



Cultivating relational values and sustaining socio-ecological production landscapes through ocean literacy: a study on Satoumi

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Abstract

Sound management of social-ecological systems should reflect diverse values; otherwise, the systems may inadvertently lead to neither fair nor desirable states. Relational values are one of three primary value domains of these diverse values. Since they may strongly motivate care for nature, nurturing these values could be a useful management measure for people involved in management (e.g., policy makers and nonprofit organizations) to realize a desirable state of social-ecological systems. To test this hypothesis, we studied ocean literacy programs at a district junior high school in Hinase District, Okayama, Japan. The district is known as a Satoumi (Japanese coastal socio-ecological production landscape). First, we measured the significance of relational values in the district. Second, we assessed the effect of the ocean literacy programs on cultivating relational values. Third, to test the feasibility of the ocean literacy programs as management measures to cultivate relational values, we used a contingent valuation method, developed in environmental economics, to measure residents' willingness to support the programs. Our study reveals that relational values are a critical component of Satoumi. Students are promising supporters of Satoumi given the declining and aging population of guardians, a result of the decline in revenues from fishery; moreover, the programs cultivate relational values in students. Residents support the ocean literacy programs, and their willingness to pay for them is connected with relational values. Therefore, ocean literacy can be an effective and feasible management measure for sustaining Satoumi through cultivation of relational values.

Keywords Relational values · Satoumi · Ocean literacy · Socio-ecological production landscapes · Contingent valuation method

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1 Introduction

While human–nature relationships vary depending on social-ecological contexts (McGinnis and Ostrom 2014), reflecting their diverse values in decision-making is integral to sound management of social-ecological systems (Pascual et al. 2017). However, values such as relational values have not been received much attention until recently (Klain et al. 2017) and are therefore neither well studied nor explicitly reflected in management decisions. Relational values represent one of three primary value domains comprising the diverse values of nature, along with intrinsic and instrumental values (Chan et al. 2016; Díaz et al. 2015; Pascual et al. 2017).

While relational values have only recently been implemented in ecosystem management (Díaz et al. 2015; Pascual et al. 2017), a similar notion is found in many disciplines, regions, and periods, including shared/social values (Kenter et al. 2015); cultural ecosystem services (Milcu et al. 2013); and philosophies such as classic Greek (Aristotelian “ought”), contemporary Western, indigenous (Tsawalk, Sumak kawsay), feminist (care ethics), and Eastern (Confucian, Buddhist) (Chan et al. 2016; van den Born et al. 2017). Pascual et al. (2017, p. 15) defined them as

[v]alues relative to the meaningfulness of relationships, including the relationships between individuals or societies and other animals and aspects of the lifeworld (all of whom may be understood as conscious persons), as well as those among individuals and articulated by formal and informal institutions. Another type of relational values, *eudaimonistic* values are associated with a good life, which includes considerations of principles and virtues, and values the actions and habits that are conducive to a meaningful and satisfying life.

Relational values are linked to other primary value domains, particularly instrumental values. Pascual et al. (2017) argue that instrumental and relational values are both anthropocentric, and some values of nature cannot be squarely categorized into one type of value. Instead of demarcating instrumental values from relational values, they propose a kaleidoscopic view of values.

Relational values have particular importance because they may provide stronger motivation for caring for nature, compared to intrinsic and instrumental values (Admiraal et al. 2017; van den Born et al. 2017). Hence, cultivating relational values could be a leverage point (Meadows 2008) for sustaining human–nature relationships.

Given these critical roles of relational values and the importance of empirical studies in specific social-ecological contexts for relational value discussions (Chan et al. 2016; Klain et al. 2017), we conducted a case study of Satoumi in Hinase District, Okayama, Japan. Through the case study, we answer three research questions: how critical relational values are for residents in the district as a component of the values that underpin Satoumi (RQ1), how ocean literacy at the district junior high school contributes to cultivating relational values in students (RQ2), and residents’ willingness to support continuation of ocean literacy as a measure for cultivating relational values (RQ3).

Satoumi can be defined as a desired state of human–coastal relationships that enhances both biological productivity and biodiversity through human interaction or management (Yanagi 2013). Satoumi, which dates to at least the Edo period (1620–1850) before the Japanese Industrial Revolution and was ruled by the Tokugawa shogunate (Komatsu and Yanagi 2015), is beneficial for both nature and humans (Ministry of Environment (MoE) n.d.a). For example, rich and diversified ecosystems were maintained during the intense

fishery that was undertaken (Tanaka, 2014). Although it exists across Japan, characteristics and management practices vary by location (Yanagi 2013). It is also called Japanese coastal socio-ecological production landscapes (SEPLs) (Gu and Subramanian 2014).

