

*Full Length Research Paper*

## Valuing the recreational benefits of wetland biodiversity

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**Loss in biodiversity of wetlands is a worldwide problem in maintaining the ecosystem of the earth. Thus, environmental valuation studies have performed benefit calculations to show the value of biodiversity. Here, few studies use the revealed preference methods due to the lack of data on wetland biodiversity. To solve this issue, this paper presented an approach to create data using expert judgment. Data on total numbers of representative species (TNRS) which were selected by experts was employed as indicators of the biodiversity of wetlands, and data on wetland area (AREA) were also employed for analysis. Data on travel behaviors to eleven Ramsar wetlands in Hokkaido, Japan were applied in the repeated discrete choice model. The results indicate that the approach of this paper would be applicable for estimating the relationship between individual behaviors and the biodiversity of wetlands. Next, benefit calculations were performed under the hypothesis that the values of AREA and TNRS improves by 10, 50, and 90%. The benefits of increasing wetland areas ranged from JPY 1 (USD 0.01) per year to JPY 14,901 (USD 182.19) per year. Those of improving wetland biodiversity ranged from JPY 44 (USD 0.54) per year to JPY 3,190 (USD 39.00) per year. Two types of wetlands were revealed by calculations. The first type includes wetlands in which the benefits of AREA are larger than those of TNRS. The second type includes wetlands in which the benefits of TNRS are larger than those of AREA, and the feature of the second type is that the wetland area is smaller than the first type. It means that large wetlands should be protected, and the small one with high biodiversity. Consequently, the research on wetlands species is required. The result indicates that benefits are connected to recreational services of wetland ecosystems.**

**Key words:** Benefit analysis, wetlands, biodiversity, travel cost method, JEL: D12, Q26, Q57.

### INTRODUCTION

Wetlands are important natural resources for maintaining biodiversity (Uden et al., 2014). All over the world, however, many wetlands are in danger of decrease and/or disappearance due to developments of industries or agriculture (Turner et al., 2000). Thus, an

intergovernmental treaty, the Ramsar Convention, has been established in order to provide the framework for national action and international cooperation for the conservation and wise use of wetlands (Maltby and Barker 2009; Matthews, 2013).

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In Japan, the Geospatial Information Authorities of Japan (hereafter GIS; <http://www1.gsi.go.jp/geowww/lake/shicchimenseki2.html>) researched a total area of wetlands and results indicated the area decreased from 2110.62 km<sup>2</sup> in the Meiji-Taisho era (between 1868-1926 years) to 820.99 km<sup>2</sup> in the Heisei era (between 1996-1999 years); 61.1% of the total area of wetlands in Japan disappeared. The region where there is drastic decrease of wetland area is in Hokkaido (Hokkaido Prefectural Government, 2014). In Hokkaido, 1771.99 km<sup>2</sup> wetland areas in the Meiji-Taisho era decreased to 708.67 km<sup>2</sup> in the Heisei era due to development of industries or agriculture, having caused losses in the biodiversity of wetlands (Kuriyama, 1998; Kamayama et al., 2001; Morino et al., 2005).

A cause of loss in the biodiversity of wetlands is that developers and policy makers have not recognized the values of wetlands and wetland biodiversity. Thus, benefit measurement methods have been developed to explain the values of wetland biodiversity. Here, however, there are two problems in valuing wetland biodiversity. The first problem is that most wetlands have little related to economic markets, leading to difficulty in collecting individual behavior data for measurements (Shrestha et al., 2002). In such instances, the stated preference methods (hereafter, SPM) such as the contingent valuation method (hereafter, CVM) and conjoint analysis (hereafter, CA) have been used. Since surveys on SPMs are implemented by asking respondents their monetary values of the benefits of wetland biodiversity directly in a questionnaire, individual behavior data is then not needed. In particular, the benefits calculated by using data obtained from respondents who have not visited wetlands (non-users) are called the non-use value of wetland biodiversity (Krutilla, 1967).

In previous studies on SPMs, Kosz (1996) estimates the benefits for conserving a wetland area and endangered species, etc. by the CVM with hypothetical development projects scenario, resulting that conserving wetlands in a natural state might be more economically efficient than developing the areas. Loomis et al. (1991) and Pate and Loomis (1997) estimates the benefits of (hypothetical) improvements of a wetland, contamination control techniques, and river/salmon, finding that geographical distance from respondents' homes to the objective area influences their benefit amounts. Hammit et al. (2001) and Amigues et al. (2002) estimate the benefits of improving water quality and habitats of waterfront wild fowls in wetlands by designing hypothetical scenario of improving wetland qualities (e.g. water quality and number of waterfront wild fowls increase by 10%). Amigues et al. (2002) find that respondents' answers on the benefits differ when using different questionnaire formats in a survey. In the CVM surveys, researchers assess the benefit of a wetland quality, not quality by quality despite of existing several qualities in wetland amenities. The CA enables researchers

to assess benefits of improving or preserving each quality at a single survey. A common technique is to design hypothetical (improvement or preservation) scenarios on wetland quality status. Morrison et al. (1999) evaluate the trade-off between the benefits of losing jobs and of preserving wetlands. Carlsson et al. (2003) estimated the benefits of the biodiversity of animals and plants in a wetland. Birol et al. (2006) and Birol and Cox (2007) estimates the benefits by designing alternative management scenarios on biodiversity status, open water surface area status and so on, resulting that wetland qualities have significant effects for human society. Hanley et al. (2006) estimates water quality improvement benefits by comparing the status quo and the hypothetical improvement status of ecology, aesthetics/appearance, and river banks. Similarly, Carlsson et al. (2003) estimated the benefits of the biodiversity of animals and plants in a wetland, Milon and Scrogin (2006) estimated the benefits of a wetland's area and species, and Wang et al. (2007) estimated the benefits of numbers of plant species.

The previous studies indicate that not only wetlands but also its attributes have significant roles in both ecology and human society thought the benefit estimations. However, the validities of estimated values of the benefits rely on 1) the reality of hypothetical scenarios and 2) the respondents' cognitive abilities (Mitchell and Carson, 1989); whether hypothetical improvement levels and/or preservation projects are practicable as actual policies? Whether respondents certainly recognize the levels and/or the contents of hypothetically implemented projects? Thus, the estimated values of benefits would bias when respondents might misunderstand the contents of the CV or the CA questionnaires. Thus, most researchers prefer to use revealed preference methods (hereafter RPM). Data on individual real choices (decisions) is used in the RPMs, leading higher validity on the calculated values of benefits than those by using SPMs. The travel cost method (hereafter TCM) is a method of RPMs. It calculates the benefits of wetland biodiversity by estimating the relation between the number of visits to wetlands, travel costs, and wetland environmental qualities. The benefits calculated by the TCM are called as the use values since data on economic activities are used.

There are two type studies using the TCM for valuing wetlands. The first is the studies which employs no wetland quality data in estimations such as Grossmann (2011), while the second employs. As for the second type, Bockstael et al. (1987), Hanley et al. (2003), Phaneuf and Siderelis (2003), and Vesterinen et al. (2010) includes water quality (the biochemical oxygen demand or the chemical oxygen demand) as data for environmental qualities. Caulkins et al. (1986) includes the length of shoreline and lake depth. Yen et al. (2006) includes slope and width of beaches. As valuation studies on wetlands, Herriges et al. (2004) included the

number of pheasants, Whitehead et al. (2009) employs wetland area, Carson et al. (2009) employs numbers of species of fish in fishing activities.

From previous studies on the TCM, data used as environmental quality were water quality indicators or geographic indicators such as area, slopes, and widths. Few studies estimated the relationship between the number of trips and the biodiversity (number of species) of wetlands (This fact is similar to the SPM). It is pointed out that the second problem in valuing wetland biodiversity was the lack of data on wetland biodiversity related to individual behavior. The supposed reason of this is that data on number of species would not be researched in most wetlands due to the huge numbers of species living there.

In valuing wetlands, the TCM would contribute to show 1) the higher valid benefits than those by the SPM due to the usage of individual actual behavior data (the result of individual decision making on comparison of the costs with the benefits in recreating) as discussed above, 2) the rapid assessments needed for decision making to prioritize important wetlands that need rehabilitation and more protection (Phaneuf and Siderelis, 2003; Herriges et al., 2004), and 3) the information on the benefit transfer method for valuing another important wetlands in which researchers could not perform surveys (Camacho-Valdez et al., 2014). Since the lack of data on biodiversity prohibit researchers from applying the TCM, then it is necessary to consider a way to construct data on biodiversity which is simple but broadly applicable for the TCM.

The purposes of this paper are to examine an operationally useful approach to construct data on wetland biodiversity, and to show the significance of valuing wetland biodiversity through benefit calculations. A significant contribution of this paper is to present a simple technique of constructing wetland biodiversity data which may be widely applicable for other case studies.

