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COPARISON BETWEEN THE COMPENSATORY MITIGATION PLAN BASED ON HEP AND CREATED SUBSTITUTIVE PONDS FOR SPAWNING

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Abstract: Since the environmental assessment technique has never been established in Japan, an impact of the environmental restoration project cannot be justified objectively. Habitat Evaluation Procedures (HEP), which is one of the most applicable methods in evaluating the environments in the U.S.A, has been recently introduced to Japan together with the investigation of its applicability. This paper aims to examine whether the environment condition and its compensatory mitigation projects can be evaluated by using HEP or not. As a case study, the environmental conditions of the spawning ponds for the Tokyo salamander, which disappeared by constructing the Chiba-Togane road, and the substitutive ponds for spawning created by the Japan Highway Public Corporation (JH) as the compensatory measure for disappeared habitat area were evaluated by using HEP. Moreover, the study also assessed how this compensatory measure can contribute to the conservation of environments around the road through the comparison of the results evaluated for these ponds.

Key Words: Environmental Plan, Habitat Evaluation Procedures, HEP, Tokyo Salamander, Compensatory Mitigation

1. INTRODUCTION

During the last five decades, a lot of constructions for various infrastructures had been established together with the high economic growth in Japan. Based on these dramatic changes, the natural environment and also its habitants have suffered from the destruction (Ecosystem Conservation Society, 1994). Highway, an essential infrastructure, used to be constructed in local rich natural area. Although, it has not occupied much space itself, its impact on the surrounding environments has been huge and significant.

Corresponding to the situation, Environment Impact Assessment (EIA) Law was enacted in 1999 and the environment conservation measures, namely avoidance, minimization and compensation of impacts of development had to be considered at the planning phase of a road construction project in which the change of route and curtailment of road scales were included. However, at moment the enforcement of compensatory mitigation with quantitative evaluation of the effects by conserving environment is not obligated under this Japanese EIA procedure. Even if it is required, the environment assessment method to evaluate the functions and values of disappeared and compensated environment quantitatively has never been established (Tanaka 2000).

In order to deal with these problems, an environment assessment method so-called HEP that widely has been utilized in the United States has been introduced and applied as trials in Japan recently.

This paper also tested whether HEP can be applied to evaluate the actual project to conserve the natural environment or not. Thus, the following approaches were employed.

- The results evaluating spawning ponds compensated by Japan Highway Public Corporation through using HEP were assessed as a compensatory mitigation.

- The results of a case study of a HEP compensatory mitigation plan were compared with the ones assessed by the actual compensation of substitutive ponds in spawning.

2. THE PRESENT CONDITIONS OF SUBSTITUTIVE PONDS FOR SPAWNING OF TOKYO SALAMANDER

As mentioned above, the compensatory mitigation has not been compulsory yet, but the JH has been carrying out an environmental creation actively for the area along their highway. This is to be a conservation measure for the natural environments, which are disappeared by a highway construction (JH, 1997).

In the case of Chiba-Togane road, which was constructed since 1990, JH had to create substitution ponds for Tokyo salamander on the conservation plan. In the opinion document submitted by the governor of Chiba prefecture to JH, it reported that from the phase of draft environment impact statement of the construction in 1989 various species of animals had to be conserved. In particular, the Tokyo salamander had been was nominated as endangered specie, therefore it should be seriously protected.

As the results, JH acquired spaces by purchasing private lands around roadside, and they created the four substitutive ponds for spawning of Tokyo salamander in order to compensate the disappeared habitat area, and two existed ponds were disappeared as shown in Figure 1. The substitutive ponds created by JH were demonstrated in Figure 2 to 5. The substitutive ponds for spawning were created by using nature materials, and the pumping system to provide fresh spring water automatically was equipped to make quantity of water stable. JH also designed the ponds with the consideration on continuity between surrounded forest and slope of the ponds that is necessary for Tokyo salamander to move from the ponds to forest for growing.