Satoumi has undergone two significant social-ecological changes. First, during the rapid economic progress beginning in the mid-twentieth century, ecosystems were destroyed or degraded. For example, mudflats and seagrass beds decreased by 72% (1960–1990) and 53% (1898–2006), respectively, in the Seto Inland Sea (SIS), the location of our study area (MoE, Government of Japan n.d.b). The primary reason for the decrease was the development involving land reclamation (MoE, Government of Japan n.d.c). Second, the fishing population declined 73% over the past 50 years primarily due to a decline in the revenues from fishery (Ministry of Agriculture, Forestry, and Fisheries (MAFF), Government of Japan 2016). Fishers, who are knowledgeable about coastal zones, have traditionally been their guardians (Yanagi 2013). Approximately half of the Fisheries Cooperative Associations (MAFF, Government of Japan 2006) have reported that conservation activities will be difficult to maintain in the future owing to aging and dwindling membership along with a declining fishing population.

Adapting to social-ecological changes, decision-makers at local, regional, and national levels have promoted Satoumi. Under the Basic Act on Ocean Policy (April 20, 2007), the Japanese Cabinet Office passed the Basic Plan on Ocean Policy in 2008, which includes promoting Satoumi. The MoE (n.d.b) launched Satoumi-net to promote it, and the Governors and Mayors' Conference on the Environmental Conservation of the SIS (2007) endorsed it. A recent amendment (October 2, 2015) to the Act on Special Measures concerning SIS Conservation shifted the focus from water pollution prevention to realization of Satoumi.

While various studies have been conducted (Duraiappah et al. 2012; Mizuta and Vlachopoulou 2017; Sakurai et al. 2018; Uehara et al. 2016; Uehara and Mineo 2017; Yanagi 2013), no studies have highlighted relational values in the context of Satoumi. Our study is intended to fill this gap.

To answer our research questions, we first assessed how residents think about relational values. Second, we assessed onsite ocean literacy programs at Hinase Junior High School (HJHS) as a means of cultivating relational values. Third, we measured residents' willingness to support the programs, since without support, the programs may be infeasible under "real-world constraints" (Klain et al. 2017, p. 17).

2 Methods

2.1 Study area: Hinase District

Hinase District (Fig. 1) covers an area of 35.92 km², with a population of 7485 (City of Bizen 2015). Fishing, particularly oyster culture, is a primary industry.

The district is well known as a Satoumi (Mizuta and Vlachopoulou 2017; Tanaka 2014; Tsurita et al. 2018). The fishery is sustained by fishers who adapted their management to social-ecological changes (Tanaka, 2014), and their efforts to restore eelgrass beds are notable. Eelgrass beds provide structure and function for water purification, biodiversity maintenance, carbon sequestration, prevention of beach erosion, and recreational and cultural services (MAFF, Government of Japan 2008). During the period of rapid economic growth, eelgrass beds were decimated, dropping from approximately 590 ha in the 1940s

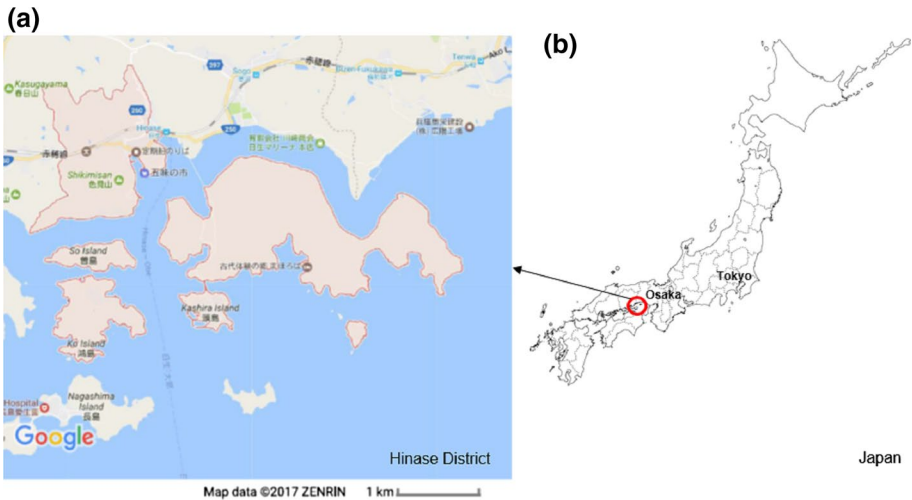


Fig. 1 Location of Hinase District: **a** Hinase District (red areas), and **b** its position in Japan

to 12 ha in the 1980s (Tanaka 2014). Fishermen implementing *Tsubo-ami* (a type of fishing using pound net) initiated a campaign for eelgrass bed restoration in 1986 (unpublished); knowledge of seabed conditions allowed them to identify appropriate measures for eelgrass bed restoration. Restoration began approximately three decades ago, involving fishers and other stakeholders (the municipality, nonprofit organizations (NPOs), and the urban population). More than 200 ha of eelgrass bed have been recovered (Tanaka 2014). Although Satoumi has been shaped and sustained over centuries through adaptive management led by fishermen as *Satomori* (guardians), the current management system faces difficulties because the fishing population is aging (Tanaka 2014); although there are young people with stewardship for the marine environment entering the fishing industry, few and few young people are entering the fishing industry because of a decline in the revenues from fishery.