**MATERIALS AND METHODS**

A basic assumption of TCM is that the visitor makes a single site trip (that is, an individual visits a site and returns his/ her home). This means individuals see one level of environmental quality, so it is inadequate to estimate the relationship between the individual number of trips and the environmental quality. Thus, the repeated discrete choice (hereafter RDC) model, which is one of the random utility models, was used in this study. Morey et al. (1993), Needelman and Kealy (1995), Shaw and Ozog (1999), and Suwa (2008) are previous studies of the RDC. An advantage is flexibility on benefit calculations. The regression models were suitable for calculating benefits of environmental quality changes for a single site, but such models are not suitable for calculating benefits of quality changes for multi sites, for example, when an environmental quality in site A and site B simultaneously changes. Otherwise, the model structure of RDC allows us to calculate benefits even in the case of multi sites environmental quality changes.

The structure of RDC is as follows. Let  $i$  ( $i = 1, 2, \dots, N$ ) be an index

for individuals,  $j$  ( $j = 0, 1, 2, \dots, M$ ) and  $k$  ( $k = 1, 2, \dots, M$ ) be an index for sites. Here,  $j=0$  means an individual  $i$  does not choose to travel to sites. Assume that an individual  $i$  has a fixed-choice occasion for a trip ( $T$ ). In this study,  $T$  is designated as a maximum value of the respondents' total numbers of visits which is calculated from the observed data,  $T = 94$ . On each occasion, the individual is supposed to decide whether to visit a site and, if so, which one. Let  $v_i$  be individual  $i$ 's indirect utility, then the indirect utility function is given by Equation (1) if the individual  $i$  decides to visit site  $j$  and by Equation (2) if the individual  $i$  does not make the trip. Here,  $m_i = Y_i / T$  where  $Y_i$  is the individual  $i$ 's household income per year.  $p_{ij}$  is the individual  $i$ 's travel cost per site  $j$ ,  $z$  is a vector of the individual  $i$ 's socio-economic characteristics,  $q$  is a vector of site  $j$ 's environmental qualities.  $\beta_0$  is a constant parameter,  $\beta_m$  is a parameter of  $m$ ,  $\beta'_z$  is a transposed vector of parameters of  $z$ , and  $\beta'_q$  is a transposed vector of parameters of  $q$ . The disturbance term,  $\varepsilon_{ij}$ , from individual  $i$ 's visit to site  $j$ , is assumed to have an independent Gumbel distribution. Let  $Pr_{ij}$  be the probability that individual  $i$  will choose to visit site  $j$  on one occasion, and  $x_{ik}$  be individual  $i$ 's number of visits to site  $k$  on another occasion. Then,  $Pr_{ij}$  is defined as Equation (3), and individual  $i$ 's log likelihood,  $ll_i$ , is given by Equations (3) and (4).

$$v_{ij} = \beta_m (m_i - p_{ij}) + z_i \beta'_z + q_j \beta'_q + \varepsilon_{ij} \tag{1}$$

$$v_{i0} = \beta_0 + \beta_m m_i + \varepsilon_{i0} \tag{2}$$

$$Pr_{ij} = \exp(v_{ij}) / \sum_{j=0}^M \exp(v_{ij}) \tag{3}$$

$$ll_i = (T - \sum_{k=1}^M x_{ik}) \ln(Pr_{i0}) + \sum_{k=1}^M x_{ik} \ln(Pr_{ik}) \tag{4}$$

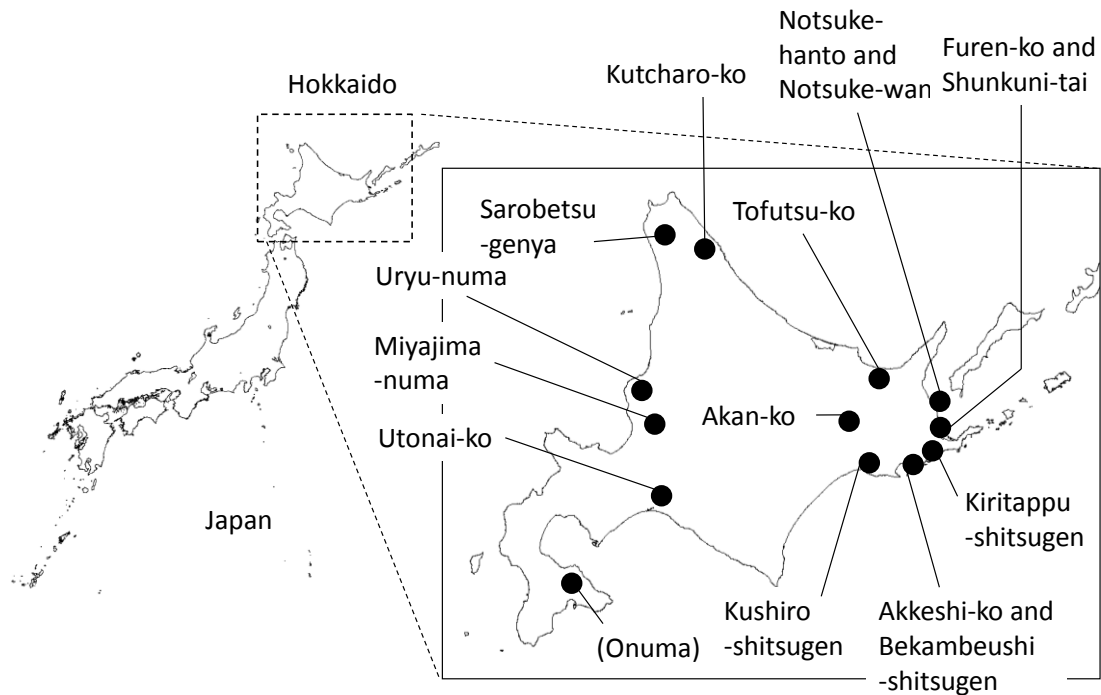
The procedure for benefit calculations using RDC is as follows. Let the indirect utility function be rewritten as  $v_{ij}^s = \beta_m (m_i - p_{ij}) + z_i \beta'_z + q_j^s \beta'_q + \varepsilon_{ij}$ . Here,  $s$  is a superscript which indicates environmental qualities are changed by a project if  $s = w$ , and it is not if  $s = wo$ ; A benefit generated from the change of site  $j$ 's environmental quality (hereafter  $BQC$ ) is defined as Equation (5). Here, authors set  $\beta_m = \beta'_m / 10,000$  for adjusting values of parameters. Thus, unit values of  $m_i$  and  $p_{ij}$  were set as ten thousand yen.

$$BQC_j = (T / \beta_m) \left( \ln \left( \sum_{j=0}^J \exp(v_{ij}^w) \right) - \ln \left( \sum_{j=0}^J \exp(v_{ij}^{wo}) \right) \right) \tag{5}$$

For comparisons on parameters, the ordinary least square regression (hereafter, OLS), the poisson regression (hereafter, PS) and the negative binomial regression (hereafter, NB) were employed followed by Cameron and Trivedi (2013). Most studies employ PS and/or NB for estimating travel demand functions, benefit calculations, or comparisons of signs of parameters such as in Shrestha et al. (2002), Heberling and Templeton (2009). Here, pooled data constructed from individual travel behaviors for wetlands and wetland environmental qualities were employed in estimations on OLS, PS and NB.

**Research area**

The decrease in wetland areas is an environmental problem in



**Figure 1.** Locations of Hokkaido and Wetlands.



**Figure 2.** Recreation activities in Ramsar wetlands: The cases of Miyajima-numa and Sarobetsu-genya, Ministry of the Environment, Japan.

Japan. The Japanese government designed the National Biodiversity Strategy based on the Convention on Biological Diversity. The strategy requires to value the benefits of wetland biodiversity. Hokkaido is a main target area for the strategy due to the existence of numerous wetlands. Thus, the Hokkaido prefectural government has been proceeding with the registration of wetlands with national or international conservation programs. In particular, registrations with the Ramsar Convention have proceeded. In 2013, 13 wetlands have been registered in Hokkaido with the Convention (Hokkaido Prefectural Government, 2014). Their location is presented on the Figure 1 and the characteristics

of the wetlands referred from Ministry of the Environment, Japan (2014) are described in Appendix 1: The zone of vegetation for Hokkaido is categorized from the cool-temperate zone to the subarctic zone. Various endangered birds, such as the red-crowned crane (add the scientific name), Blakiston's fish owl (add the scientific name), and white-tailed eagle (add the scientific name) use wetlands or adjacent areas as foraging habitats. Many people have visited there in order to enjoy tracking/walking, camping, observing, canoeing, or fishing each season (Figure 2).

