iRIC Software

Changing River Science

DHABSIM Solver Manual

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This manual is applicable for DHABSIM version 1.0.1 and 1.1.x. Screen shots in this manual are mainly taken from version 1.0.1 on iRIC v2.3. New functions for version 1.1.x are explained using screen shots of version 1.1.0 on iRIC v3.

I. Overview

I.1 About DHABSIM

DHABSIM (Diversity based HABitat SIMulation) is developed by Masahiko Sekine Dr. Eng. Professor of Yamaguchi University. "DHABSIM" is an easy-to-use two-dimensional habitat calculator. The purpose of development is to provide outcome of existing fish habitat researches for river environmental planning as simple as possible. It can calculate habitat condition of mid to small scale river without using HSI for specific fish species. It shows a habitat distribution map by using geometry, velocity and depth exported by other flow calculation solvers. DHABSIM is based on the research supported by JSPS (24560666).

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.

I.2 Features of DHABSIM

This tool can calculate Eco-Environmental Diversity index (EED) by using geometry, velocity and depth exported by other flow calculation solvers.

・Score range of EED is varied from 0 to 1. If EED score increases by a 0.1 point, a species of fish may increase about one species. And also, If EED score is over 0.8 point, you can conclude that the habitat has good conditions for fish habitat.

・Default fish preference parameters in calculating EED are decided by using HSI of Ayu, Japanese dace, Pale chub, Dark chub, Pike gudgeon, Bitterlings, Crucian carp, Carp, Goby, and so on which are popular in mid to small scale Japanese river. When you evaluate habitation of mixed fish species which size are approximately 50 to 250 mm, you can use the default value.

・DHABSIM essential, another version, makes it possible to alter several elements of file setting more flexible. You can get this version from **https://www.facebook.com/PhabWinJ/** (DHABSIM version 1.1.x allows you to set the grid size of EED calculation manually, which was the most essential benefit of DHABSIM essential.)

・DHABSIM is based on the research supported by JSPS (24560666).

II. Evaluation of fish habitats

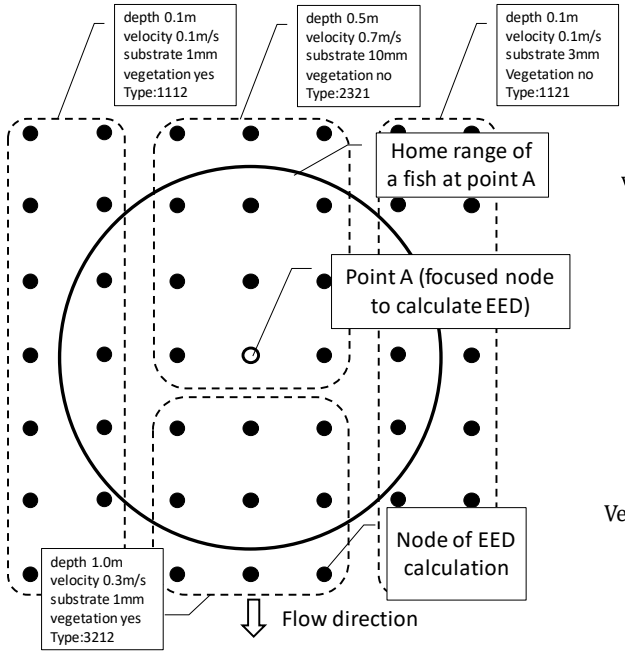
II.1 Eco-Environmental Diversity index; EED

EED, Eco-Environmental Diversity index, is the index used to evaluate fish diversity easily in river. It is calculated based on Simpson's diversity index.

EED of a point (point A) is calculated as shown in figure II-1. The home range of fish is calculated by Minns' formula(Charles K. Minns 1995).

Simply speaking, the environment which has riffle and pool within home range of a fish is highly evaluated by EED. However, EED includes more information of fish preference for different behavioral modes like feeding and resting based on existing HSI researches (see Ito et.al 2016).