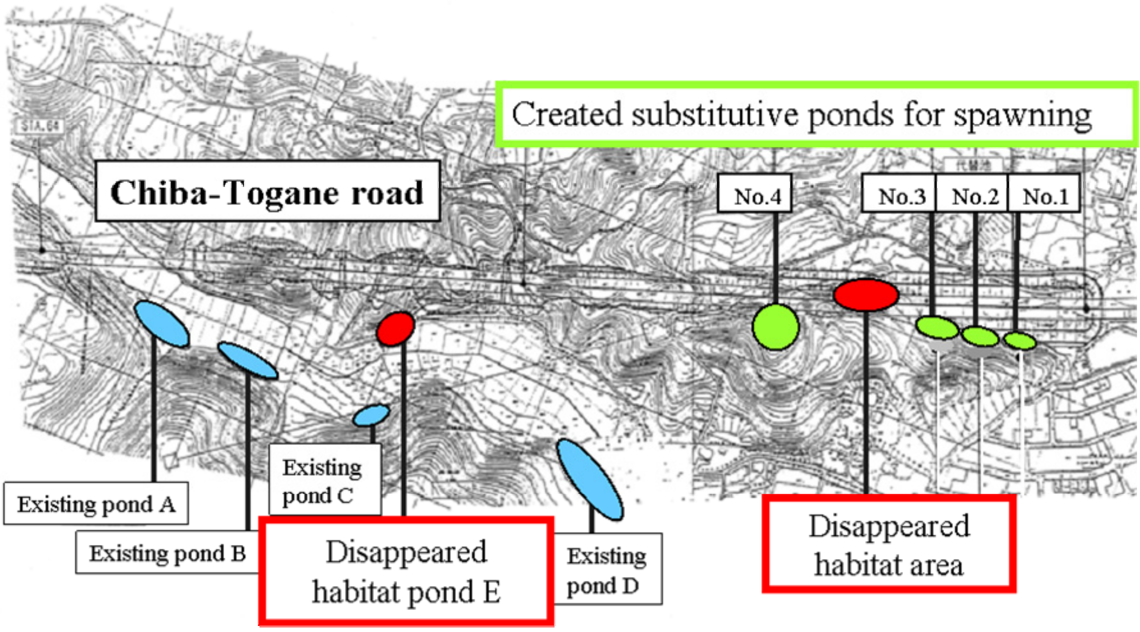

Figure 1. Project Area

Figure 2. Substitutive Pond for Spawning No,1

Figure 3. Substitutive Pond for Spawning No,2

Figure 4. Substitutive Pond for Spawning No,3

Figure 5. Substitutive Pond for Spawning No,4

3. APPLYING THE HEP TO THE TOKYO SALAMANDER

3.1 Introduction of HEP

In Japan, environment conservation measures have been recommended by enactment of Environment Impact Assessment Law in 1999, but there are no environment assessment methods for assessing compensatory mitigation. Therefore, it is impossible to assess the effect of environment conservation and whether the success or not by creating habitat artificially. For dealing with this problem, the HEP that has been using in many states in the U.S.A. is taken into account for Japan, and various societies and Ministry of Land, Infrastructure and Transport attempt to introduce the HEP into Japan in recent years (Tanaka 2002).

The fundamental concept of HEP can be explained as follows (Morimoto 2004):

1) The indispensable living conditions like food, water, cover and reproduction for target creature can be defined by using the Suitable Index (SI). The SI means the quality of habitat, and it is represented from 0 (unsuitable) to 1 (most suitable).
2) The synthetic quality can be calculated as the Habitat Suitable Index (HSI) by a geometric mean of all SIs.
3) The HU (Habitat Unit) can be computed simply by multiplying HSI by area.
4) Created habitat can be assessed as compensatory mitigation by comparing the HU of disappearing habitat by project with the HU of compensated habitat.
5) It is possible to consider the changes of HU in each year by making each baseline, and also assess how much HU is increased in project life by calculating accumulation of HU that is estimated by subtracting disappeared total HU from compensated total HU.