The objective areas are the following eleven sites; Miyajima-numa, Uryunuma-shitsugen, Sarobetsu-genya, Kutcharo-ko,

**Table 1.** Wetland areas and reduction rates

Site names	Base (km <sup>2</sup> ) <sup>a</sup>	Period A (km <sup>2</sup> ) <sup>b</sup>	Period B (km <sup>2</sup> ) <sup>c</sup>	Reduction rates (%)
Miyajima-numa area	0.41	3536.05	37.66	98.93
Uryunuma-shitsugen area	6.24	N.D.	195.13	N.D.
Sarobetsu-genya area	25.6	12250.36	6042.78	50.67
Kutcharo-koarea	16.07	4534.52	459.41	89.87
Utonai-koarea	5.1	8178.13	1350.42	83.49
Kushiro-shitsugen area	78.63	33738.97	22656.13	32.85
Tofutsu-ko area	9	1534.77	155.96	89.84
Akkeshi-ko and Bekambeushi-shitsugen area	52.77	10743.61	12192.68	-13.49
Kiritappu-shitsugen area	25.04	2558.19	2977.04	-16.37
Furen-ko and Shunkuni-tai area	61.39	409.56	373.19	8.88
Notsuke-hanto and Notsuke-wan area	60.53	N.D.	N.D.	N.D.
All Japan	-	2110.62	820.99	61.1

<sup>a</sup>Values (km<sup>2</sup>) of the part of wetland area protected with the Ramsar Convention, <sup>b</sup>the values during the Meiji-Taisho era (1868-1926), <sup>c</sup>the values during the Showa-Heisei era (1996-1999); N.D. means no data.

Utonai-ko, Kushiro-shitsugen, Tofutsu-ko, Akkeshi-ko and Bekambeushi-shitsugen, Kiritappu-shitsugen, Furen-ko and Shunkuni-tai, Notsuke-hanto and Notsuke-wan. The Akan-ko wetlands were excluded from our research and estimations due to the lack of data on an environmental quality. The Onuma wetlands were also excluded because it was not registered with the Ramsar Convention during the research period.

#### Data on environmental qualities

Previous studies have made use of various indicators of environmental quality in monitoring wetlands (Caulkins et al., 1986; Hanley et al., 2003; Carson et al., 2009; Vesterinen et al., 2010). In this study, both wetland area (Table 1) and biodiversity were employed because the former is the only data published as standard geographic information and the latter is a target in this study. Firstly, the data on wetland areas is described. Table 1 shows the data. The row for "Base" shows values (km<sup>2</sup>) of the part of wetland area protected with the Ramsar Convention. The row for "Period A" shows the values during the Meiji-Taisho era (1868-1926), and "Period B" shows the values during the Showa-Heisei era (1996-1999) that were researched by the GIS. "N.D." means there were no data because the areas were not included in the GIS research.

In this paper, the values of Base were used for estimations, and the data set in Base is denoted as AREA. The values of Period A and B were used for setting hypothetical scenarios described in benefit calculations. "Reduction rates" shows percentages of reduction rates of wetland areas calculated from the values of Periods A and B. One reason for negative values in reduction rates (increment rates) of the Akkeshi-ko area, the Bekambeushi-shitsugen area and the Kiritappu-shitsugen area is that new areas were added due to a change in map-making process when research on Period B was performed.

Secondly, the data on wetland biodiversity was described. First of all, let biodiversity in a wetland be defined as the total number of species in the wetland. Because of the difficulty of counting huge number of species, previous studies rarely employ the one in valuations by RPMs. A solution for this issue is simply to limit the number of species in counting. Actually, the purpose of visitors in a wetland would be to enjoy observing not all species in the wetland

but *representative* species in which visitors are interested.

Two selection methods were considered; the one is research for visitors and the other is expert judgment. The expert judgment was employed in this study. The experts were officers of the Hokkaido Institute of Environmental Sciences, and the Japan Science and Technology Agency (hereafter, HIESJSTA). HIESJSTA (2004) presents a "BirdBase (<http://birdbase.hokkaido-ies.go.jp/rdb.html>)" and provides names of representative species (plants, wild birds, insects, mammals, fishes and shellfishes, amphibians and reptiles) living in objective wetlands. By counting the names, Table 2 shows the numbers in each category and the total number of representative species (hereafter TNRS).

#### Survey and individual behaviors

Data on travel behaviors was obtained through an internet survey from Hokkaido residents in March of 2011. E-mails sent to 2,754 respondents registered by the internet research company, and 2,300 respondents answered questionnaires about their travel behaviors for eleven wetlands during the past year. On the web site of the internet research company, respondents were questioned regarding the number of visits to Ramsar wetlands, their postal codes, their interests in species, and their socio-econometric information. Here, data for 44 respondents out of 2300 were excluded due to their incorrect postal code numbers. Table 3 shows definitions of variables.

In the question on the number of visits, a matrix type of answer format was used. Wetland names were displayed in the first row, and alternatives of number of visits were displayed in the first column. The alternatives were A: one time (1), B: two times (2), C: three to five times (4), D: six to ten times (8), E: eleven to fifteen times (13), F: sixteen to twenty times (18), G: over twenty one times (21), H: did not go (0). Numbers in the parentheses were used for estimations. In the results of all answers (11 x 2,256), there were fourteen answers selected for alternative G. Although true values for the fourteen answers would be over 21 times, it is thought that this has little influence on estimation results due to the small response rates. The number of visits, represented by the variable VISIT, is modeled as a dependent variable in the OLS, PS, and NB regressions, and modeled as  $x_{ij}$  in the RDC model.

The research type of this paper is off-site sampling survey,

**Table 2.** Numbers of representative species in wetlands

Site names	Plants	Wild birds	Insects	Mammals	Fish and shellfish	Amphibian and reptiles	Total number of species
Miyajima-numa	8	18	0	0	7	0	33
Uryunuma-shitsugen	17	6	14	0	0	0	37
Sarobetsu-genya	18	8	0	5	0	6	37
Kutcharo-ko	18	17	9	5	10	0	59
Utonai-ko	18	18	12	3	10	1	62
Kushiro-shitsugen	16	18	8	6	9	6	63
Tofutsu-ko	18	17	0	0	7	0	42
Akkeshi-ko and Bekambeushi-shitsugen	23	26	0	7	2	0	58
Kiritappu-shitsugen	17	19	12	2	5	0	55
Furen-ko and Shunkuni-tai	30	25	5	7	9	2	78
Notsuke-hanto and Notsuke-wan	31	22	9	7	0	0	69

**Table 3.** Definitions of variables used in models.

Variable	Explanations
VISIT	Number of visit to Ramsar wetlands in past a year
PRICE	Round trip travel cost from the individual <i>i</i> 's home to wetlands (ten thousand yen)
GND	1, if the individual <i>i</i> is male, 0 otherwise
AGE	The individual <i>i</i> 's actual age (years)
MAR	1, if individual <i>i</i> was married, 0 otherwise
ICM	The individual <i>i</i> 's household income (tax included) per past a year (ten thousand yen)
SCAPE	1, if the individual <i>i</i> is interested in wetlands' landscapes, 0 otherwise
WILD	1, if the individual <i>i</i> is interested in the wetlands' wild birds and/or animals, 0 otherwise
PLANT	1, if the individual <i>i</i> is interested in the wetlands' plants, 0 otherwise
AMPH	1, if the individual <i>i</i> is interested in the wetlands' amphibians and/or reptiles, 0 otherwise

resulting to collect 613 visitors and 1,643 non-visitors data sets. Thus, both data sets from 2,256 and from 613 respondents were employed for estimations by the RDC model.

Respondents' travel costs to wetlands were calculated as follows. A respondent *i*'s distances ( $d_{ij}$ ) and travel times ( $t_{ij}$ ) from the respondent's home to  $j^{\text{th}}$  wetlands were calculated by using the respondent *i*'s postal code and PC software, Zenrin Professional 7. Respondents' average gas bill during 2011 was set at 138 yen per liter from data of Oil Information Center, Japan. Respondents' average gasoline mileage was set at 17.8ℓ/km from data of the Ministry of Land, Infrastructure, Transport and Tourism. The opportunity cost was set at 24.98 yen per minute per person. The respondent *i*'s travel cost to  $j^{\text{th}}$  sites was calculated as  $p_{ij} = 2 \times \{138 \times (d_{ij} / 17.8) + 24.98 \times t_{ij}\}$ . The travel costs, represented by variable PRICE, are modeled as an independent variable of the OLS, PS, and NB regressions, and the  $p_{ij}$  of the RDC model.

Other independent variables in the model include individual interests in biodiversity and socioeconomic characteristics. Independent variables concerning the individual interests include the following variable; SCAPE if an individual *i* was interested in

wetland landscapes, WILD if the individual *i* was interested in wild birds and/or animals living in wetlands, PLANT if the individual *i* was interested in plants growing in wetlands, AMPH if the individual *i* was interested in amphibians and/or reptiles living in wetlands.