Relationships are a critical component of Satoumi in Hinase District. By involving fishery-related activities from eelgrass bed restoration to harvesting oysters and fishing to selling and eating them, people are connected with other people and the ocean. For example, Inoue and NHK (2015), who surveyed Satoumi there, argue that it recovers something lost during modernization. “People become happy simply by connecting with each other. People in Satoyama and Satoumi are more skilled at connecting. They easily and freely connect with each other, along with their connections to nature and creatures in their region.” (Inoue and NHK 2015, p. 193).

2.2 Ocean literacy programs at HJHS

Ocean literacy programs were initiated and designed by HJHS for “a period of integrated studies” following guidelines of the Ministry of Education, Culture, Sports, Science, and Technology (n.d.). All schools are mandated to design programs and content for this period, allowing the programs to reflect local context. The programs at HJHS, started in 2000, are part of the formal curriculum; therefore, all children in the district, about 200 students (13–15 years old), participate.

There are three programs: restoration of eelgrass beds (*Zostera marina L.*) (Figure 2a and b), experiencing oyster culture (Fig. 2c), and learning through *kikigaki* (listening and noting dictation) from people experienced in the practices of Satoumi (Fig. 2d). Stakeholders, including local fishermen, residents, and NPOs, collaborate in the programs. Eelgrass bed restoration is the main activity of Satoumi management, while oyster culture is an important industry in the district. In *kikigaki*, students are taught by people knowledgeable about Satoumi, allowing them to gain insight into and knowledge of the community and to ponder future human–nature relationships. The programs continue throughout the year for all participating students with the following goals/aims:

- (1) Learn about the community and understand the sea in their district of Hinase, the role of eelgrass beds, and how restoration contributes to revitalizing the fishery industry and strengthening the future of Hinase;
- (2) Learn that eelgrass bed restoration helps revitalize the ecosystem (e.g., fish nursery, purification of bottom sediment, and carbon sequestration (Tanaka 2014));
- (3) Develop a sense of attachment and pride in their hometown by contributing to district revitalization;
- (4) Learn the significance of work in general; and
- (5) Provide opportunities for communication with residents students might otherwise not have.



Fig. 2 Ocean literacy programs at Hinase Junior High School (HJHS): **a** collecting floating eelgrass; **b** washing decayed eelgrass to extract seeds for sowing; **c** scraping oysters to remove excrescences such as barnacles (*Balanomorpha*) and sea squirts (*Ascidiacea*); and **d** *Kikigaki*, with a fisherman explaining oyster culture

2.3 Measuring the importance of relational values for residents (RQ1)

We mailed a questionnaire to all households in the district (2980 questionnaires) in December 2016. The questionnaire included questions about the importance of relational values for residents (RQ1) and questions to elicit residents' willingness to support literacy using the contingent valuation method (CVM) (RQ3). The response rate was 15.8% (472 households) (see Supporting Information (SI) for descriptive statistics).

We developed seven relational value statements (RVS) based on Chan et al. (2016, Fig. 1):

1. Hinase is important to me (individual identity).
2. Hinase is important to our people (cultural identity).
3. Relating to the sea at Hinase provides a vehicle for connecting with people (social cohesion).
4. Caring for the sea at Hinase is crucial to caring for my fellow humans, the present, and the future (social responsibility).
5. Caring for the sea at Hinase and its life forms is a moral necessity (moral responsibility to non-humans).
6. Caring for the sea at Hinase fulfills me and helps me lead a good life (stewardship eudaimonic).
7. Keeping the sea at Hinase healthy is the right thing to do (stewardship principle/virtue).

The degree of agreement with each statement was measured using a five-point Likert scale (strongly disagree=1; strongly agree=5) similar to the relational values surveys deployed in Klain et al. (2017).

In addition to comparing statement responses using histograms, we used Cronbach's alpha and exploratory factor analysis (EFA) to assess internal consistency and dimensionality of the statements for comparability with Klain et al. (2017). Cronbach's alpha measures the internal consistency or homogeneity of statements (Cronbach 1951) and is the most common measure of scale reliability (Field et al. 2012). EFA identifies common factors that underlie the statements; the number of common factors represents the number of dimensions. When statements are internally consistent and unidimensional, they can be used as an index; in other words, as an explanatory variable for CVM.

For Cronbach's alpha, EFA, and regression analysis, we used the statistical analysis software STATA (Version 14.2) by StataCorp LP (<http://www.stata.com>).

2.4 Assessment of ocean literacy programs regarding relational values (RQ2)

The assessment comprises two parts. First, the authors visited the district several times beginning in 2015 to participate in and observe the programs, and assess whether the programs conform to strategies of the relational values approach discussed by Chan et al. (2016).

