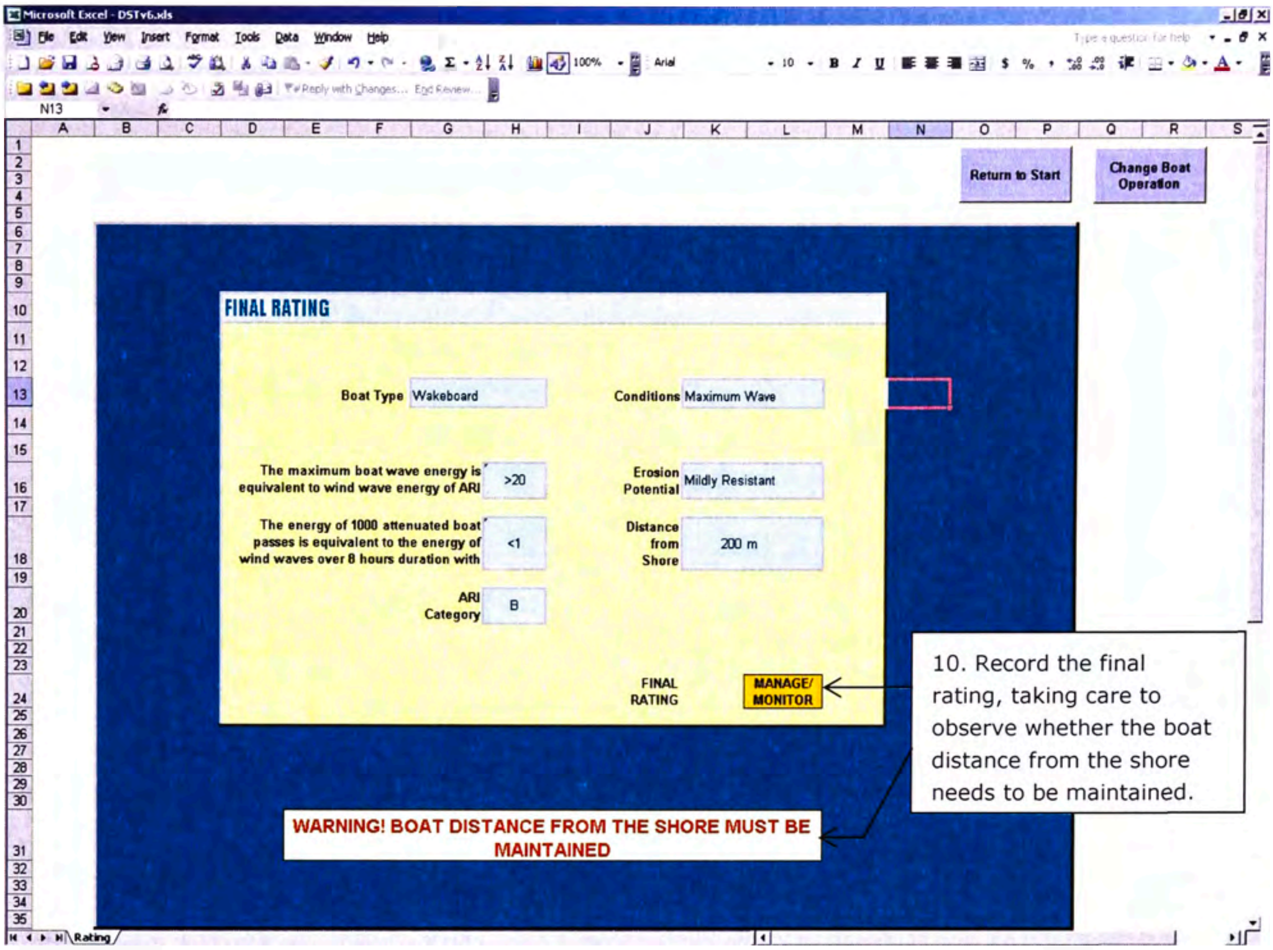








9. After rating the Transect 3, click Determine Rating.



10. Record the final rating, taking care to observe whether the boat distance from the shore needs to be maintained.

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