The socioeconomic characteristics include the individual *i*'s gender (GND), age (AGE), income (ICM), and MAR if the individual *i* was married. Here, ICM equals to  $Y_i$  in the RDC model; the variable of  $m_i$  was denoted as TICM. The positive sign of the parameter of income allows us to calculate benefits from quality changes under the concept of compensating variation (Morey et al., 1993). The signs of AREA and TNRS are supposed to be positive following Whitehead et al. (2009) and Carson et al. (2009). Signs of other parameters were confirmed by estimations.

## RESULTS

### Socioeconomic characteristics

The descriptive statistics of individual travel behaviors and socioeconomic characteristics are presented from

**Table 4.** Descriptive statistics of numbers of visits of sites

Site name	Mean	Std. Dev.	Minimum	Maximum
Miyajima-numa	0.06383	0.51445	0	13
Uryunuma-shitsugen	0.06294	0.51197	0	13
Sarobetsu-genya	0.07402	0.46645	0	8
Kutcharo-ko	0.07314	0.59597	0	21
Utonai-ko	0.25532	1.26156	0	21
Kushiro-shitsugen	0.21720	1.29258	0	21
Tofutsu-ko	0.05541	0.58589	0	21
Akkeshi-ko and Bekambeushi	0.07181	0.67003	0	21
Kiritappu-shitsugen	0.06959	0.57827	0	13
Furen-ko and Shunkuni-tai	0.07004	0.65888	0	18
Notsuke-hanto and Notsuke-wan	0.10461	0.76836	0	21
ALL	0.10163	0.77206	0	21

Std.Dev., standard deviation; Number of observation is 2,256 from Miyajima-numa to Notsuke-hanto and Notsuke-wan; Number of observation is 2,256 x 11 in ALL.

**Table 5.** Descriptive statistics on travel costs

Site name	Mean	Std. Dev.	Minimum	Maximum
Miyajima-numa	0.93933	0.78323	0.0536	3.9937
Uryunuma-shitsugen	1.28042	0.70268	0.3267	4.0069
Sarobetsu-genya	2.84760	0.68934	0.5228	5.1291
Kutcharo-ko	2.53952	0.65003	0.4496	4.8786
Utonai-ko	0.83261	0.80624	0.0409	4.2404
Kushiro-shitsugen	3.25923	0.94093	0.2076	5.5402
Tofutsu-ko	2.74752	0.81657	0.0744	5.3671
Akkeshi-ko and Bekambeushi	3.53618	0.95323	0.5262	5.8503
Kiritappu-shitsugen	3.66914	0.96266	0.4176	6.003
Furen-ko and Shunkuni-tai	3.83959	0.96683	0.1081	6.3673
Notsuke-hanto and Notsuke-wan	3.58522	0.93958	0.2942	6.2805
ALL	2.64330	1.36540	0.0409	6.3673

Std.Dev., Standard deviation; Number of observation is 2256 from Miyajima-numa to Notsuke-hanto and Notsuke-wan; Number of observation is 24,816 in ALL

Tables 4 to 6. ALL in the column of Site names in Tables 4 and 5 means descriptive statistics calculated from pooled data. Table 4 shows values of VISIT by wetland. The mean value of ALL is about 0.10163 times per person. The maximum value in the mean values of VISIT is the value of Utonai-ko; the minimum value is the value of Tofutsu-ko. Table 5 shows the values of PRICE. The mean value of ALL is about 2.64330 ten thousands yen. The maximum value in the means of PRICE is the value of Furen-ko and Shunkuni-tai, the minimum value is the value of Utonai-ko. From Table 4 and Table 5, it is supposed that there are some elements, other than the prices, that influence the number of visits for wetlands. The mean value of PRICE for Kushiro-shitsugen (or Notsuke-hanto and Notsuke-wan) is over the mean of PRICE of ALL, otherwise, the mean value of VISIT of Kushiro-shitsugen is over the mean value of VISIT of

ALL. In short, the demand level for Kushiro-shitsugen is high despite the high level of the price. Finally, Table 6 shows socioeconomic characteristics. The result shows that respondents are interested in SCAPE the most. The order of degree of influences of the variables for demands was confirmed by estimations.

Assumptions of signs of estimated parameters are as follows; the sign of PRICE is supposed to be negative because natural environments are considered to be normal goods in general economic theory. The sign of TICM is supposed to be positive because an increment of an individual income leads to an increase of the individual demand.

### Estimation results

Table 7 shows the estimation results using OLS, PS, NB,

**Table 6.** Descriptive statistics of individual characteristics and interests

Variable	Mean	Std. Dev.	Minimum	Maximum
GND	0.55408	0.49718	-	-
AGE	43.40736	10.17062	16	81
MAR	0.37101	0.48318	-	-
ICM	528.72340	327.52091	150	1600
SCAPE	0.36436	0.48136	-	-
WILD	0.16312	0.36956	-	-
PLANT	0.04610	0.20975	-	-
AMPH	0.01950	0.13832	-	-

Std.Dev., Standard deviation; Number of observation is 2,256.

**Table 7.** Estimation results.

Parameter	OLS	VIF	PS	NB	RDC_ALL	RDC_VIS
CONT	-0.12383 <sup>a</sup> (0.03388)		-5.55293 <sup>a</sup> (0.15479)	-5.99600 <sup>a</sup> (0.27395)	9.99138 <sup>a</sup> (0.15103)	8.34951 <sup>a</sup> (0.15550)
PRICE	-0.03812 <sup>a</sup> (0.00443)	1.58	-0.36402 <sup>a</sup> (0.01785)	-0.25345 <sup>a</sup> (0.03408)	-	-
ICM/TICM	0.00001 <sup>d</sup> (0.00001)	1.13	0.00018 <sup>a</sup> (0.00005)	0.00042 <sup>a</sup> (0.00011)	0.36710 <sup>a</sup> (0.01796)	0.33065 <sup>a</sup> (0.01784)
GND	0.04005 <sup>a</sup> (0.00986)	1.04	0.48730 <sup>a</sup> (0.04640)	0.49288 <sup>a</sup> (0.07881)	0.51427 <sup>a</sup> (0.04690)	0.44754 <sup>a</sup> (0.04715)
AGE	0.00079 <sup>d</sup> (0.00052)	1.21	0.01066 <sup>a</sup> (0.00214)	0.00456 <sup>d</sup> (0.00393)	0.01037 <sup>a</sup> (0.00216)	0.01633 <sup>a</sup> (0.00215)
MAR	0.03225 <sup>a</sup> (0.01121)	1.27	0.36843 <sup>a</sup> (0.04745)	0.41611 <sup>a</sup> (0.08702)	0.33547 <sup>a</sup> (0.04623)	0.43267 <sup>a</sup> (0.04711)
SCAPE	0.18274 <sup>a</sup> (0.01035)	1.07	2.12488 <sup>a</sup> (0.05928)	2.38988 <sup>a</sup> (0.08292)	2.16525 <sup>a</sup> (0.05937)	1.02768 <sup>a</sup> (0.06006)
WILD	0.12196 <sup>a</sup> (0.01391)	1.14	0.82348 <sup>a</sup> (0.04558)	1.36777 <sup>a</sup> (0.08679)	0.86002 <sup>a</sup> (0.04626)	0.45771 <sup>a</sup> (0.04696)
PLANT	0.21184 <sup>a</sup> (0.02446)	1.13	0.56278 <sup>a</sup> (0.05799)	0.69423 <sup>a</sup> (0.13865)	0.62047 <sup>a</sup> (0.05952)	0.50725 <sup>a</sup> (0.06083)
AMPH	0.29556 <sup>a</sup> (0.03532)	1.03	0.78145 <sup>a</sup> (0.07168)	0.51813 <sup>b</sup> (0.20600)	0.87545 <sup>a</sup> (0.07534)	0.75176 <sup>a</sup> (0.07647)
AREA	0.00090 <sup>a</sup> (0.00029)	2.50	0.00893 <sup>a</sup> (0.00107)	0.00401 <sup>c</sup> (0.00216)	0.00914 <sup>a</sup> (0.00107)	0.00735 <sup>a</sup> (0.00107)
TNRS	0.00219 <sup>a</sup> (0.00048)	1.96	0.02052 <sup>a</sup> (0.00191)	0.02281 <sup>a</sup> (0.00364)	0.02029 <sup>a</sup> (0.00190)	0.02040 <sup>a</sup> (0.00192)
Max. LL	-28326.55766		-8070.01463	-5549.34759	-17505.08355	-15681.99182
AIC	56679.11532		16164.02926	13102.09590	35032.16711	31385.98366
MR <sup>2</sup>	0.01617		0.21343	0.12192	0.11283	0.04403
N	24,816		24,816	24,816	2,256	613

Numbers of parentheses are standard errors of the coefficients; the super scripts of coefficients "a" means the coefficient significant at  $p < 0.1$ , "b" means  $p < 0.5$ , "c" means  $p < 0.1$ , "d" means  $p > 0.1$ , respectively.

and RDC. The RDC model was used for estimating two set of data. The column of RDC\_ALL shows estimated parameters from the data of 2,256 respondents and RDC\_VIS shows estimated parameters from 631 respondents who went to at least one wetland one time during the past year. VIF shows values of the Variance Inflation Factor were small, confirming the less influences of multicollinearity in parameters. Here, Appendix 2 shows the results of estimating different models with the ones in Table 7

Signs of all parameters of variables (without constants) are the same in OLS, PS, NB, and RDCs. The signs of PRICE are negative and the significant levels are  $p < 0.01$  across models. These results are consistent with previous studies. The signs of ICM are positive across models and the significant levels are  $p < 0.01$  in PS, NB,

RDCs. As a reference, the value of the residual deviance/ the degree of freedom is 0.53823 in PS.