Generally, the successful standard of the compensatory mitigation using the HEP can be defined as follows. Under the preconditions representing the characteristic of disappeared and compensated environments by accurate SI model, the HU accumulation is calculated based on the baseline, and if it is more than 0, it may be able to assess as a successful compensatory mitigation project. However, the final judgment for a successful mitigation project depends on the results of monitoring survey. In this paper, the substitutive ponds of spawning for Tokyo salamander was evaluated by using HEP whether it was an enough compensatory mitigation, because those had been created without mitigation plan and the effect would not be estimated in advance. As the result of HEP assessment, it can be said that it succeeds as a compensatory mitigation, if the existing conditions can be maintained. Nevertheless, it is considered that a continuous monitoring is also necessary in the future.

3.2 Current Situation of Tokyo Salamander

The Tokyo salamander is specified as one of endangered species on the Wildlife-Red Data Book in Japan (the edited by the reptiles and amphibians 2000) edited by the Ministry of the Environment. In addition, it is also classified as a local population with fear of extinction, an important protection living thing, or a vulnerable specie on the Red Data Book of Tokyo, Chiba, Saitama, and Ibaragi prefectures.

The Tokyo salamander inhabits the paddy field which are scattered in the valley of the hilly country of the Pacific Ocean shore, waterside space, such as the waterway, the forest of a low mountainous area, etc, and eat insects and earthworms. According to many reports (JH 2001, Amejima 2003), the Tokyo salamander used to breed from February to April. And their eggs hatch from February and their transformation to adults used to start in May.

3.3 Reproduction Conditions and Summary of Investigation

The indispensable living conditions and SI of Tokyo salamander were referred to the studies of Amejima (Amejima 2003, Komatsu 2003). The crucial conditions (V_1, V_2, V_3, and V_4) of Tokyo salamander are distance from pond to forest, depth of water, water quality and water temperature. The SI for distance from forest to pond (V_1) becomes 1 if distance is between 0 to 20 m. and SI approaches 0 if distance is longer as shown in Figure 6. The most suitable depth of water is in the range of 15 to 20 cm. as depicted in Figure 7. If it is too deep, Tokyo salamanders cannot get oxygen. The most suitable water quality is with PH 6 to 7 in Figure 8. The most suitable water temperature is between 15 to 20 degrees centigrade as shown in Figure 9.

In order to obtain data of substitutive ponds, a field survey was conducted in 16 March 2004. The depth of the pond was obtained as the average of the depths that were measured at 5 positions of the pond, and the water quality of spawning pond was measured by pH meter, and the water temperature was measured using the water thermometer (see Figure 10). Since it is impossible to acquire all data concerning disappeared habitat area, the field survey was carried out at a similar area to the disappeared habitat area in term of quality. The area of substitution spawning ponds, disappeared habitat area and disappeared pond E was calculated based on the information from the report, plans, our field survey and the monitoring survey.