Second, we conducted interviews with students who participated in the programs. We used semi-structured interview techniques (Barriball and While 1994; Otani et al. 2013), preparing certain questions in advance, while encouraging students to talk freely and as much as they wanted. We anticipated that students would hold different views of the sea and local community and that their impressions of the programs would vary. Therefore,

a questionnaire with predetermined answers was considered inappropriate. Furthermore, although ocean literacy assessment instruments are available (Plankis and Marrero 2010), none of these assess relational values.

Students were divided into 12 groups of three students for each grade (first, second, and third year). Interviews with each group lasted approximately 20 min. In April 2016, we interviewed 108 students (57 boys and 51 girls): 12 groups each of first-year, second-year, and third-year students (13, 14, and 15 years old, respectively). We posed eight questions to all students about their attitudes toward the sea at Hinase and their awareness of the relationship between the sea and their lives (SI). We posed two additional questions to second- and third-year students about their impressions of the programs (SI). Questions were based on observations of the programs at HJHS in 2015 and a pilot interview in March 2016 including fifteen students (one month before this study was conducted; Sakurai et al. (2018)). Interviews were recorded and transcribed for analysis. Using the findings regarding the contributions of ocean literacy programs to relational values as a base to construct a hypothetical scenario, we conducted CVM to measure resident support for the programs.

2.5 Measuring resident support for ocean literacy programs (RQ3)

We adopted CVM to measure residents' willingness to support the programs. Using non-market valuation such as CVM is sometimes controversial (Freeman et al. 2014; Kallis et al. 2013; Matulis 2014; McCauley 2006). Some people reject monetary valuation for ethical reasons. For example, McCauley (2006) asserted that "Nature has an intrinsic value that makes it priceless" (p.28). An empirical study by Klain et al. (2014) revealed that most cultural ecosystem services are not very amenable to market or non-market economic valuation, although some can be captured by market and non-market economic valuation. Norton et al. (1998) argued that non-market economic valuations relying on consumer sovereignty capture individual preferences and they may be inconsistent with community preferences. Supporting educational programs involves long-term and collective preferences.

The relational value literature neither encourages nor rejects monetary measurement (e.g., willingness to pay (WTP)) (Chan et al. 2016; Pascual et al. 2017). The kaleidoscopic view of values proposed by Pascual et al. (2017) shows that there is no clear demarcating line between relational values and instrumental values to which non-market valuations are often applied. We believe that CVM could shed light on some aspects of relational values if appropriately applied as we discuss below, and discuss justification for using CVM, aspects of relational values that it captures, and techniques, with a focus on reliability and validity.

2.5.1 Justification for CVM

CVM makes three contributions to relational value studies. First, this is an "empirical testing of relational values in the context of trade-offs and/or external constraints, including scenarios or choices to more accurately reflect the types of decisions people make on a daily basis." (Klain et al. 2017, p. 17). CVM presents respondents with hypothetical scenarios of real-world constraints, such as income. Second, program implementation requires funds, and WTP can provide guidance for making funding decisions. As Chan et al. (2016) argue, "[w]ithout investing in human-nature relationships and broadly shared values, the proenvironment community may soon find that the relational values that have always propelled it are rapidly deteriorating." (p. 1465). Third, CVM can incorporate "relational value

statements as an index” (Klain et al. 2017, p. 17) to explore the relationship between statements and WTP for the programs.

Our CVM meets the four criteria for using monetary valuation proposed by Kallis et al. (2013). The first is additionality, or consideration of whether the environmental conditions at stake are improved. WTP sheds light on certain, but not all, aspects of relational values nurtured by literacy. It does not “omit,” “reduce,” or “unconsciously marginalize” environmental values (Kallis et al. 2013; Klain et al. 2017; Milcu et al. 2013). The second criterion is equality; inequalities should be reduced and power-distributed. Since the payment method proposed in CVM is donation, low-income households are not exploited. Third, plural value-articulating institutions should be maintained; our valuation aims to contribute to integrated valuations. Fourth is confronting commodification under neoliberalism, considering whether valuation will serve processes of enclosure of the commons. As Kallis et al. (2013) claim, “valuation does not necessarily lead to commodification.” (p. 100). Monetary valuation of the programs does not privatize them or their benefits.

2.5.2 Aspects of relational values captured by CVM

CVM measures WTP for an improvement and can be described as:

$$v_i(P^0, Q^0, y_i) = v_i(P^0, Q^1, y_i - WTP_i), \quad (1)$$

where v_i is the indirect utility function of the i th individual, P^0 is a vector of prices assumed to be constant, Q is a vector of attributes (e.g., environmental conditions) where at least one element improves from Q^0 to Q^1 , and y_i is income of the i th individual (Bishop and Boyle 2017). Hence, WTP_i is the amount of money that individual i would sacrifice while maintaining individual utility before and after the improvement in Q . WTP_i captures increases in utility caused by improvements. In our study, Q is the improvement in relationships (see the hypothetical scenario in 2.5.3. Estimation techniques) due to ocean literacy and WTP_i is positive if it improves resident utility. It is therefore worth noting that WTP_i does not value whole aspects of education such as the knowledge students acquire. Q and its contributions are described in the survey in words based on findings from the program assessment.