The results of GND and MAR are positive and the significant levels are  $p < 0.01$  across models. The results suggest that males and persons who were married are likely to visit wetlands. The results of AGE are positive across models. The significant levels are  $p < 0.01$  in PS and RDCs, but  $p > 0.1$  in OLS and NB. The results of AGE suggest that older persons are more likely to visit wetlands. The results of SCAPE, WILD, PLANT and AMPH are positive and the significant levels are  $p < 0.01$  across all models. Finally, the results of AREA are positive across models, and are consistent with Whitehead et al. (2009). The significant levels are  $p < 0.01$  in OLS, PS, RDC\_ALL, and RDC\_VIS, but  $p < 0.1$  in NB. Although the significant level in NB was not



**Table 8.** Benefits of increasing of wetland areas

Increment rates	10%		50%		90%	
	ALL	VIS	ALL	VIS	ALL	VIS
Miyajima-numa	1 (0.01)	5 (0.06)	6 (0.07)	26 (0.32)	12 (0.15)	47 (0.57)
Uryunuma-shitsugen	21 (0.26)	83 (1.01)	111 (1.36)	428 (5.23)	206 (2.52)	791 (9.67)
Sarobetsu-genya	76 (0.93)	310 (3.79)	422 (5.16)	1,726 (21.10)	849 (10.38)	3,470 (42.43)
Kutcharo-ko	53 (0.65)	206 (2.52)	283 (3.46)	1,104 (13.50)	546 (6.68)	2,127 (26.01)
Utonai-ko	26 (0.32)	93 (1.14)	133 (1.63)	474 (5.80)	244 (2.98)	872 (10.66)
Kushiro-shitsugen	814 (9.95)	3,338 (40.81)	5,720 (69.94)	23,459 (286.82)	14,901 (182.19)	61,043 (746.34)
Tofutsu-ko	20 (0.24)	85 (1.04)	107 (1.31)	443 (5.42)	201 (2.46)	828 (10.12)
Akkeshi-ko and Bekambeushi-shitsugen	272 (3.33)	1,134 (13.86)	1,702 (20.81)	7,102 (86.83)	3,890 (47.56)	16,243 (198.59)
Kiritappu-shitsugen	66 (0.81)	278 (3.40)	368 (4.50)	1,547 (18.91)	737 (9.01)	3,101 (37.91)
Furen-ko and Shunkuni-tai	409 (5.00)	1,664 (20.34)	2,659 (32.51)	10,832 (132.44)	6,346 (77.59)	25,854 (316.10)
Notsuke-hanto and Notsuke-wan	398 (4.87)	1,627 (19.89)	2,579 (31.53)	10,550 (128.99)	6,127 (74.91)	25,073 (306.55)

**Table 9.** Benefits of improving wetland biodiversity

Improvement rates	10%		50%		90%	
	ALL	VIS	ALL	VIS	ALL	VIS
Miyajima-numa	51 (0.62)	154 (1.88)	272 (3.33)	813 (9.94)	522 (6.38)	1,539 (18.82)
Uryunuma-shitsugen	58 (0.71)	179 (2.19)	315 (3.85)	949 (11.60)	608 (7.43)	1,808 (22.11)
Sarobetsu-genya	49 (0.60)	159 (1.94)	262 (3.20)	843 (10.31)	507 (6.20)	1,604 (19.61)
Kutcharo-ko	88 (1.08)	274 (3.35)	495 (6.05)	1,501 (18.35)	1,000 (12.23)	2,959 (36.18)
Utonai-ko	146 (1.79)	414 (5.06)	820 (10.03)	2,274 (27.80)	1,666 (20.37)	4,504 (55.07)
Kushiro-shitsugen	279 (3.41)	910 (11.13)	1,569 (19.18)	4,996 (61.08)	3,190 (39.00)	9,900 (121.04)
Tofutsu-ko	44 (0.54)	144 (1.76)	238 (2.91)	769 (9.40)	464 (5.67)	1,476 (18.05)
Akkeshi-ko and Bekambeushi-shitsugen	131 (1.60)	434 (5.31)	730 (8.93)	2,370 (28.98)	1,470 (17.97)	4,662 (57.00)
Kiritappu-shitsugen	65 (0.79)	219 (2.68)	363 (4.44)	1,191 (14.56)	728 (8.90)	2,332 (28.51)
Furen-ko and Shunkuni-tai	227 (2.78)	736 (9.00)	1,319 (16.13)	4,139 (50.61)	2,769 (33.85)	8,409 (102.81)
Notsuke-hanto and Notsuke-wan	198 (2.42)	644 (7.87)	1,129 (13.80)	3,572 (43.67)	2,324 (28.41)	7,152 (87.44)

enough to prove the relationship between individual behaviors and wetland areas, AREA was used in benefit calculations for comparisons.

### Benefit calculations

Benefits calculations by Equation 5 were performed. Let  $BQC_{area}^h$  be benefits for increasing wetland areas, and  $BQC_{bio}^h$  be benefits for improving wetland biodiversity. The super script  $h$  means that benefits calculated by using parameters of RDC\_ALL when  $h = ALL$ , RDC\_VIS when  $h = VIS$ , respectively. Values in parentheses were USD values calculated by using the average exchange rate of USD1 = JPY81.79 in March, 2011 from the Bank of Japan. Hypothetical improvements of environmental qualities for benefit calculations were designed from reduction rates in Table 1. Reduction rates in Table 1 ranged from 8.88 to 98.93%, designing the hypothetical

improvement rates as 10%, 50%, and 90% for wetland areas (AREA) in Table 1 and biodiversity (TNRS) in Table 2.

Table 8 shows the benefits for increasing in wetland areas ( $BQC_{area}^h$ ).  $BQC_{area}^{ALL}$  ranges from JPY 1 (USD 0.01) per year to JPY 14,901 (USD 182.19) per year;  $BQC_{area}^{VIS}$  ranges from JPY 5 (USD 0.06) per year to JPY 61,043 (USD 746.34) per year. Results show that the values of  $BQC_{area}^{VIS}$  are larger than those of  $BQC_{area}^{ALL}$ . The minimum value is the values in Miyajima-numa and the maximum value is the ones in Kushiro-shitsugen.

Table 9 shows benefits for improving in wetland biodiversity ( $BQC_{bio}^h$ ).  $BQC_{bio}^{ALL}$  ranges from JPY 44 (USD 0.54) per year to JPY 3,190 (USD 39.00) per year; ranges from JPY 144 (USD 1.76) per year to JPY 9,900 (USD 121.04) per year in VIS, respectively. Results also show that  $BQC_{bio}^{ALL}$  calculated from RDC\_VIS are larger than those from RDC\_ALL. The minimum values of benefits

are those for the Tofutsu-ko and maximum values are the ones of Kushiro-shitsugen.

## DISCUSSION

A problem in valuations on wetland biodiversity by the revealed preference methods is the lack of data on it. This paper examined a simple approach on works for constructing data on wetland biodiversity, and to confirm the availability through estimations and benefit calculations. The discussion and conclusion are as follows.

### The validity of approach

The approach of this paper was to select representative species in wetlands by expert judgment, using the total number of them for estimations. The estimation results show this approach enables researchers to estimate relationships between individual behaviors and wetland biodiversity by the revealed preference methods. Because of this simplicity on the data creation, this approach would be widely available for valuing other natural environments in the world.