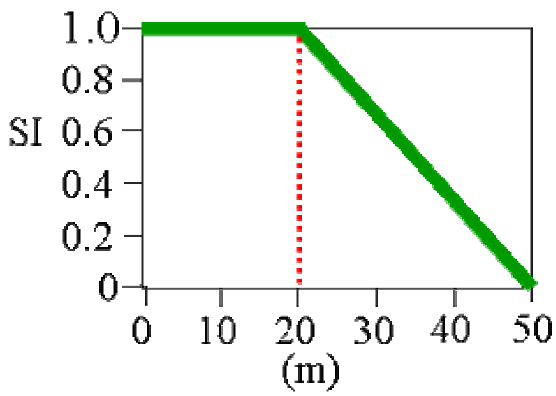

Figure 6. Distance from Pond to Forest

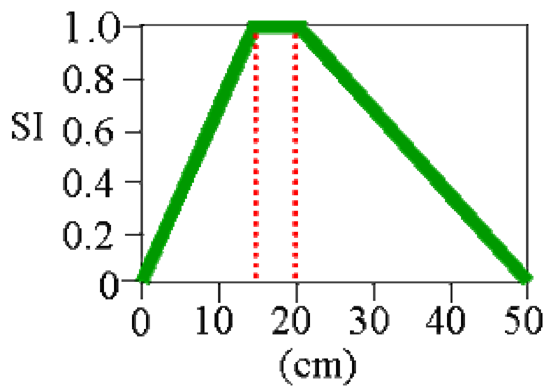

Figure 7. Depth of Water

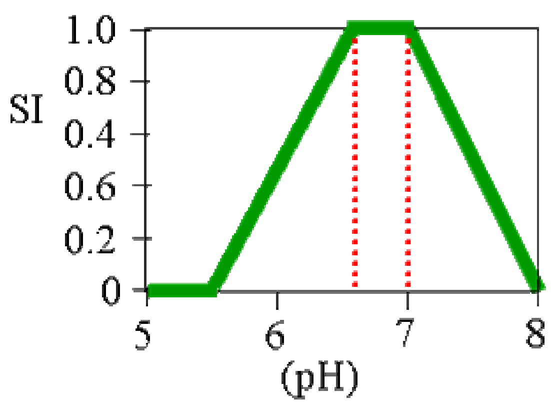

Figure 8. Water Quality

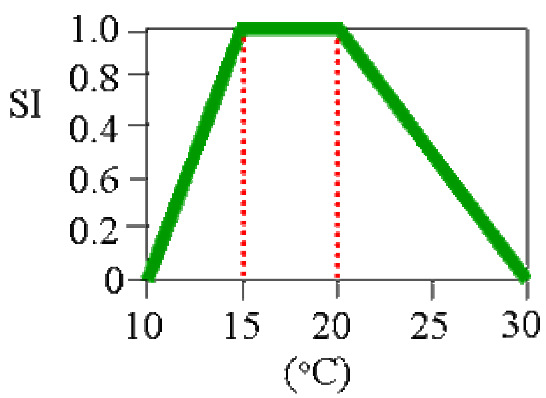

Figure 9. Water Temperature

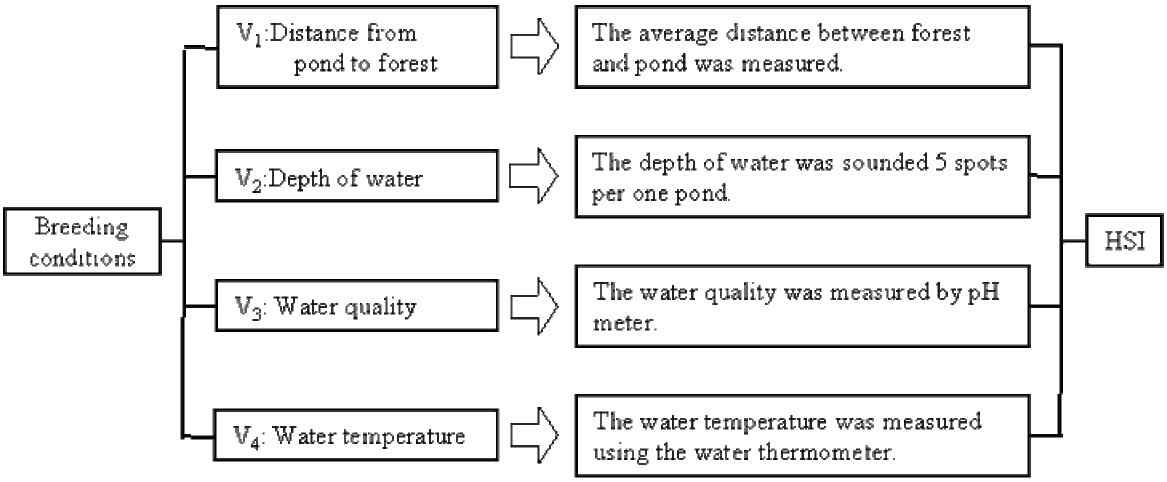

Figure 10. Reproduction Conditions and Methodology on Field Survey

4. ESTIMATION OF ACCUMULATION HU OF CREATED SUBSTITUTIVE PONDS

4.1 Estimation of SI and HSI

The SI for each condition and HSI were estimated for the disappeared habitat area, the disappeared habitat pond E and the substitutive pond from No. 1 to No. 4 for spawning as shown in Table 1. The SIs for V_1 (distance from a pond to a forest) became 1.0 at all disappeared habitat area. The SIs for V_2 and V_4 at all substitutive ponds became higher than those at the disappeared habitat area and the disappeared habitat pond E, while the SIs for V_3 at all substitutive ponds were almost equal to the SI at the disappeared habitat pond E, but those were lower than that at the disappeared habitat. The reason of the lower water temperature at the substitutive pond No.1 was that the sunshine time at this pond was less than at the other ponds. This is because of covering with a lot of forest canopy.

On the other hand, the HSI of disappeared habitat area and disappeared habitat pond E were 0.72 and 0.66, and the average HSI of existing substitutive ponds was 0.82. According this result, it could be concluded that the quality of created ponds for Tokyo salamanders were better than that of the disappeared area and pond with increment of the 62.5 m^2 of preserved lands.

4.2 Results of Each HU