We should note that what WTP captures is assigned values, not underlying held values (Brown 1984). Held values are certain types of behavior (e.g., loyalty), end states (e.g., freedom), and quality (e.g., beauty) that people value (Segerson 2017). People have held values related to environmental protection if they perceive it as a desirable behavior, end state, or quality. Values are based on reasons or motivations, such as environmental ethics, spirituality, aesthetics, or eudaimonic (relational) values (Segerson 2017; van den Born et al. 2017). Non-market valuation does not measure held values because they are not directly measurable in economic terms (Segerson 2017). Hence, economic theory does not talk about held values, and it is nearly completely flexible for accommodating competing systems of preferences (Flores 2017). This means that WTP does not directly conflict with motivation in terms of relational values as held values. Accordingly, “non-market valuation simply seeks to measure the values that individuals assign to a given change based on their preferences over alternative outcomes and the trade-offs they are willing to make” (Segerson 2017, Kindle Locations 236–237); that is, assigned values. Held values are manifested in, but distinct from, the assigned values of a given change (Segerson 2017).

Our CVM captures values assigned to a change derived from program continuation, which could contribute to relational values, but does not measure them as held values. This

is not an attempt to monetize relational values themselves as WTP, although they underlie it. Therefore, what CVM captures and its intention are distinct from studies that adopt different approaches for examining relational values as held values, which become motivation for nature conservation (Admiraal et al. 2017; van den Born et al. 2017). Although our focus is assigned values, we investigated their relationship with relational values using RVS as an index in WTP estimation.

2.5.3 Estimation techniques

As true values are unobservable, criteria for reliability and validity have been proposed (Bishop and Boyle 2017; Freeman et al. 2014). Reliability addresses variance in WTP estimation. There are three types of validity: content, construct, and criterion. Content validity concerns the design and procedures of CVM, construct validity concerns consistency with economic theory, and criterion validity involves comparison of results with other reliable measures.

Our goal was to value the continuation of an ocean literacy educational program. Since HJHS covers Hinase, we assumed that the beneficiaries of the relational values cultivated through the program are residents in the district (see the hypothetical scenario below) and mailed a questionnaire to all households in the district. To ensure the content validity, we followed Boyle (2017) and conducted a pretest with college students who were accessible by the authors and elderly people who may have difficulty in understanding a questionnaire (e.g., due to word choice and font size) to check questionnaire design. They were not residents in the district because we aimed at mailing the questionnaire to all households. To reduce hypothetical bias, we added a budget constraint reminder in the questionnaire.

The questionnaire design, including the hypothetical scenario regarding changes in Q in Eq. 1, reflected findings from the assessment of the ocean literacy programs at HJHS (see SI for the hypothetical scenario). The scenario was followed by the return (or contribution to indirect utility, v_i in Eq. 1) on the payment as:

1. Programs could build a rich relationship between students and the sea, and between students and residents. (Currently, all students (approximately 200) participate in the programs.)
2. By nurturing students who can lead Satoumi in the future, it is possible to build and maintain the rich relationship between the sea and residents, and among all residents in the district. However, the exact degree of contribution of the programs to such future relationships is unknown.

Return involves both short- and long-term outcomes, conforming to the investment argument of Chan et al. (2016), stating that investment justification involves a long-term perspective.

To elicit WTP, we adopted a double-bound dichotomous choice method (Mitchell and Carson 1989), using six amounts of bid (300, 500, 1000, 3000, 5000, and 10 000 JPY). This method is less susceptible to bias than other formats (Mitchell and Carson 1989).

In WTP estimation, we conducted two separate estimation methods for reliability and convergent validity, and one type of construct validity test (Bishop and Boyle 2017). We conducted parametric log-logistic and nonparametric Turnbull model estimations to compute WTP with 95% confidence intervals, obtained by bootstrapping (Aizaki et al. 2015). We also estimated two multivariate log-logistic models: One added income to test consistency with economic theory, while the other added socioeconomic attributes, including a

relational values index based on the RVS, to identify variables affecting WTP. To construct the relational values index, we treated the summation of RVS measured by Likert items as interval data (Carifio and Perla 2008). To ensure content validity, we removed respondents who were not confident in their answers.

For WTP estimation, we used a package by Nakatani, Aizaki, and Sato (<https://cran.r-project.org/web/packages/DCchoice/citation.html>) run in R (Version 3.4.3 for Windows (64 bit), R Foundation, <https://www.r-project.org/>).