Here, there is a second approach that is a (preliminary) survey to ask respondents about their favorite species. An advantage of the second approach is that researchers would research representative species whether experts exist or not. Note that there are possibilities to outcome more or less similar results if only a richness species data would be used as the biodiversity variable if a researcher used the approach of this paper. If possible, the second approach would be useful to know the tourists' complete preferences for wetland biodiversity. In particular, the indigenous species (or subspecies) would attract tourists (naturalists) more (building the data is needed for performing further analyses) A disadvantage, however, is that the survey would take much time and money when the number of target wetlands increases or the survey carries on during years. Consequently, the approach of this paper would present more rational research process for researchers (if experts exist) than the second approach.

### Parameter estimations

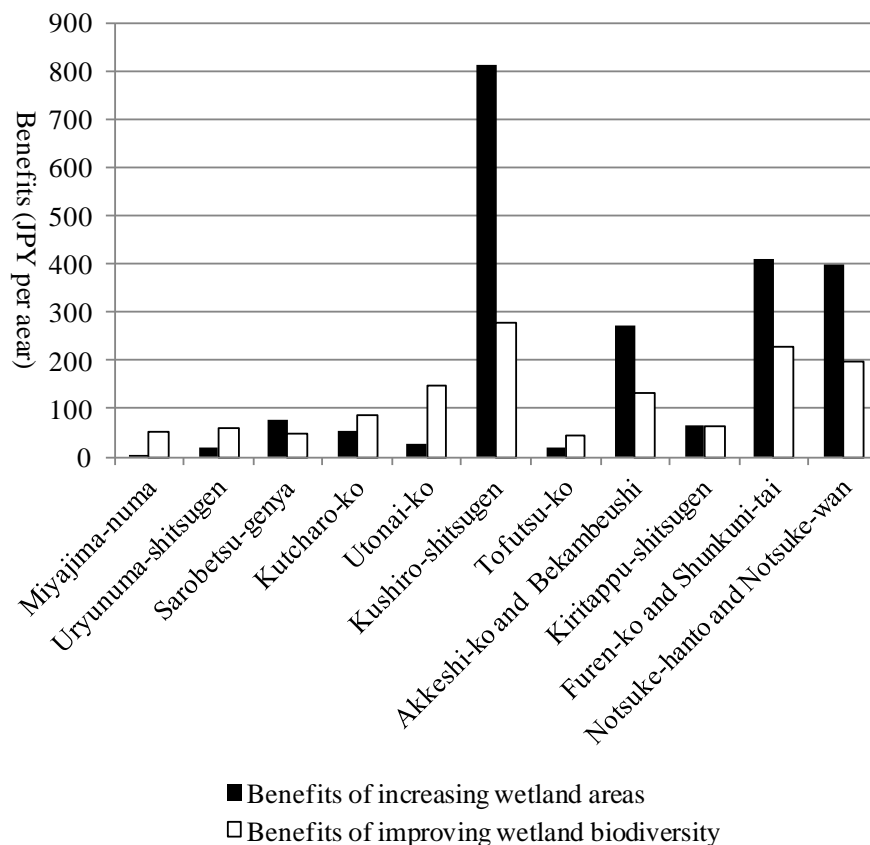
In Table 7, a reason for the positive signs of GND and MAR is thought to be that males have more opportunities for family trips, making bike trips with friends, or touring on bicycles than females. Hokkaido is one of the most famous areas where people enjoy driving or touring, and males living in Hokkaido have more leisure time to enjoy outdoor recreation.

Secondly, the reason for the positive signs of AGE may be that older persons have more leisure time than younger persons. Otherwise, this result indicates younger

persons have less opportunity to visit wetlands (although young people who have high income might visit wetlands more often than those who have low income). Thus, policy makers should create changes to generate younger person interest in wetlands by extracurricular activities in schools or announcing volunteer activities in wetlands. Thirdly, the positive signs of SCAPE, WILD, PLANT and AMPH suggest that persons who were interested in wetland landscapes, wild birds and / or animals, plants and amphibians and/or reptiles are likely to visit wetlands. This indicates that increments of individual interests in biodiversity lead to increases of visitors for wetlands and may generate economic impacts for regions surrounding wetlands due to recreational activities. Finally, the positive signs of AREA suggest that individuals prefer to visit larger wetlands. A reason for such results was thought to be that larger wetlands often have more long-walking and/or tracking courses with beautiful landscapes, rare birds and animals than smaller wetlands. The results for TNRS are positive, and consistent with Carson et al. (2009), and the significant levels are  $p < 0.01$  across models. The positive signs of TNRS also suggest that individuals prefer to visit ecologically richer wetlands. The results show that variety of species entertains visitors. The results of AREA and TNRS may indicate that policy makers maintain wetland areas and biodiversity for visitors in order to achieve a state of "wise use" for wetlands (Maltby and Barker, 2009).

### The valuing of wetland biodiversity

The results in Table 9 show the order of the value of benefits in each increment rate are maintained, illustrating the values of  $BQC_{area}^{ALL}$  and  $BQC_{bio}^{ALL}$  in the case of the 10% increment rate in Figure 3. Figure 3 indicates that there are two types of wetlands. The first type in which the values of  $BQC_{area}^{ALL}$  are larger than those of  $BQC_{bio}^{ALL}$  are as follows: Sarobetsu-kenya, Kushiro-shitsugen, Akkeshi-ko and Bekambeushi-shitsugen, Kiritappu-shitsugen, Furen-ko and Shunkuni-tai, Notsuke-hanto and Notsuke-wan. The second type in which the values of  $BQC_{bio}^{ALL}$  are larger than those of  $BQC_{area}^{ALL}$  are as follows: Miyajima-numa, Uryunuma-shitsugen, Kutcharo-ko, Utonai-ko, Tofutsu-ko. A feature of wetlands in the second type is that the wetland areas is smaller than those of the first type. A mean value of area for the second type is about 7.4 km<sup>2</sup>, and for the first type is about 50.7 km<sup>2</sup>. The facts indicate that an economic valuation of biodiversity of wetlands is important for showing the values of small wetlands rather than large wetlands. The reason is thought that the biodiversity of a wetland would not be always related to the wetland area, leading the economic valuation on biodiversity in the wetland to be performed for conserving small wetlands.



**Figure 3.** Benefits of wetland areas and biodiversity in the case of 10 % increment rate.

### Political implications

It is thought that there are two frames for an improvement in biodiversity in this study. Considering conservations, the first frame is to increase the number of new individual favorite species living in a wetland. If so, policy makers plan to recover animals and/ or plants which do not live in the wetlands at present. Considering uses, the second frame is to increase the number of species which influence individual behaviors. If so, policy makers plan to enhance individual interest in the wetland biodiversity. Estimation results show that individual interest in biodiversity in WILD, PLANT, and AMPH, have a positive influence on individual travel behaviors and the value of benefits. Since it takes much time for policy makers to recover a variety of species in the wetland, the results indicate that policy makers would like to implement a short term policy to raise non-visitor interests in wetlands, and simultaneously implement a long term project to recover the numbers of species in order to achieve the state of wise-use of wetlands.

Since few studies have been performed to calculate benefits of improving wetland biodiversity by revealed preference methods, it is a future task of this study to confirm the validity for calculated values of benefits; by

using the contingent behavior method or the combined method including revealed and stated preference data as in Whitehead et al. (2000, 2009) and Grossmann (2011).

### Achievements of this paper

In previous studies, valuing wetland biodiversity are mainly performed by the stated preference data with an anxiety for the biases on estimated benefits. The method of this study would enable researchers to value wetland biodiversity, not only in Japan but also in the world, without the anxiety. A crucial finding of this study is that the improvements of biodiversity in small wetlands are more important than large wetlands. The finding would help to prevent small wetlands in natural status from (economic) developments. The result would indicate that the improving and preserving wetland biodiversity - even small wetlands - give the higher welfare status for human society.

### Conflict of interests

The authors have not declared any conflict on interests.

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## Author contributions

Tadahiro Okuyama undertook the survey, was responsible for the econometric models and analysis, and was involved in manuscript development and review. The guarantor for the overall content of the manuscript is Tadahiro Okuyama.

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## Appendix 1. Summaries on Ramsar wetlands in Hokkaido.