The HU on each habitat was calculated by multiplying HSI with the area of habitat. 50 years was assumed for the project life, which is required to compute the total HU by utilizing each baseline. The increase of HU by creating habitat area was assumed to start after the habitat area was damaged for 3 years, because it took 3 years to complete substitutive pond preparation. The total HU represents the totaled HU for 50 years on each area, and the net gain HU means the subtracting decreased total HU from increased total HU in this project area, which is equal to the HU accumulation at the 50^{th} year.

It was calculated that 372 HU is lost by Chiba-Togane road construction for every year, however, creating substitutive ponds can increase 488 HU annually. Regarding this result, 116 HU can be gained every year from the 3^{th} year. The HU accumulation line represents that it drops until -1116 HU for 3 years but finally it becomes 4346 HU at 50^{th} year. And the no-net-loss level that means the same habitat quality as before carrying out road project is at 10^{th} year. AAHU (Average Annual Habitat Unit) is 87 HU. The results of calculated each HU is shown in Figure 11.

Table 1. Results of SI, HSI, and HU

	Disappeared habitat area		Disappeared habitat area E		Substitutive ponds for spawning		
	Value	SI	Value	SI	No.	Value	SI
V_1 : Distance from pond to forest(m)	1.50	1.0	5.46	1.0	1	1.18	1.0
					2	2.07	1.0
					3	2.84	1.0
					4	1.77	1.0
					Average		1.0
V_2 : Depth of water (cm)	7.50	0.5	6.90	0.46	1	11.60	0.77
					2	14.30	0.95
					3	23.58	0.88
					4	21.43	0.95
					Average		0.89
V_3 : Water quality(pH)	7.10	0.9	7.30	0.7	1	7.33	0.67
					2	7.23	0.77
					3	7.27	0.73
					4	7.20	0.80
					Average		0.74
V_4 : Water temperature(℃)	8.84	0.59	8.84	0.59	1	7.86	0.52
					2	9.51	0.63
					3	11.40	0.76
					4	13.50	0.90
					Average		0.66
HSI	0.72		0.66		1	0.72	
					2	0.83	
					3	0.84	
					4	0.91	
					Average	0.82	
Area(m^2)	453		71		1	86.3	
					2	125.5	
					3	249.7	
					4	125.0	
					Average	586.5	
HU per a year	325		47		1	62	
					2	104	
					3	209	
					4	114	
Total	372				Total	488	
Total HU (50 years)	16259		2353		22958		
Net gain HU (50 years)	4346		AAHU		87		