3 Results

3.1 Importance of relational values (RQ1)

Overall, respondents support all RVS (Fig. 3). Most respondents strongly agree with “stewardship principle/virtue.”

Cronbach’s alpha for the test scale is 0.891. Deleting different RVS did not improve the score (SI).

EFA was conducted without rotation to extract one or more factors (SI for detail). Using Kaiser’s criterion of eigenvalues greater than 1, only one factor was retained. Factor loadings were greater than 0.4, meaning that all statements contributed to factor 1 (Field et al. 2012).

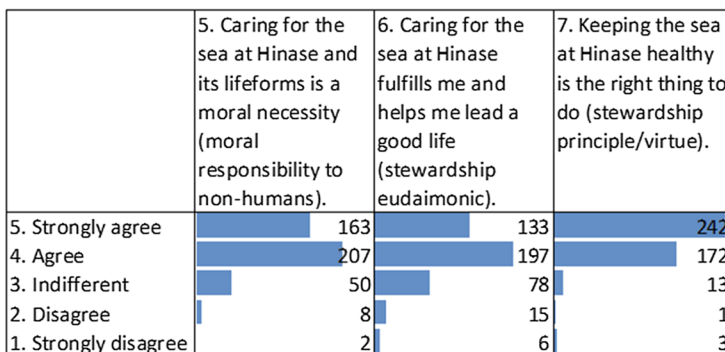
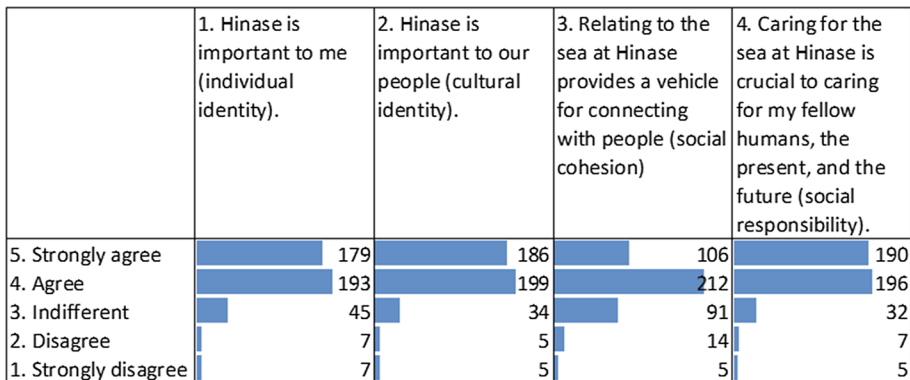


Fig. 3 Respondent support for RVS measured by Likert items (number of respondents)

3.2 Contributions of ocean literacy to relational values (RQ2)

The programs were consistent with strategies for cultivating relational values (Chan et al. 2016). All HJHS students participated in eelgrass bed restoration and experienced oyster culture, strengthening the relationship between the sea and people, and enhancing Satoumi. The bond between fishermen and students could serve “as a conduit for social norms of respect for, knowledge of, and passion about nature” (Chan et al. 2016, p. 1464). Bonding is facilitated through struggling and suffering together, and celebrating (Chan et al. 2016). Through our participation in the programs, we observed that the eelgrass bed restoration and oyster culture projects involve painstaking activities for students, including washing putrefied eelgrass to extract seeds and cleansing oyster shells. At the end of the oyster culture project, students celebrated their hard work by eating harvested oysters. *Kikigagi* (listening and noting dictation) from the fishermen, who had struggled with maintaining Satoumi, facilitated students’ learning of local narratives and challenges related to Satoumi.

In interviews, we asked questions about awareness of the sea. Here, we focus on findings associated with relational values nurtured by the programs (see Sakurai et al. (2018) for detailed results of the interviews). We found that the longer students participated in the programs, the closer they felt to the sea. Most third-year students felt close to the sea, while there were fewer such students in first and second grades. Some third-year students commented that the programs changed their appreciation of the sea and willingness to protect it for themselves, their communities, and future generations. Examples include (see SI for more comments):

“[the sea at Hinase] makes me feel calm because this is my sea” (individual identity),

“I feel good about people working at the sea” (social cohesion),

“After listening to stories, ..., I want to do my best because I have the same feelings as the fishers.” (social cohesion),

“Before studying, I did not have a particular awareness or feeling about the sea. After studying, I feel that it is our turn to protect the sea.” (social responsibility, moral responsibility),

“I became interested in the restoration of eelgrass. Making the sea better gives me a feeling of achievement, which makes me happy.” (stewardship eudaimonic),

“When I commute to school by bicycle and see eelgrass floating by the coast, I feel that I should collect it.” (stewardship principle/virtue).

These comments, although subjectively interpreted by the authors, indicate that ocean literacy programs at HJHS contributed to providing opportunities for students to learn their relationship with the sea, as well as with residents, including fishermen. Moreover, students came to recognize the value of their relationship with nature, as well as with local people.

3.3 Residents’ willingness to support ocean literacy (RQ3)

Parametric and nonparametric mean WTP value estimations differ (5881.2 and 3639.2 JPY, respectively), but their 95% confidence intervals overlap, 4899.4 – 7048.7 JPY for parametric and 2527.7 – 5320.9 JPY for nonparametric (Table 1). Relatively low mean WTP from the (nonparametric) Turnbull model is reasonable, since this method gives lower bound estimates (Aizaki et al. 2015).

Model 1 confirms that the model conforms to economic theory (construct validity) in that income is a key variable for the indirect utility function [Eq. (1)] and is indeed statistically significant in the model. Model 2 shows that in addition to the bid, the relational values index and households with HJHS students are statistically significant as explanatory variables for residents’ willingness to support the programs (Table 2).

Table 1 Mean willingness to pay (WTP) values obtained from parametric log-logistic and nonparametric Turnbull models

	Parametric log-logistic	Non-parametric Turnbull
Mean WTP (JPY)	5881.2 ^a	3639.2
95% CI lower bound (JPY)	4899.4	2527.7
95% CI upper bound (JPY)	7048.7	5320.9
N	287	287

^aMean WTP for parametric log-logistic was truncated at the maximum bid

Table 2 Multivariate log-logistic models

	Coefficients ^a	
	Model 1	Model 2
	Economic theory	Full
Constant	8.455*** (0.700) ^b	5.300*** (1.358)
log(Bid)	-1.129*** (0.088)	-1.278*** (0.099)
Income	0.001** (0.000)	0.001 (0.000)
Knowledge about ocean literacy		-0.403 (0.447)
Knowledge about Satoumi		-0.024 (0.274)
Relational values index		0.135*** (0.033)
Gender		0.233 (0.277)
Age		0.009 (0.012)
Junior high school students		1.236** (0.480)
Elementary school students or younger		0.149 (0.505)
Log-likelihood	-297.156	-284.794
LR statistic	2.403 ($P=0.121$)	27.129 ($P=0.001$)
AIC	600.313	589.587
BIC	610.841	624.681
N	247	247

See SI for the detail of variables

^aSignificance: ***at 1%; **at 5%; and *at 10%

^bSE in brackets

4 Discussion

4.1 Importance of relational values (RQ1)

Much higher than our nationwide online survey conducted in 2015 (9.18%, $N=7264$, unpublished), 55% of residents answered that they are familiar with the term Satoumi (SI). We asked district residents if they agreed with the RVS characterizing Satoumi and overall residents valued all seven RVS (Fig. 3). This shows the importance of relational values as one part of the motivations underpinning the practices that sustain Satoumi in the district; hence, it is important to include in integrated valuation to facilitate sound decisions (Chan et al. 2016; Pascual et al. 2017) about Satoumi management.

Since the development of RVS is in the early stages and there has been no agreed-upon set of RVS, we explored the characteristics of the seven RVS. Although not directly comparable because different RVS and populations were used, Klain et al. (2017) also found support for RVS but with more varying distributions. This necessitates further study of the choice of RVS themselves, in addition to the importance of RVS corresponding to various social-ecological contexts. For example, further studies using interviews (van den Born et al. 2017) may help develop other ways of phrasing relational value statements and also understand their implications. Cronbach's alpha is higher than the threshold values (0.7 to 0.8), indicating internal consistency (Field et al. 2012). EFA extracted one factor; therefore, the RVS are unidimensional. This is consistent with Klain et al. (2017), who suggested that RVS can be a single construct and have potential as an index. We used a relational values index in the WTP estimate, showing that the index is statistically significant as an explanatory variable for residents' willingness to support the programs.

However, the low response rate (15.8%), although not exceptionally low as a mail-based survey (e.g., 16.4 and 17.5% by a study conducted by Oishi et al. (2010)), could imply that the results do not represent the population; rather, respondents could be biased toward residents with an interest in the programs (80% knew the programs (SI)). To raise the response rate, it could be effective to ask for the municipality to accredit a mail survey as an official survey.

4.2 Ocean literacy programs as a means of nurturing relational values (RQ2)

The ocean literacy programs conformed with strategies for relational values (Chan et al. 2016). Students commented that the programs changed their appreciation of and relationship with the sea, and their willingness to protect it for themselves, their communities, and future generations. Their motivations were related to relational values (i.e., RVS), revealing the potential importance of the programs for nurturing relational values in students. This finding is consistent with van den Born et al. (2017). Onsite learning has been recognized as important in growing relational values (van den Born et al. 2017). Students with higher relational values may have stronger motivation to support Satoumi in the long term (Admiraal et al. 2017; van den Born et al. 2017). This is critical given the declining and aging fishing population who have guarded Satoumi. Because of the importance of relational values as part of Satoumi, nurturing relational values contributes to Satoumi.

The programs at HJHS are formal, designed for a period of integrated studies compulsory at junior high school, and follow government guidelines. Therefore, institutional barriers to transplantation are low; other schools in Japan could introduce similar programs reflecting their own social-ecological contexts. The programs could also be insightful for

other countries. For example, ocean literacy in K-12 in the USA, promoted by NOAA (2013), may adopt strategies that could cultivate relational values.

Our findings have at least three limitations, related to understanding causal links between learning and outcomes (Suškevičs et al. 2017). First, interviews were not explicitly designed to explore relational values, but to elicit whatever students wished to express. Questions designed for relational values may reveal the programs' further impacts on relational values. Second, interviews were not longitudinal; we did not conduct pre- and post-interviews, which is preferable for assessing program impact (Ernst et al. 2009; Rossi et al. 2003). Hence, there is room to argue whether the findings can be solely attributed to the programs. Third, interviews with other stakeholders, including teachers, residents, fishers, and NPOs, along with student self-assessment, could corroborate the assessment. A systematic approach such as 360-degree feedback (Tee and Ahmed 2014) may help.

4.3 Residents' willingness to support the programs (RQ3)

CVM revealed residents' willingness to support the programs, reinforcing their future feasibility. Mean WTP was estimated at 2528–7049 JPY per household. This represents values assigned to the benefits derived from program continuation for ten years. Although this does not capture all the relational values comprising Satoumi in the district, but values assigned to the programs, WTP is informative for ocean literacy because financial support is critical for the programs. Income was statistically significant in the economic theory sound model (model 1) and respondents reflected their real-life constraints (Klain et al. 2017). Multivariate model 2 revealed that the relational values index is statistically significant, implying that WTP as an assigned value is related to the relational values underlying it. Alternatively, relational values as held values were manifested in the assigned value measured in WTP. This suggests ocean literacy likely has strong public support and may be a feasible management measure for sustaining Satoumi.

Household WTP could also be used as a unit value in benefit transfer (Rosenberger and Loomis 2017) to assess the potential benefits of ocean literacy at other schools. Whereas programs at HJHS received funding from multiple sources because of reputation, other schools cannot expect similar funding and would require other sources such as donations. The transfer, of course, should be very careful about the differences in the contexts between our study site and a place where the WTP is transferred (Spash 2008).

Our study has limitations. First, since neither the true value (the value when real payment was made) nor how much people actually donate was available, no criterion validity test could be conducted, though this does not negate the results (Bishop and Boyle 2017). Second, actual funding decisions should be carefully considered because of the crowding-out effect (Frey and Oberholzer-Gee 1997), which means that monetary compensation might reduce intrinsic motivation, leading to less motivation for stakeholders (e.g., fishers) to be involved in the programs. Third, by focusing on assigned values using CVM, held values behind the assigned values were not investigated. As some scholars argue, articulating these values is matters for debate and deliberation (Spash 2008). For example, small group deliberative monetary valuation could be useful (Spash 2007).

In addition to our research question findings, the programs also had a positive effect on fishermen, for whom eelgrass bed restoration is an arduous task. Our observations of the program participants indicated that fishermen were motivated and encouraged by helping the students and watching them enjoy restoration activities. This aspect needs

further investigation to explore how being part of the programs contributes to fishermen's well-being.

5 Conclusions

Satoumi, a Japanese socio-ecological production landscape (SEPL), has maintained a desirable human–nature relationship for the community. However, because of ecosystem degeneration, and the recent decline in the fishing population, the traditional guardians of Satoumi, management must adapt. We conducted semi-structured interviews with students participating in ocean literacy programs to collect qualitative data to assess the programs regarding relational values, and CVM to collect quantitative data to measure residents' support for the programs. The findings obtained from the semi-structured interviews were also used to design a hypothetical scenario for CVM. Our empirical study reveals that relational values are an important component of the district's Satoumi. Ocean literacy can cultivate relational values in students, who may become future supporters of Satoumi. Relational values can motivate people to take action for nature (van den Born et al. 2017). Hence, literacy could raise and maintain the value of Satoumi in the district. CVM shows resident support for the programs, or its feasibility under hypothetically set real-world constraints. We show that WTP as assigned values of an improvement brought by ocean literacy is positively related to relational values as held values measured by a relational values index.

Ocean literacy is an effective (as interviews with students indicate) and feasible Satoumi management measure in the face of ecological degradation and a declining and aging fishing population. Our research supports how ocean literacy could be a leverage point for enforcing positive feedback (Meadows 2008) to sustain Satoumi; it engenders stronger relational values that motivate students to contribute to Satoumi management, resulting in stronger relational values.

Studies on relational values in ecosystem management are relatively novel. We hope our empirical findings encourage further studies, and that relational values are further incorporated into integrated valuation and ecosystem management.

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Compliance with ethical standards

Conflicts of interest All authors declare that they have no conflict of interest.

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