Site names	Summary
Miyajima-numa	Major Type: Freshwater lake, Summary: Miyajima-numa is a round lake in Bibai City, located 50 km northeast of Hokkaido's capital city, Sapporo. It is a shallow lake with an average depth of 1.7 m. An astounding number of waterfowl including geese, ducks and swans visit this lake every autumn and spring. The Miyajima-numa is one of the most important stopover points in Japan. Especially, the number of white-fronted geese ( <i>Anser albifrons</i> ) exceeds 50,000, constantly accounting for more than 1% of the species population in East Asia. Main plants are <i>Trapa bispinosa</i> var. <i>iinumai</i> , <i>Zizania latifolia</i> , <i>Phragmites communis</i> , etc.; Main birds are <i>Anser albifrons</i> , <i>Cygnus cygnus</i> , <i>Cygnus columbianus</i> , etc.; Main fish and shellfish are <i>Cyprinus carpio</i> , <i>Tribolodon hakonensis</i> , <i>Phoxinus phoxinus sachalinensis</i> , etc.
Uryunuma-shitsugen	Major Type: High moor, Summary: The Uryunuma-shitsugen is located at 70km north of Sapporo, Hokkaido. Diverse vegetation of approximately 150 species of plants is observed in the Uryunuma wetland in its pristine condition, including the spatterdock ( <i>Nuphar luteum</i> ), peat moss ( <i>Sphagnum</i> ssp.) and <i>Moliniopsis japonica</i> . The summer months (June-September) are an excellent season to appreciate the flower garden of Broad Dwarf Day-Lily, Arctic Iris and Plantain Lily. Main plants are <i>Nymphaea tetragona</i> association, <i>Menyanthes trifoliata</i> community, <i>Veratrum stamineum</i> - <i>Calamagrostis canadensis</i> var. <i>langsдорffii</i> community, etc.; Main birds are <i>Anas platyrhynchos</i> , <i>Gallinago hardwickii</i> , <i>Lanius bucephalus</i> , etc.
Sarobetsu-genya	Major Type: High moor, intermediate moor, low moor, and fresh-water lake, Summary: The Sarobetsu-genya is a vast peat land located approximately 40km south of Wakkanai City, a northernmost city in Japan. From spring to autumn, the Sarobetsugenya is covered with colorful flora with more than 100 species of plants including cranberry ( <i>Vaccinium macrocarpon</i> ), Hare's tail cotton grass ( <i>Eriophorum vaginatum</i> ), bog rosemary ( <i>Andromeda polifolia</i> ) and broad dwarf day-lily. The two lakes in this wetland are important habitats for breeding waterfowls and migratory birds. They constantly support 1% of the species' population of middendorff's bean goose ( <i>Anser fabalis middendorffi</i> ), and tundra swan ( <i>Cygnus Columbianus</i> ) in East Asia. Main plants are <i>Ledum palustre</i> subsp. <i>diversipilosum</i> var. <i>yesoense</i> , <i>Empetrum nigrum</i> var. <i>japonicum</i> , <i>Chamaedaphne calyculata</i> , etc.; Main birds are <i>Motacilla flava taivana</i> , <i>Emberiza aureola</i> , <i>Emberiza schoeniclus</i> , etc. Main mammals are <i>Sorex minutissimus hawkeri</i> , <i>Myotis daubentoni</i> , <i>Myotis mystacinus</i> . Main amphibian and reptiles are <i>Lacerta vivipara</i> , <i>Elaphe climacophora</i> , <i>Elaphe quadrivirgata</i> .
Kutcharo-ko	Major Type: Freshwater lake, low moor, Summary: The Kutcharo-ko is one of the northernmost lakes in Japan. The lake is surrounded by a northern forest of firs and spruces, and has a reed community on the shore. A variety of unique aquatic plants such as <i>Ruppia occidentalis</i> are found here. It also is a ground for commercial fishing for shrimps, clams and smelts. The area is an important staging ground for migratory waterfowl, where 290 species of birds, mainly Anatidae, have been recorded. This area is included in the Flyway Site Network under the Partnership for the East Asian-Australasian Flyway. Main plants are <i>Phragmites communis</i> , <i>Typha latifolia</i> , <i>Scirpus lacustris</i> subsp. <i>creber</i> , etc. Main birds are <i>Anas platyrhynchos</i> , <i>Anas penelope</i> , <i>Aythya marila</i> , etc. Main insects are <i>Lestes dryas</i> , <i>Sympetrum striolatum imitoides</i> , <i>Sympetrum flaveolum flaveolum</i> , etc. Main mammals are <i>Sorex minutissimus hawkeri</i> , <i>Myotis daubentoni</i> , <i>Myotis mystacinus</i> , etc. Main fish and shellfish are <i>Oncorhynchus masou masou</i> , <i>Salvelinus leucomaenis</i> , <i>Hypomesus nipponensis</i> , etc.
Utonai-ko	Major Type: Freshwater lake, low moor, Summary: The Utonai-ko is a freshwater lake in southwestern Hokkaido. The area is one of the most important stopover sites and wintering grounds for migratory birds. Tens of thousands of birds including the white-fronted goose ( <i>Anser albifrons</i> ), bean goose ( <i>Anser fabalis</i> ), whooper swan ( <i>Cygnus cygnus</i> ), etc. visit every year. More than 260 bird species are recorded. The marshland around the lake serves as an important breeding ground for siberian rubythroat ( <i>Luscinia calliope</i> ), and yellow-breasted bunting ( <i>Emberiza aureola</i> ), and the forest is a winter habitat for white-tailed sea eagle ( <i>Haliaeetus albicilla</i> ) and Steller's sea eagle ( <i>European Storm-petrel</i> ). Main plants are <i>Phragmites communis</i> , <i>Calamagrostis canadensis</i> var. <i>langsдорffii</i> , <i>Carex middendorffii</i> , etc. Main birds are <i>Anas platyrhynchos</i> , <i>Anas penelope</i> , <i>Anas acuta</i> , etc. Main insects are <i>Lestes dryas</i> , <i>Anax parthenope julius</i> , <i>Sympetrum parvulum</i> , etc. Main mammals are <i>Vulpes vulpes schrencki</i> , <i>Tamias sibiricus</i> , <i>Lepus timidus ainu</i> . Main fish and shellfish are <i>Cyprinus carpio</i> , <i>Carassius auratus</i> , <i>Tribolodon hakonensis</i> , etc. Main amphibian and reptiles are <i>Rana pirica</i> .