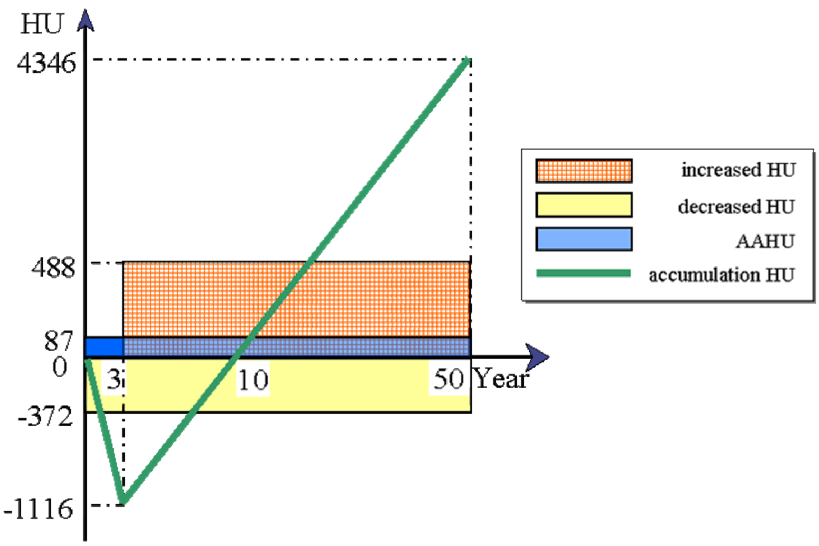

Figure 11. Results of Calculated Each HU

5. COMPARISON OF CREATED SUBSTITUTIVE PONDS AND IDEAL COMPENSATORY MITIGATION PLAN

5.1 Ideal Compensatory Mitigation Plan

In the U.S.A, it is obligated to make a compensatory mitigation plan through EIA procedure, before the nature environment degradation caused by any development, including road construction. In general, U.S. Army Corps of Engineers and other responsibility agencies order to carry out compensatory mitigation before destroy the disappearance of natural environments, which is called on-time mitigation. In addition, the quality of created artificial environment is verified by applying the environment assessment method likes HEP.

In this article, the compensatory mitigation plan is developed ideally by using each SI model under the concept of on-time mitigation, and the study compares the HU accumulation between the compensatory mitigation plan and the created ponds. Moreover, it is assumed to be completed for 3 years earlier than the substitutive ponds actually created in the field. The SI of the pond is set up as 1.0, because it is the most suitable environment for habitats. The habitat area and SI of the disappeared habitat area are employed as described in Chapter 4.

5.2 Results of Each HU under Compensatory Mitigation Plan

Of course, the HSI for the compensatory mitigation plan is resulted as 1.0, because the plan was designed to be all of SIs would be 1.0 in this study. According to this compensatory mitigation plan, the HU was calculated as 587 HU per year increased. Therefore, it is possible to gain 215 HU per year, after the road project has been started. As a result, the HU accumulation line indicated in Figure 12 represents that it becomes 10,723 HU at the 50th year, and the AAHU is 215 HU.

5.3 Results of Comparing Created Ponds with Ideal Compensatory Mitigation Plan

The results of comparison among created ponds and ideal compensatory mitigation plan are shown in Table 3. Since the HSI of each pond under the compensatory mitigation plan exceeded comparing with HSI by created ponds, there were 0.18 differences in the averaged HSI. The net-gain of HU by ideal compensatory mitigation plan became 6,377 and it was grater than that of created substitutive ponds. Because there were 578 HU differences per year until the 3rd year, after the project was started. