iRIC Software

Changing River Science

EvaTRiP

Solver Manual

Version 3.0 For iRIC ver.3.0

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Contents

I. Overview

1. About EvaTRiP

EvaTRiP (Evaluation Tools for River environmental Planning) is a solver developed by Aqua Restoration Research Center PWRI (National Research and Development Agency Public Works Research Institute, Japan) and Prof. Masahiko Sekine (Yamaguchi University). The purpose of the solver is to provide outcome of existing research or our research for river environmental planning.

This tools can evaluate followings
- the necessity of river bank protection
- the region of critical grain size
- the region of terrestrial plant growth
- the region of fish habitat

So you can use it for river environment research and river planning etc.

We will continue to develop and maintenance for being this tools more useful. Please use it and let us know when you have questions or comments.

June , 2018.

2. Features of EvaTRiP

1) Necessity of River bank protection can be evaluated.

2) Growth and destruction conditions of terrestrial plant can be evaluated.

3) Sediment particle size which moves under the flow conditions can be evaluated.

4) Fish Habitat Suitable Index can be evaluated.

Notice: This document describes about “Evatrip v3.0” solver and it is **ONLY FOR iRIC ver. 3.0**. If you have to run the EvaTRiP on iRIC ver. 2.3, please download an old version of “EvaTRiP v2.1” on iRIC Home Page.

II. Basic Setting

Basic conditions for EvaTRiP Evaluation Tools can be set here. These setting are used in every evaluation tools.

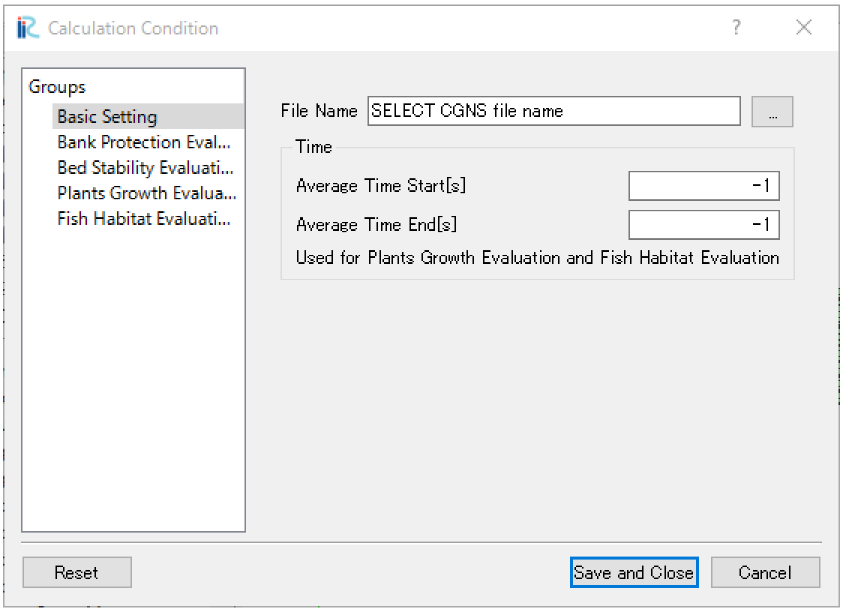


Figure II-1 Basic setting display capture

Table II-1 Description of Basic settings

<table>
<tr><th>#</th><th>Name</th><th>Description</th><th>Notice</th></tr>
<tr><td>1</td><td>File name</td><td>Select a file of the cgns format which includes flow solution</td><td></td></tr>
<tr><td>2</td><td>Average Time Start[s]</td><td rowspan="2">Specify the time range to calculate average depth and average velocity used for Plants Growth Evaluation and Fish Habitat Evaluation</td><td></td></tr>
<tr><td>3</td><td>Average Time End[s]</td><td></td></tr>
</table>

III. Evaluation of necessity of Bank Protection

Necessity of bank protection can be evaluated by this tool.

1. Evaluation Method

Depth averaged velocity $V\,(\mathrm{m/s})$ is used for the evaluation of the necessity of bank protection.

$V \le V_1$	Unnecessary
$V_1 \le V \le V_2$	Necessary Level 1
$V_2 \le V$	Necessary Level 2

Here $V_1\,(\mathrm{m/s})$ and $V_2\,(\mathrm{m/s})$ should be set considering the channel condition. Depth Averaged velocity $V\,(\mathrm{m/s})$ can be obtained by

$$V = \sqrt{{v_x}^2 + {v_y}^2} \tag{1}$$

$v_x\,(\mathrm{m/s})$ and $v_y\,(\mathrm{m/s})$ are the velocity which are calculated in flow analysis.

2. Input Calculation Condition

Following conditions should be set for the bank protection evaluation.

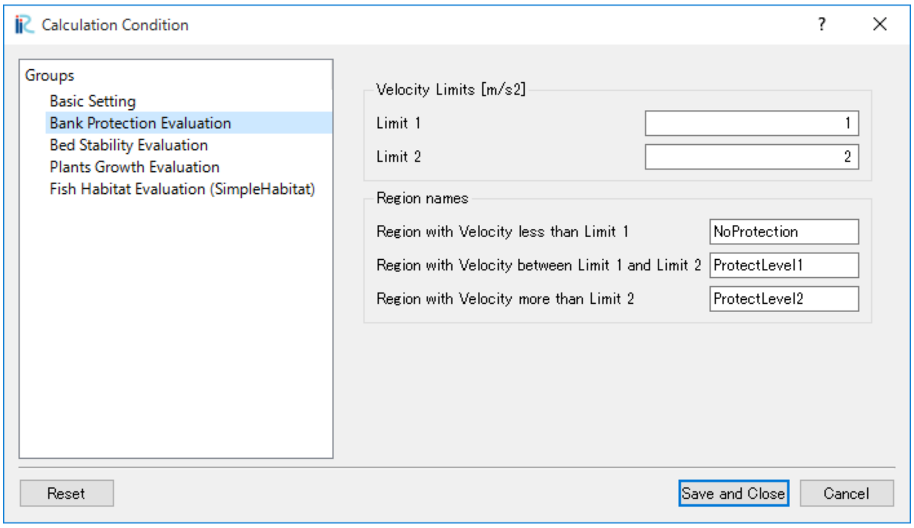


Figure III-1 Window image of bank protection evaluation settings

Table III-1 Description of input conditions

#	Name	Description	Notice
1	Limit1	Specify the threshold velocity: V1 to Evaluate the necessity of bank protection.	
2	Limit2	Specify the threshold velocity: V2 to Evaluate the necessity of bank protection.	
3	Region with Velocity less than Limit1	Specify the name for the region where the velocity is less than limit1.	
4	Region with Velocity between Limit1 and Limit2	Specify the name for the region where the velocity is between limit1 and limit2.	
5	Region with Velocity more than Limit2	Specify the name for the region where the velocity is more than limit2.	

3. Result

This tool outputs 3 regions whose name is given as the evaluation conditions. For example, if executed with the default names, The variables below are output.

Table III-2　Description of output variables

Name	Description
pro_NoProtection	1 for region where velocity is less than Limit1, 0 otherwise.
pro_ProtectLevel1	1 for region where velocity is between Limit1 and Limit2, 0 otherwise.
pro_ProtectLevel2	1 for region where velocity is more than Limit2, 0 otherwise.
MAX_pro_NoProtection	1 for region where maximum velocity is less than Limit1, 0 otherwise.
MAX_pro_ProtectLevel1	1 for region where maximum velocity is between Limit1 and Limit2, 0 otherwise.
MAX_pro_ProtectLevel2	1 for region where maximum velocity is more than Limit2, 0 otherwise.

For variables with “MAX” prefix, value is output at the last step only, and value 0 is output as dummy data for other time steps.

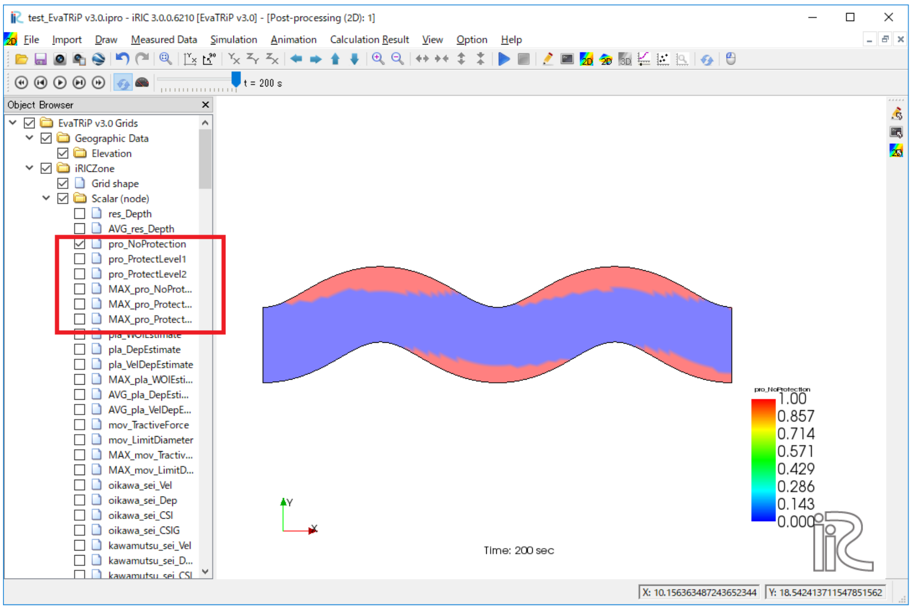


Figure III-2 Window image of bank protection evaluation result

IV. Evaluation of critical grain size

Shear stress and grain size under the critical shear stress can be evaluated by this tool.

1. Evaluation method

Shear stress $\tau_0(\mathrm{N \cdot m})$ can be estimated by

$$\tau_0 = \rho g R I_e \tag{2}$$

Here, $\rho(\mathrm{kg})$ is water density, $g(\mathrm{m/s^2})$ is gravity acceleration, I_e is energy slope. And $R(\mathrm{m})$ is treated as $h(\mathrm{m})$ in this estimation. Also, I_e is obtained by

$$I_e = \frac{n^2 V^2}{h^{4/3}} = \frac{n^2 \sqrt{v_x^2 + v_y^2}}{h^{4/3}} \tag{3}$$

$v_x(\mathrm{m/s})$ and $v_y(\mathrm{m/s})$ are the depth averaged velocity which are provided by flow analysis. And $n(\mathrm{s/m^{1/3}})$ is manning roughness coefficient which is used in flow analysis. Critical grain size $d_{\max}(\mathrm{cm})$ is obtained by comparing the shear velocity which estimated from shear stress, and the critical shear stress which is obtained by Iwagaki's Formula.

$$\begin{array}{lll}
u_*^2 = 10000 \times \dfrac{\tau_0}{\rho} (\mathrm{cm^2/s^2}) & & \\
0.303 \le u_*^2 / 80.9 & \rightarrow & d_{\max} = u_*^2 / 80.9(\mathrm{cm}) \\
0.118 \le \left(u_*^2 / 134.6\right)^{22/31} & \rightarrow & d_{\max} = \left(u_*^2 / 134.6\right)^{22/31} (\mathrm{cm}) \\
0.0565 \le u_*^2 / 55.0 & \rightarrow & d_{\max} = u_*^2 / 55.0(\mathrm{cm}) \\
0.0065 \le \left(u_*^2 / 8.41\right)^{32/11} & \rightarrow & d_{\max} = \left(u_*^2 / 8.41\right)^{32/11} (\mathrm{cm}) \\
\mathit{else} & \rightarrow & d_{\max} = u_*^2 / 226(\mathrm{cm})
\end{array} \tag{4}$$

2. Input Calculation Condition

Following conditions should be set for the stability bed evaluation.

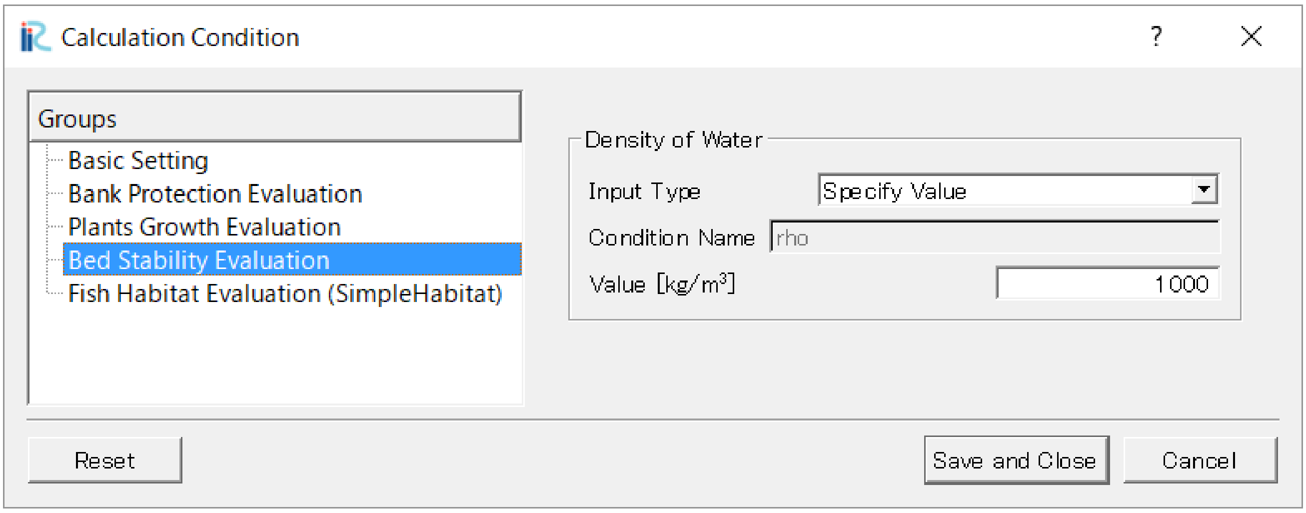


Figure IV-1 Window image of stability bed evaluation settings

Table IV-1 Description of input conditions

#	Name	Description	Etc.
1	Input Type	Select the input type for specifying the water density.. - Load from calculation condition - Specify the value	You do not need to specify this parameter, if you select "Nays2DH(Nays2D)" or "FaSTMECH" at the basic setting.
2	Condition Name	Specify the parameter name when you select "Load from calculation result".	
3	Value[kg/m3]	Specify the water density value when you select "Specify the value".	

3. Result

This tool outputs 4variables as evaluation result.

Table IV-2 Description of output variables

Name	Description
mov_TractiveForce	Shear stress estimated by Eq (2) from velocity.
mov_LimitDiameter	Sediment particle size which is estimated by Eq (4) from velocity.
MAX_mov_TractiveForce	Shear stress estimated by Eq (2) from maximum velocity.
MAX_mov_LimitDiameter	Sediment particle size which is estimated by Eq (4) from maximum velocity.

For variables with “MAX” prefix, value is output at the last step only, and value 0 is output as dummy data for other time steps.

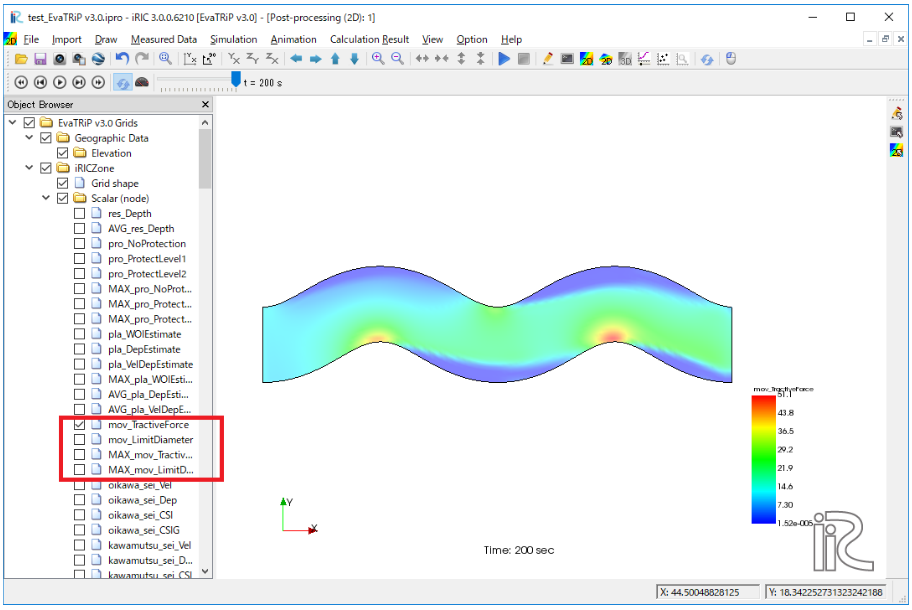


Figure IV-2 Window image of Stability bed evaluation result

V. Evaluation of Terrestrial plant growth

The region where terrestrial plants are destructed by a flood, and the region where terrestrial plants can grow, are able to evaluate by this tool.

1. Evaluation Method

Three kinds of methods to evaluate terrestrial plant growth are implemented in this tool.

(1) Using the duration averaged depth

In this method, the duration averaged depth: (h) is used to evaluate the region where the terrestrial plants grow or not.

$h < 0.2$ (m)	Probability of terrestrial plant growth is very high
$0.2(\mathrm{m}) < h \leq 0.3$ (m)	Probability of terrestrial plant growth is high
$0.3(\mathrm{m}) < h \leq 0.4$ (m)	Probability of terrestrial plant growth is low
0.4 (m) $< h$	Probability of terrestrial plant growth is very low

(2) Using the relationship between depth and velocity

A relationship formula between depth and velocity as follow is used to evaluate terrestrial plant growth in this tool. h_{VD_est} is the threshold depth whether terrestrial plants can grow or not. Terrestrial plant growth can be evaluated comparing $h_{\mathrm{VD\_est}}$ (m) and h (m).

$$h_{\mathrm{VD\_est}} = -0.1 \log(V) + 0.05 \tag{5}$$

$h < h_{VD\_est}$	Terrestrial plants cannot grow
$h > h_{VD\_est}$	Terrestrial plants can grow

(3) Using the Wash-Out Index (*WOI*)

WOI (Wash-Out Index) is used to evaluate terrestrial plant growth in this tool. *WOI* is defined by Eq. (6).

$$WOI = \frac{\tau_{*90}}{\tau_{*c90}} \tag{6}$$

Where τ_{*90} and τ_{*c90} are non-dimensional shear stress and non-dimensional critical shear stress for d_{90} respectively. τ_{*90} and τ_{*c90} are defined by Eqs (7) and (8) respectively.

$$\tau_{*90} = hI_e/sd_{90} \tag{7}$$

$$\frac{\tau_{*c90}}{\tau_{*c50}} = \left[\frac{\log_{10} 19}{\log_{10} 19(d_{90}/d_{50})}\right]^2 \tag{8}$$

Where d_{50} and d_{90} are the grain diameters at which 50 and 90% volume passes through the sieve respectively, s is the specific gravity of river bed material (=1.65), h is the water depth (m), I_e is the energy gradient, τ_{*c50} is the non-dimensional critical shear stress of d_{50} (=0.06).

$WOI < 1$	Terrestrial plants can grow
$WOI \geq 1$	Terrestrial plants cannot grow

2. Input Calculation Condition

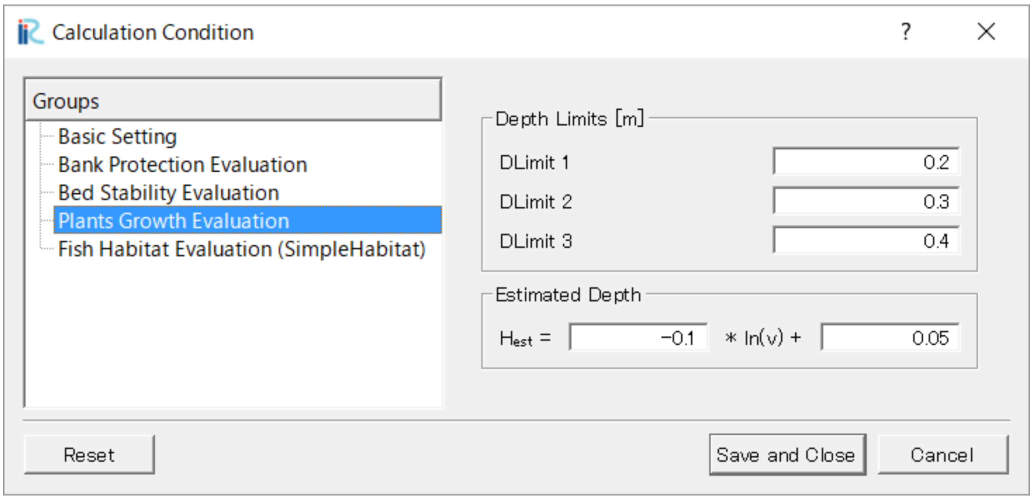


Figure V-1　Window image of terrestrial plant growth evaluation settings 2

Table V-1　Description of input conditions

#	Name	Description	Etc.
1	Limit1	Specify the threshold depth: H1 to evaluate the region of terrestrial plant growth.	
2	Limit2	Specify the threshold depth: H2 to evaluate the region of terrestrial plant growth.	
3	Limit3	Specify the threshold depth: H3 to evaluate the region of terrestrial plant growth.	
4	Estimated Depth	Coefficient for Eq.（5）	

3. Result

This tool outputs 6 variables as evaluation result.

Table V-2 Description of output variables

Name	Description
pla_DepEstimate	Values mean followings, calculated from depth: In case of "3" , *h(m)* is more than 0.4m. In case of "2" , *h(m)* is between 0.3m and 0.4m. In case of "1" , *h(m)* is between 0.3m and 0.3m. In case of "0" , *h(m)* is less than 0.2m.
pla_VelDepEstimate	This parameter means the result of comparing depth *h(m)* and h_{VD_est} which is estimated by Eq(5) from velocity. Values mean followings. $h < h_{VD\_est}$ →0 $h > h_{VD\_est}$ →1
pla_WOIEstimate	This parameter means the result of comparing τ_{*90} and τ_{*c90} which are estimated by Eq (6), calculated from depth and velocity. Values mean followings. WOI < 1 →0 WOI ≥ 1 →1
AVG_pla_DepEstimate	Values mean followings, calculated from average depth: In case of "3" , *h(m)* is more than 0.4m. In case of "2" , *h(m)* is between 0.3m and 0.4m. In case of "1" , *h(m)* is between 0.3m and 0.3m. In case of "0" , *h(m)* is less than 0.2m.
AVG_pla_VelDepEstimate	This parameter means the result of comparing average depth *h(m)* and h_{VD_est} which is estimated by Eq(5) from average velocity. Values mean followings. $h < h_{VD\_est}$ →0 $h > h_{VD\_est}$ →1
MAX_pla_WOIEstimate	This parameter means the result of comparing τ_{*90} and τ_{*c90} which are estimated by Eq (6), calculated from maximum depth and maximum velocity. Values mean followings. WOI < 1 →0 WOI ≥ 1 →1

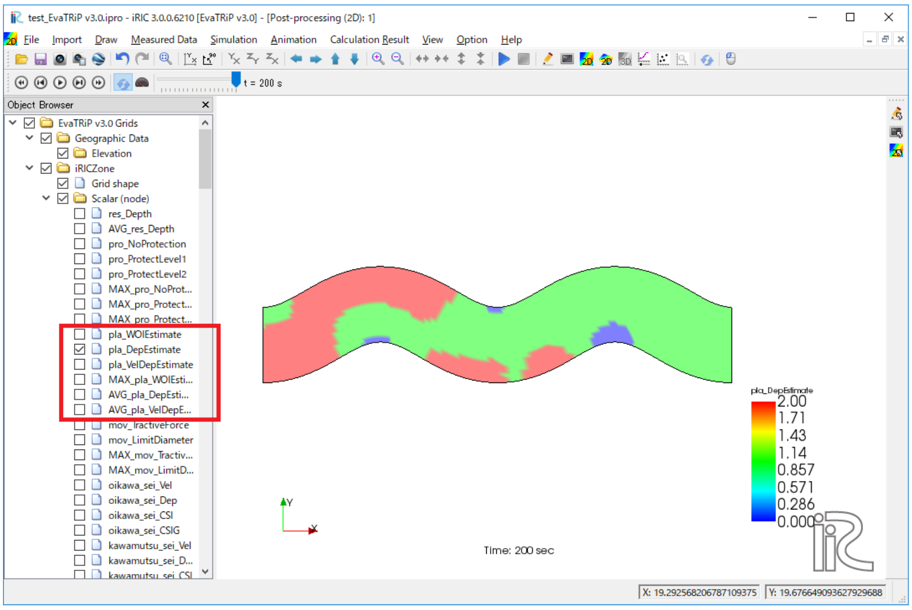


Figure V-2 Window image of terrestrial plant growth evaluation result

VI. Evaluation of Fish habitat

Fish habitat can evaluated by this tool.