## Appendix 1. Contd

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Kushiro -shitsugen	<p>Major Type: Low Moor, Freshwater Lake, River, Summary: The Kushiro-shitsugen located in eastern Hokkaido, and is the largest marshland in Japan. Approximately 80% of the peat land is a low moor dominated by a reed and sedge community and alder forest. The plant community in the wetland has a variety of species including marsh jacob's ladder, a relict of the ice age, etc. This wetland is blessed with rich fauna including 26 species of mammals and 170 species of birds. It also is home of the internationally endangered Japanese crane (<i>Grus japonensis</i>), white-tailed sea eagle (<i>Haliaeetus albicilla</i>), and Steller's sea eagle (<i>European Storm-petrel</i>). This is the only habitat in Japan for the unique amphibian Siberian Salamander. Main plants are <i>Phragmites communis</i>, <i>Alnus japonica</i>, <i>Carex lasiocarpa</i> subsp. <i>occultans</i>, etc. Main birds are <i>Grus japonensis</i>, <i>Gallinago hardwickii</i>, <i>Alauda arvensis</i>, etc. Main insects are <i>Sympetrum flaveolum flaveolum</i>, <i>Lestes dryas</i>, <i>Leucorrhinia intermedia ijimai</i>, etc. Main mammals are <i>Mustela vison</i>, <i>Mustela itatsi itatsi</i>, <i>Clethrionomys rufocanus bedfordiae</i>. Main fish and shellfish are <i>Pungitius pungitius</i>, <i>Chaenogobius laevis</i>, <i>Hucho perryi</i>, <i>Lethenteron reissneri</i>, etc. Main amphibian and reptiles are <i>Salamandrella keyserlingii</i>, <i>Hynobius retardatus</i>, <i>Elaphe climacophora</i>, etc.</p>
Tofutsu-ko	<p>Major Type: Brackish lake, Summary: The Tofutsu-ko located in the northeast Hokkaido, and is an important habitat for more than 60,000 ducks and geese, supporting more than 1% of East Asian regional population of bean goose (<i>Anser fabalis</i>), whooper swan (<i>Cygnus cygnus</i>), wigeon (<i>Anas penelope</i>), smew (<i>Mergus albellus</i>) and red-breasted merganser (<i>Mergus serrator</i>). A salt marsh has developed in the low area along the shore with aquatic communities such as seaside arrowgrass (<i>Triglochin maritima</i>) and marsh arrowgrass (<i>Triglochin palustris</i>). In Particular, the communities of common glasswort (<i>Salicornia europaea</i>) in beautiful red autumn color attracts many tourists to the lakes along the coast of the Sea of Okhotsk. Main plants are <i>Phragmites communis</i>, <i>Typha latifolia</i>, <i>Scirpus lacustris</i> subsp. <i>creber</i>, etc. Main birds are <i>Anas platyrhynchos</i>, <i>Anas penelope</i>, <i>Anas strepera</i>, etc. Main fish and shellfish are <i>Hypomesus nipponensis</i>, <i>Cyprinus carpio</i>, <i>Carassius auratus</i>, etc.</p>
Akkeshi-ko and Bekambeushi -shitsugen	<p>Major Type: Brackish lake, salt marsh, low moor, high moor, and river, Summary: The Akkeshi-ko and Bekambeushi-shitsugen located in eastern Hokkaido. The Akkeshi-ko is a brackish water lake, plant communities of saline environment are found in some places in the salt marsh along the shore, including common glasswort (<i>Salicornia europaea</i>). Approximately 200 species of birds have been recorded. As it does not completely freeze over in winter, the Akkeshi-ko is an important wintering ground for the whooper swans (<i>Cygnus cygnus</i>). In addition, almost 300 Steller's sea eagles (<i>European Storm-petrel</i>) and white-tailed sea eagles (<i>Haliaeetus albicilla</i>), winter here. Main plants are <i>Glaux maritima</i> var. <i>obtusifolia</i>, <i>Carex subspathacea</i>, <i>Triglochin maritimum</i>, etc. Main birds are <i>Ardea cinerea</i>, <i>Anas crecca</i>, <i>Anas penelope</i>, etc. Main fish and shellfish are <i>Salangichthys microdon</i>, <i>Eleginus gracilis</i>.</p>
Kiritappu -shitsugen	<p>Major Type: Salt marsh, brackish lake, river, high moor, and low moor, Summary: The Kiritappu-shitsugen located in eastern Hokkaido and is bound with snow and ice in winter. In spring and autumn, a number of migratory birds stop over the site. The marshland is an important habitat for Japanese cranes (<i>Grus japonensis</i>), and thus is included in the Flyway Site Network under the Partnership for the East Asian-Australasian Flyway. From May to September, a number of colorful wetland flowers such as the Japanese rose (<i>Rosa rugosa alba</i>), Hare's tail cotton grass (<i>Eriophorum vaginatum</i>), Arctic Iris (<i>Iris setosa</i>), and Broad Dwarf Day-lily adorn the wetland, making it the site of visitors from all over the country. Main plants are <i>Molinia japonica</i>, <i>Phragmites communis</i>, <i>Alnus japonica</i>, etc. Main birds are <i>Grus japonensis</i>, <i>Podiceps grisegena</i>, <i>Ardea cinerea</i>, etc. Main insects are <i>Cordulia aenea amurensis</i>, <i>Coenagrion ecornutum</i>, <i>Aeshna nigroflava</i>, etc. Main mammals are <i>Mustela vison</i>, <i>Vulpes vulpes schrencki</i>. Main fish and shellfish are <i>Salvelinus leucomaenis</i>, <i>Tribolodon hakonensis</i>, <i>Platichthys stellatus</i>, etc.</p>
Furen-ko and Shunkuni-tai	<p>Major Type: Brackish lake, seagrass/seaweed bed, sandbar, low moor, and tidal flat, Summary: The Furen-ko and the Shunkuni-tai located in eastern Hokkaido, and an area to embrace sand dunes, grasslands, forests, salt marshes, and tidal flats. In particular, the Sakhalin spruce (<i>Picea glehnii</i>) forest on the sand dunes has attracted international attention for its uniqueness. Furen-ko's ecosystem diversity includes approximately 280 species of birds including shorebirds, swans and geese. The lagoon is one of the most popular places for national/international visitors to observe rare species such as the white-tailed sea eagle (<i>Haliaeetus albicilla</i>), Steller's sea eagle (<i>European Storm-petrel</i>), black woodpecker (<i>Dryocopus martius</i>), Blakiston's Fish Owl (<i>Bubo blakistoni</i>), etc. all the year round. Main plants are <i>Triglochin maritimum</i>, <i>Glaux maritima</i> var. <i>obtusifolia</i>, <i>Scirpus lacustris</i> subsp. <i>creber</i>, etc. Main birds are <i>Grus japonensis</i>, <i>Anser fabalis</i>, <i>Cygnus cygnus</i>, etc. Main insects are <i>Libellula quadrimaculata asahinai</i>, <i>Procrustes kolbei aino</i>, <i>Limenitis populi jezoensis</i>, etc. Main mammals are <i>Sorex unguiculatus</i>, <i>Clethrionomys rufocanus bedfordiae</i>, <i>Clethrionomys rutilus mikado</i>, etc. Main fish and shellfish are <i>Tapes japonica</i>, <i>Corbicula japonica</i>, <i>Eleginus gracilis</i>, etc. Main amphibian and reptiles are <i>Rana pirica</i>, <i>Hyla japonica</i>.</p>

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## Appendix 1. Contd

Notsuke-hanto and Notsuke- wan	Major Type: Shallow marine water, tidal flat, seagrass/seaweed bed, salt marsh, low moor, sandspit, Summary: The Notsuke-hanto and the Notsuke-wan located in eastern Hokkaido. Because of the diverse natural wetland environment, it is an important stopover site visited by more than 20,000 migratory birds every spring and autumn. The Notsuke-wan is the inner bay surrounded by the peninsula of Notsuke-hanto. The bay has one of the largest seagrass beds in Japan. The sea grass bed of eelgrass ( <i>Zostera marina</i> ) is a rich repository of fishery resources because it serves as a good spawning and nursery ground for various fish and shellfish. Main plants are <i>Iris ensata</i> var. <i>spontanea</i> , <i>Sanguisorba tenuifolia</i> form. <i>alba</i> , <i>Hemerocallis dumortierii</i> var. <i>esculenta</i> , etc. Main birds are <i>Gallinago hardwickii</i> , <i>Tringa totanus</i> , <i>Grus japonensis</i> , etc. Main insects are <i>Sympetrum flaveolum flaveolum</i> , <i>Coenagrion lanceolatum</i> , <i>Libellula quadrimaculata asahinai</i> , etc. Main mammals are <i>Clethrionomys rufocanus bedfordiae</i> , <i>Clethrionomys rutilus mikado</i> , <i>Sorex unguiculatus</i> .
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## Appendix 2. Additional estimation results for selecting independent variables.

Model	RDC_ALL		RDC_VIS	
CONT	8.10758 <sup>a</sup> (0.11168)	8.99707 <sup>a</sup> (0.12287)	6.44673 <sup>a</sup> (0.11611)	7.34899 <sup>a</sup> (0.12810)
PRICE	-	-	-	-
ICM/TICM	0.17638 <sup>a</sup> (0.01436)	0.17378 <sup>a</sup> (0.01447)	0.16176 <sup>a</sup> (0.01470)	0.16323 <sup>a</sup> (0.01472)
GND	0.82053 <sup>a</sup> (0.04621)	0.52030 <sup>a</sup> (0.04688)	0.52640 <sup>a</sup> (0.04664)	0.44509 <sup>a</sup> (0.04710)
AGE	0.02590 <sup>a</sup> (0.00207)	0.00930 <sup>a</sup> (0.00217)	0.01911 <sup>a</sup> (0.00209)	0.01567 <sup>a</sup> (0.00217)
MAR	0.08551 <sup>c</sup> (0.04553)	0.33347 <sup>a</sup> (0.04629)	0.39268 <sup>a</sup> (0.04657)	0.44547 <sup>a</sup> (0.04718)
SCAPE	-	2.16045 <sup>a</sup> (0.05941)	-	1.01246 <sup>a</sup> (0.05992)
WILD	-	0.85554 <sup>a</sup> (0.04625)	-	0.44874 <sup>a</sup> (0.04683)
PLANT	-	0.61238 <sup>a</sup> (0.05938)	-	0.50428 <sup>a</sup> (0.06074)
AMPH	-	0.92477 <sup>a</sup> (0.07459)	-	0.81082 <sup>a</sup> (0.07586)
AREA	-	-	-	-
TNRS	-	-	-	-
LL	-19375.04631	-17714.63551	-16219.02965	-15866.24628
AIC	38760.09262	35447.27102	32448.05930	31750.49256
MR2	0.01807	0.10222	0.01130	0.03281
N	2,256	2,256	613	613

Numbers of parentheses are standard errors of the coefficients; the super scripts of coefficients "a" means the coefficient significant at  $p < 0.1$ , "b" means  $p < 0.5$ , "c" means  $p < 0.1$ , "d" means  $p > 0.1$ , respectively. Appendix 2 shows the results of RDC models omitted some variables in Table 7. Here, the values of AIC and MR2 of the RDC model in Table 7 were 35032.16711 and 0.11283 for RDC\_ALL, 31385.98366 and 0.04403 for RDC\_VIS, respectively. The values of AIC and MR2 in Appendix are higher than these values in Table 7, indicating that the models in Table 7 are suitable for estimations. However, the result also might indicate the possibility of lacking important independent variables because the values of AIC of RDC\_ALL and RDC\_VIS reach the minimum values when using all variables. See Burnham and Anderson (2002) for the details on the model selection.