Score range of EED is varied from 0 to 1. If EED score increases by 0.1 point, one species of fish may increase in the target river. And also, If EED score is over 0.8 point, you can conclude that the habitat has good conditions for fish habitat.



$$\text{Depth categoly} = \begin{cases} 1: & 0\text{m} \leqq \text{depth} < 0.2\text{m} \\ 2: & 0.2\text{m} \leqq \text{depth} < 0.6\text{m} \\ 3: & 0.6\text{m} \leqq \text{depth} \end{cases}$$

$$\text{velocity category} = \begin{cases} 1: & 0\text{m/s} \leqq \text{velocity} < 0.2\text{m/s} \\ 2: & 0.2\text{m/s} \leqq \text{velocity} < 0.6\text{m/s} \\ 3: & 0.6\text{m/s} \leqq \text{velocity} < 1.0\text{m/s} \end{cases}$$

$$\text{bed category} = \begin{cases} 1: & 0\text{mm} \leqq \text{bed material} < 2\text{mm} \\ & \text{silt to sand} \\ 2: & 2\text{mm} \leqq \text{bed material} < 75\text{mm} \\ & \text{gravel} \\ 3: & 75\text{mm} \leqq \text{bed material} \\ & \text{stone to bed rock} \end{cases}$$

$$\text{Vegetation category} = \begin{cases} 1: & \text{vegetation no} \\ 2: & \text{vegetation yes} \end{cases}$$

$$\ln(A_{hr}) = -2.41 + 1.52 \cdot \ln L$$

A_{hr}: home range [m2], L: fish body length (mm)

$$\text{EED at point A} = 1 - \sum_{i=1}^{S} \left(\frac{n_i}{N}\right)^2 = 1 - \left\{\left(\frac{3}{21}\right)^2 + \left(\frac{9}{21}\right)^2 + \left(\frac{6}{21}\right)^2 + \left(\frac{3}{21}\right)^2\right\} = 0.694$$

S : Number of type within home range, N : Node number in home range, n_i : Node number of Type i

Figure II－1 The calculation method of EED

Default threshold value of each category are decided by using HSI of Ayu, Japanese dace, Pale chub, Dark chub, Pike gudgeon, Bitterlings, Crucian carp, Carp, Goby, and so on which are popular in mid to small scale Japanese river. Default home range of fish is 200m^2 (a circle with a radius of 8m) based on the average size (160mm) of adult Pale chub and Dark chub, which also have average size among all employed fish species (approx. 50 to 250mm). You can use parameters as they are when target fish

seem to have similar size and behavior with above fish species. If their size or behavior are markedly different of the default, you have to change the home range and the threshold value of each category.

II.2 Geographic Data in Object Browser

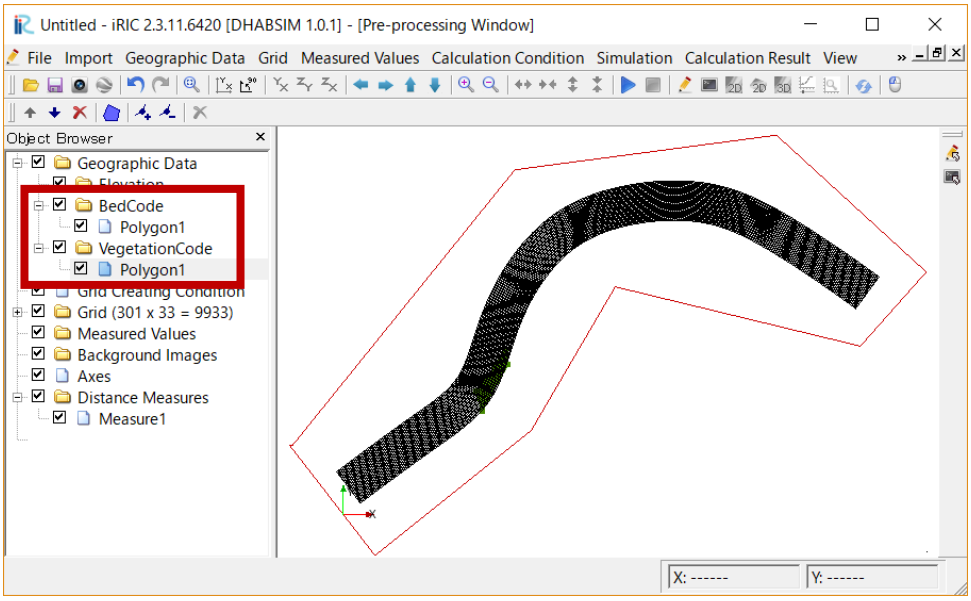


Figure II－2　Object Browser

Table II-1　Description of Geographic Data

#	Name	Description	Etc.
1	BedCode	Bedcode is added by a polygon layer. Values mean followings. "1" is the category range of silt to sand(-2mm) "2" is the category range of sand to gravel (2-75mm) "3" is the category range of stone to bed rock (75mm-)	essential
2	VegetationCode	Vegetation is added by a polygon layer. VegetationCode means followings. “Vegetation” means a group of plants is existing. “No Vegetation” means a group of plants is not existing.	optional (No polygon means “No Vegetation”)

III. Evaluation of home range of fish

III.1 Basic Settings

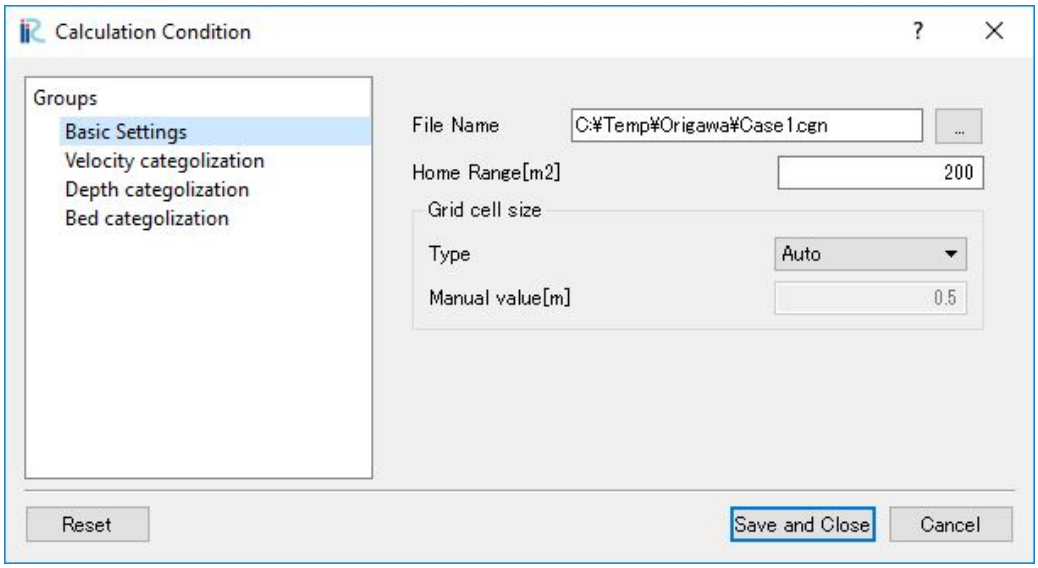


Figure III－1　Window image of basic settings (There is no Grid cell size box for version 1.0.1)

The home range of fish is calculated by Minns' formula(Charles K. Minns 1995).

$$\ln(A_{hr}) = -2.41 + 1.52 \cdot \ln L$$

A_{hr} : home range of fish(m^2)　L : fish length (mm)

The adult fish of Pale club and Dark chub is about 160mm on average, according to several surveys researched in middle to small size rivers in Yamaguchi prefecture in Japan. The default value of home range is set based on this fish length. This value is applicable to mixed fish species of 50 to 250mm (see Ito et.al 2016). If target fish size is markedly bigger than this range, you have to change the home range.

"Grid cell size" is a new function for version 1.1.0. "Grid cell" is not the grid of input cgns file, but it represents a node of EED calculation in Figure II-1. When grid cell size type is "Auto", it is one tenth of home range diameter (= approximately 1.6m for 200m^2 home range.). When you calculate EED for narrow rivers or complicated bed shape rivers, you may use smaller grid cell size manually to make enough number of nodes within the stream. Of course, smaller grid cell size requires longer calculation time.

III.2 Velocity categorization

The habitat suitability category for velocity are able to evaluate by this condition.

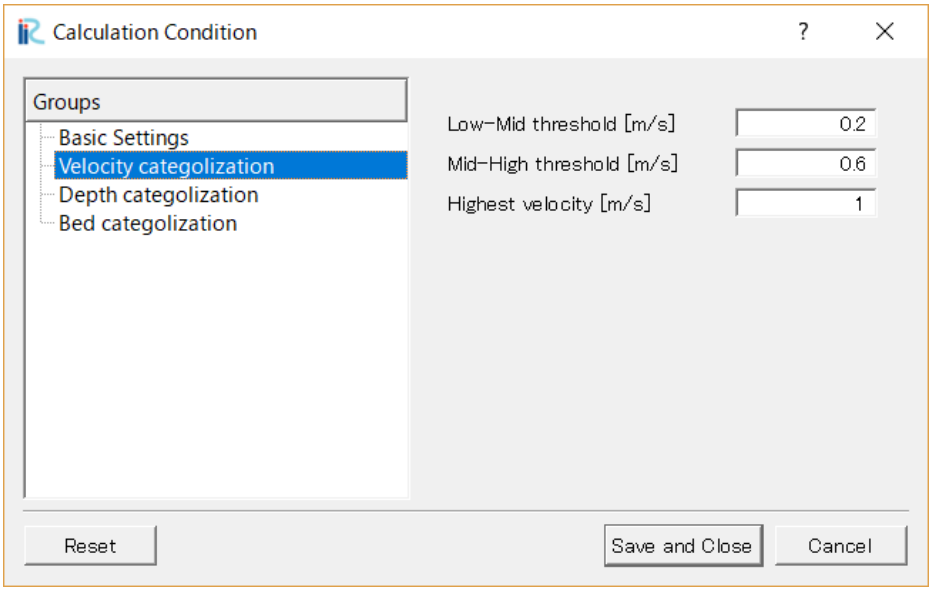


Figure III－2　Window image of Velocity categorization settings

Talbe III-1　Description of input conditions

#	Name	Description	Etc.
1	Low-Mid threshold(m/s)	One of the three categories limited by Highest velocity and divided by Low-Mid and Mid-High thresholds represents the feeding velocity, and another category represents resting velocity for each fish species.	You should change this parameter, if you evaluate the environment that large fish which size greatly exceeds 250 mm are dominant species.
2	Mid-High threshold(m/s)		
3	Highest velocity(m/s)		

III.3 Evaluation of Depth categorization

The habitat suitability category for depth are able to evaluate by this condition.

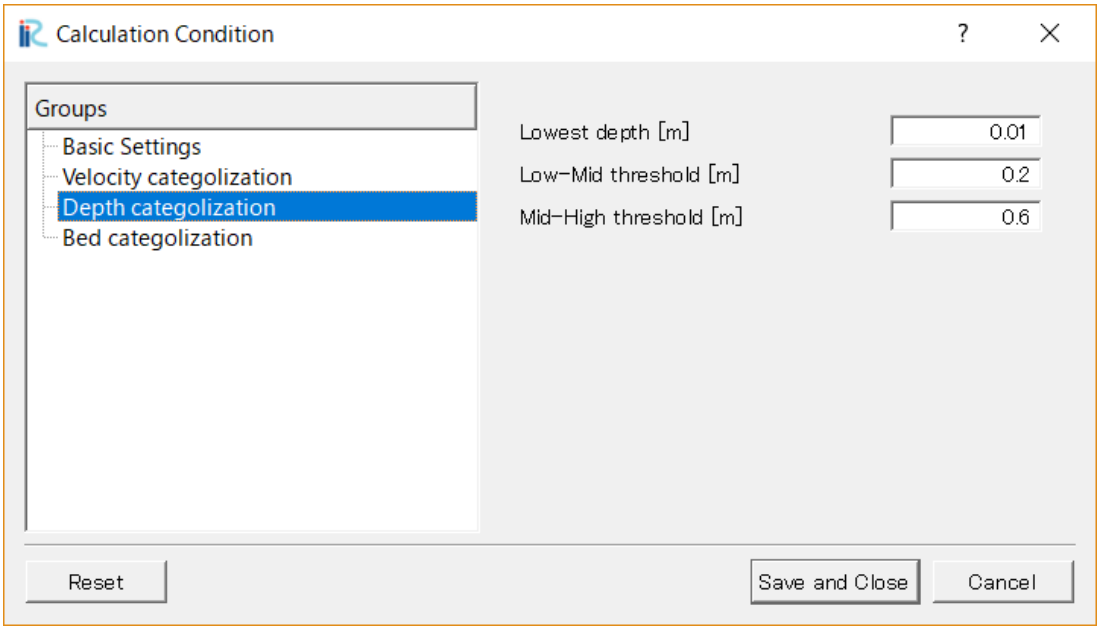


Figure III－2　Window image of Depth categorization settings

Talbe III-2　Description of input conditions

#	Name	Description	Etc.
1	Lowest depth(m)	Specify the threshold depth: The default depth shows the lowest depth for living fish.	You should change this parameter, if you evaluate the environment that large fish which size greatly exceeds 250 mm are dominant species.
2	Low-Mid threshold(m)	One of the three categories divided by these thresholds represents the feeding depth, and another category represents resting depth for each fish species.	
3	Mid-High threshold (m)		

III.4 Evaluation of Bed categorization

The habitat suitability category for fish spawning are able to evaluate by this grain size condition.

$d \leq 2(\mathrm{mm})$	This range shows grain size is silt to sand.
$2(\mathrm{mm}) < d \leq 75(\mathrm{mm})$	This range shows grain size is gravel.
$75(\mathrm{mm}) < d$	This range shows grain size is stone to bed rock.

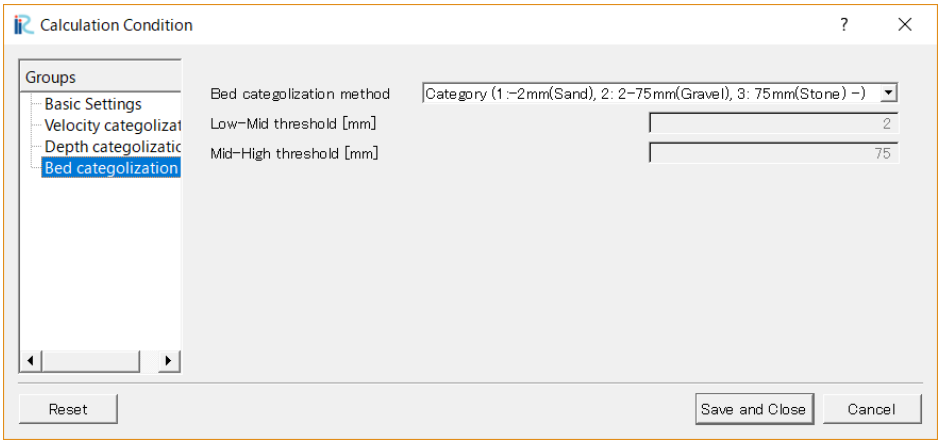


Figure III－4　Window image of Depth categorization settings

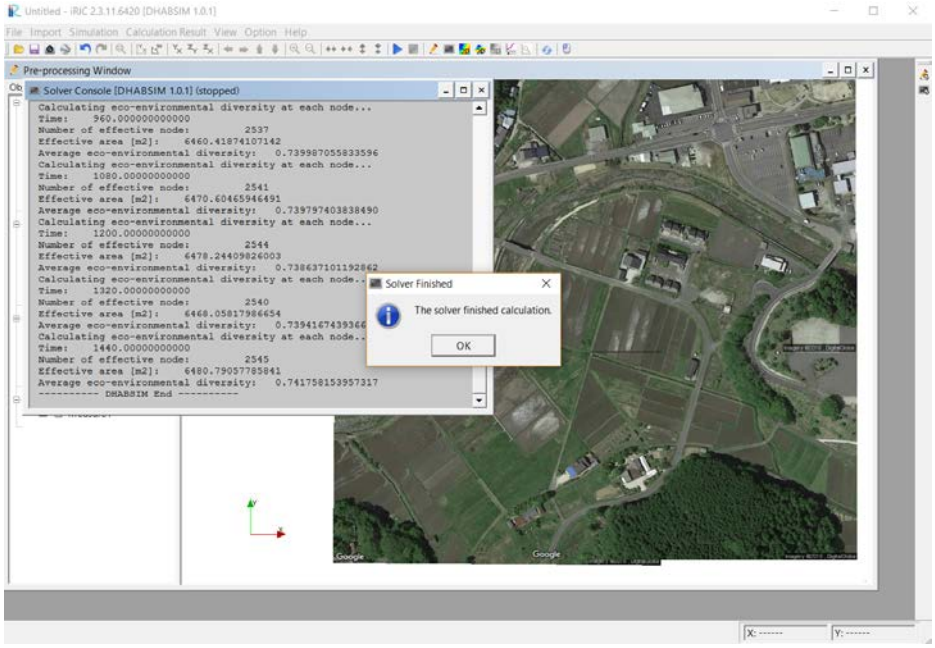
Talbe III-4　Description of input conditions

#	Name	Description	Etc.
1	Low-Mid threshold(mm)	One of the three categories divided by these thresholds represents spawning bed for each fish species.	
2	Mid-High threshold (mm)		

IV. Result

IV.1 Solver console

Talbe IV-1　solver console



Talbe IV -1　Variable types in the solver console

出力変数名	説明
Number of effective node	This variable shows the number of nodes that water is supplied in a time span.
Effective area [m2]	Water area in the calculation region.
Average eco-environmental diversity	Average EED in the water area.

IV.2 Eco-environmental diversity (EED)

This tool outputs EED as evaluation result.

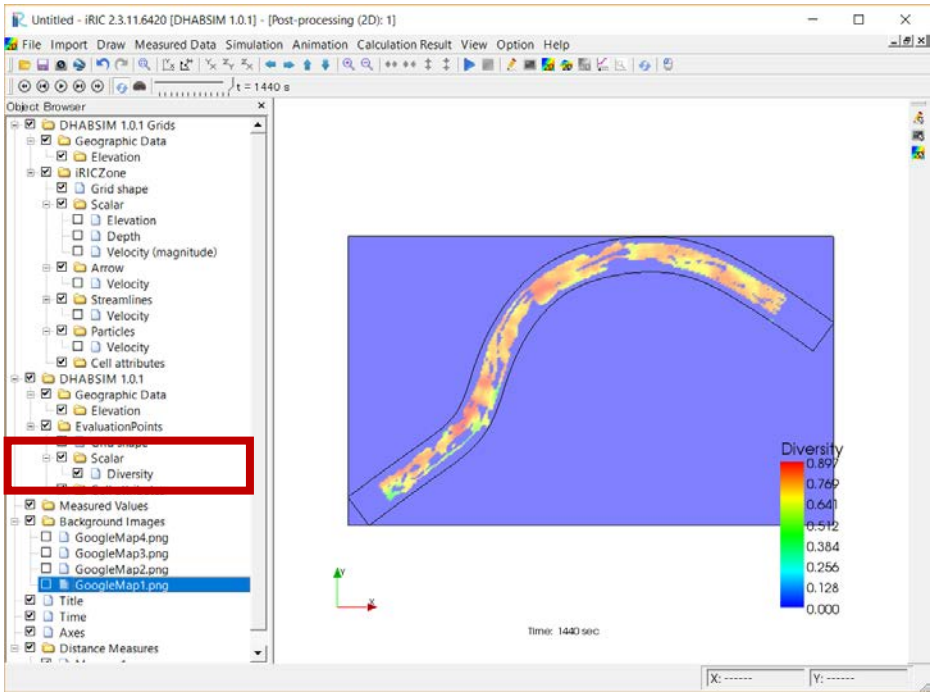


Figure IV－2　Window image of EED result

Table IV-2　Description of output parameters

Name	Description
Diversity	This parameter means the result of EED of each node by Eq(1). Score range of EED is varied from 0 to 1. If EED score increases by 0.1 point, number of species in the target river is expected to increase one. And also, if EED score is over 0.8 point, you can conclude that the habitat has good conditions for fish habitat.

V. References

1）Clair Stalnaker, Berton L. Lamb, Jim Henriksen, Ken Bovee, John Bartholow: The instream flow incremental methodology; A Primer for IFIM, National Ecology Research Center, National Biological Survey, 99pp, 1994.

2）川那部浩哉,宮地伝三郎,森主一,原田英司,水原洋城,大串竜一:遡上アユの生態 とくに淵におけるアユの生活様式について,京都大学理学部, 生理・生態学研究業績第 79 号,37pp, 1956.3.

3）Hirofumi Ito, Masahiko Sekine, Yoshiki Nakamura, Ariyo Kanno, Koichi Yamamoto, Takaya Higuchi, Tsuyoshi Imai: A proposal of eco-environmental diversity index (EED) for fish habitat evaluation in small-scale rivers, Doboku Gakkai Ronbunshuu G, 72(1), 1-11, 2016. (in Japanese)

4）Charles K. Minns: Allometry of home range size in lake and river fishes, Canadian journal of fisheries and aquatic sciences, 52, 1499-1508 1995.

5）多自然川づくり研究会：多自然川づくりポイントブックIII,中小河川に関する河道計画の技術基準；解説,財団法人リバーフロント整備センター,pp.180,2011.10.

VI. 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

DHABSIM Solver Manual

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