1. Evaluation Method

Fish Habitat Suitable Index is defined as following figure. And each points of data are defined as $h(\mathrm{k}), SI(\mathrm{k}), \mathrm{k}=1,\mathrm{nk}$.

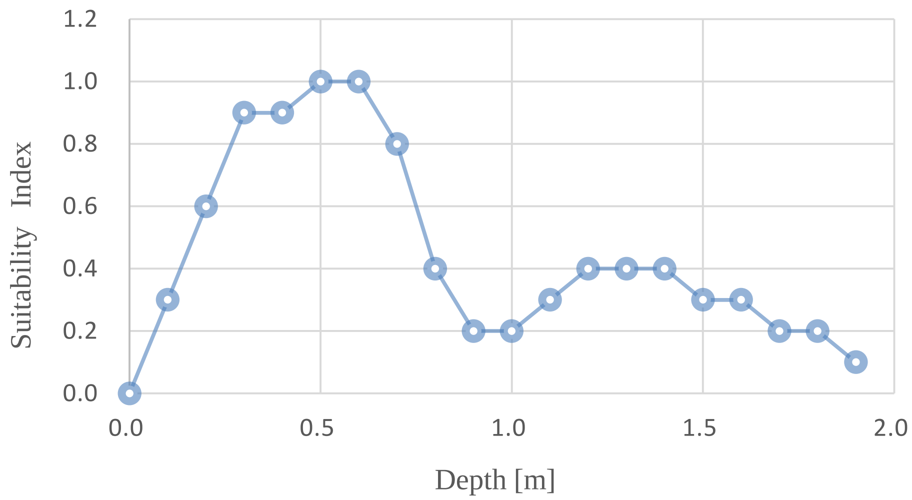


Figure V-1 Habitat Suitable Index

$SI(i,j)$ value at the each i,j node can be estimated as follow

$$f\left[h(\mathrm{k}) \le h_{i,j} \le h(\mathrm{k+1})\right] then$$
$$SI(i,j) = SI(\mathrm{k}) + \frac{SI(\mathrm{k+1}) - \mathrm{SI(k)}}{h(\mathrm{k+1}) - h(\mathrm{k})}\left[h_{i,j} - h(\mathrm{k})\right] \tag{6}$$

Depth[m]

$h_{i,j}$ is a depth value at the i,j point.

2. Input Calculation Condition

Following conditions should be set for the fish habitat evaluation.

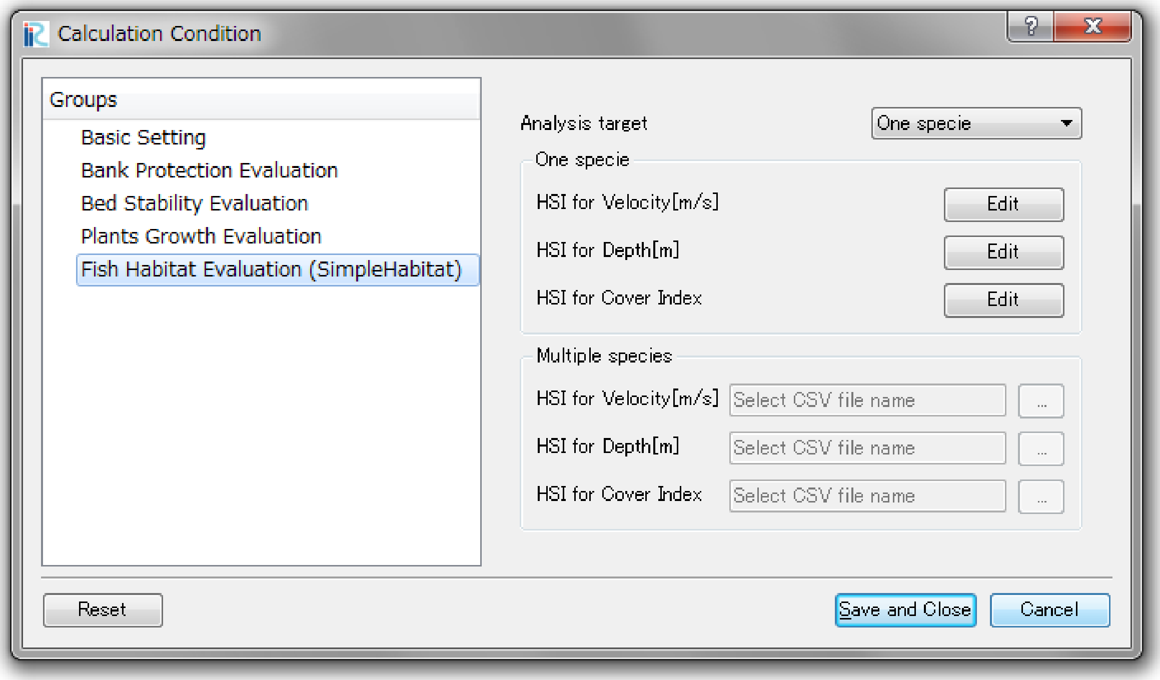


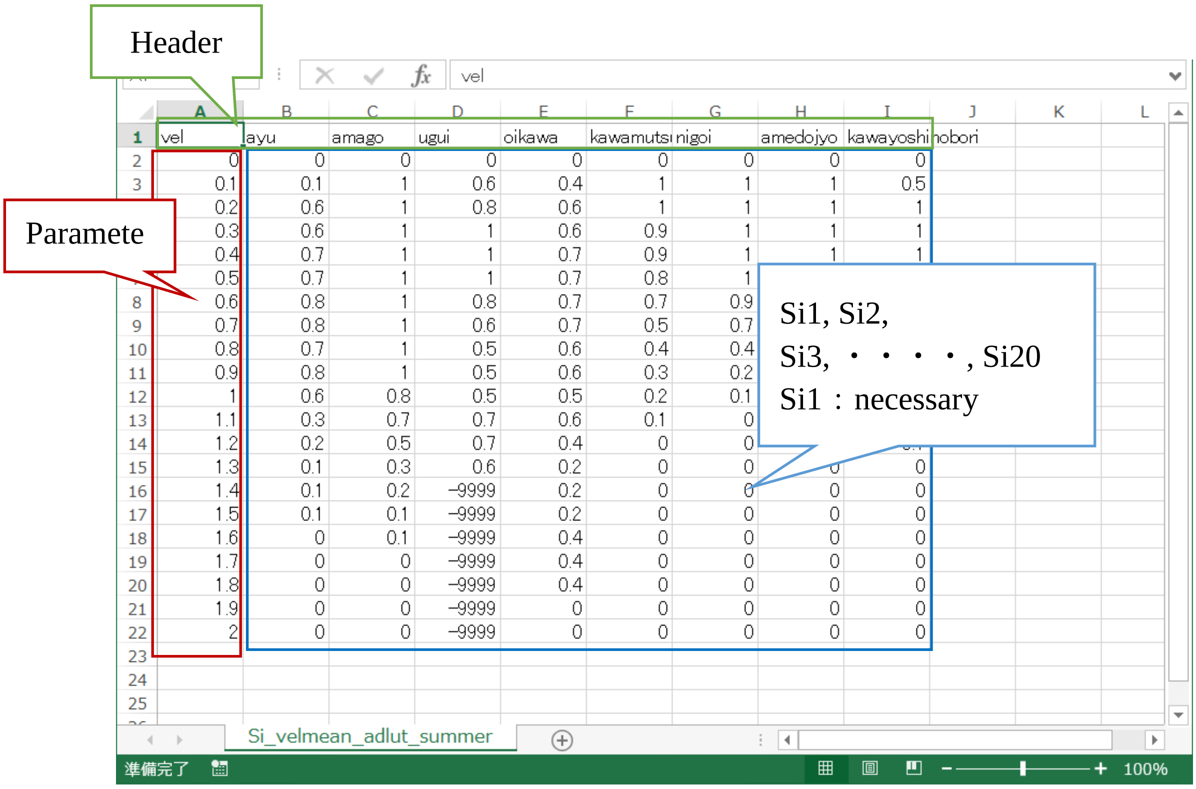
Figure V-2 Window image of fish habitat evaluation settings

Table V-1 Description of input conditions

#	Name	Description	Etc.
1	Analysis Target	Select type number of fishes from below: - One specie - Multiple species	
2	One specie	Specify the evaluation functions for Velocity, Depth, and Cover Index	HIS for Cover Index is used only when users import grid and specify Cover Index
3	SI data file	Specify the file names of CSV files that contains evaluation function s for Velocity, Depth and Cover Index	CSV files are supported. Please see next page

< Input evaluation function >

Evaluation function is constructed by parameter and Si values. Parameter can be the value of depth or velocity. Si value can set 20 kinds as maximum. Each value should be set corresponding to each parameters(i.e. depth or velocity). It is necessary to set at least one Si. But it is arbitrary to set second value. Blank or Minus value have to set when you do not have an appropriate value for Si corresponding to the parameter. Header values are used in calculation result output.



	A	B	C	D	E	F	G	H	I	J
1	vel	ayu	amago	ugui	oikawa	kawamutsu	nigoi	amedojyo	kawayoshi	nobori
2	0	0	0	0	0	0	0	0	0	
3	0.1	0.1	1	0.6	0.4	1	1	1	0.5	
4	0.2	0.6	1	0.8	0.6	1	1	1	1	
5	0.3	0.6	1	1	0.6	0.9	1	1	1	
6	0.4	0.7	1	1	0.7	0.9	1	1	1	
7	0.5	0.7	1	1	0.7	0.8	1	[illegible]	[illegible]	
8	0.6	0.8	1	0.8	0.7	0.7	0.9	[illegible]	[illegible]	
9	0.7	0.8	1	0.6	0.7	0.5	0.7	[illegible]	[illegible]	
10	0.8	0.7	1	0.5	0.6	0.4	0.4	[illegible]	[illegible]	
11	0.9	0.8	1	0.5	0.6	0.3	0.2	[illegible]	[illegible]	
12	1	0.6	0.8	0.5	0.5	0.2	0.1	[illegible]	[illegible]	
13	1.1	0.3	0.7	0.7	0.6	0.1	0	[illegible]	[illegible]	
14	1.2	0.2	0.5	0.7	0.4	0	0	[illegible]	[illegible]	
15	1.3	0.1	0.3	0.6	0.2	0	0	[illegible]	0	
16	1.4	0.1	0.2	-9999	0.2	0	0	0	0	
17	1.5	0.1	0.1	-9999	0.2	0	0	0	0	
18	1.6	0	0.1	-9999	0.4	0	0	0	0	
19	1.7	0	0	-9999	0.4	0	0	0	0	
20	1.8	0	0	-9999	0.4	0	0	0	0	
21	1.9	0	0	-9999	0	0	0	0	0	
22	2	0	0	-9999	0	0	0	0	0	

Figure V-3 Data format for the evaluation function

<Input Velocity, Depth and Cover Index >

For Velocity and Depth, Calculation result values in the CGNS file that the user specified in “Basic Setting” tab are used. For inputting Cover Index, follow the following procedure:

- In the pre-processor, import grid from the CGNS file that the user specified in “Basic Setting” tab.
- Edit Grid attribute “Cover Index” using pre-processor. You can edit Cover Index value of grid nodes by selecting grid nodes, or you can add polygons of “Cover Index” in “Geographic data”, and map it to grids. Please refer to iRIC GUI manual for detail.

3. Result

This tool outputs following variables as evaluation result.

Table V-2 Description of output variables

Name	Description
(fish species)_Vel	Output SI values calculated from velocity values
(fish species)_Dep	Output SI values calculated from depth values
(fish species)_Cov	Output SI values calculated from Cover Index values. This value is output only when user imported grid in Pre-processor.
(fish species)_CSI	Output hsi_Vel * hsi_Dep* hsi_Cov. When hsi_Cov is not output the value is hsi_Vel * hsi_Depth.
(fish species)_CSIG	Output third root of hsi_CSI. When hsi_Cov is not given by users, hsi_Cov has 1 and the CSIG value is third root of hsi_CSI.
AVG_(fish species)_Vel	Output SI values calculated from average velocity values
AVG_(fish species)_Dep	Output SI values calculated from average depth values
AVG_(fish species)_Cov	Output SI values calculated from Cover Index values. This value is output only when user imported grid in Pre-processor.
AVG_(fish species)_CSI	Output AVG_hsi_Vel * AVG_hsi_Dep* hsi_Cov. When hsi_Cov is not output the value is AVG_hsi_Vel * AVG_hsi_Depth.
AVG_(fish species)_CSIG	Output third root of AVG_hsi_CSI. When hsi_Cov is not given by users, hsi_Cov has 1 and the CSIG value is third root of AVG_hsi_CSI.

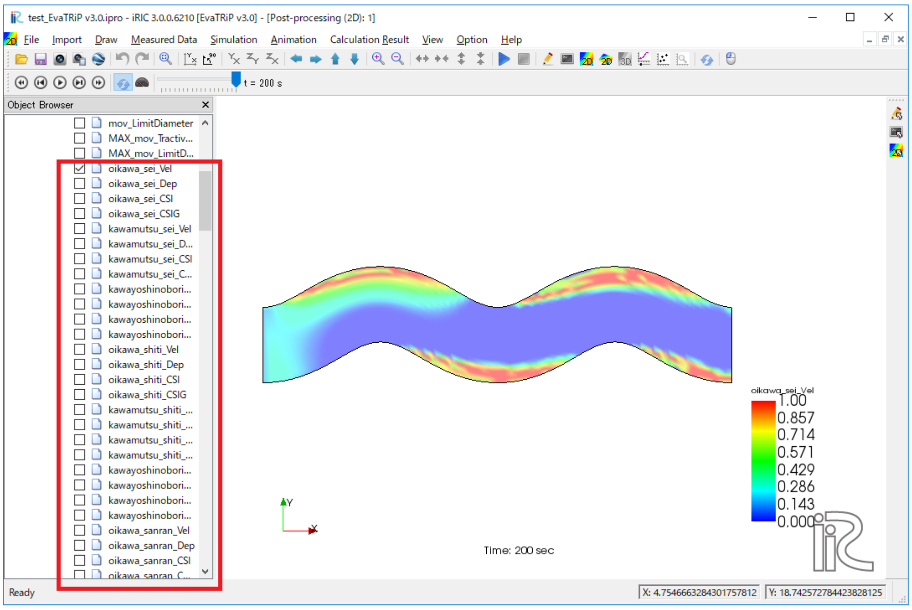


Figure V-4 Window image of Fish habitat evaluation result

VII. To User

- Please indicate that using the iRIC software, if you publish a paper with the results using the iRIC software.

- The datasets provided at the Web site are sample data. Therefore you can use it for a test computation.

- Let us know your suggestions, comments and concerns at **http://i-ric.org.**

iRIC Software

EvaTRiP Solver Manual

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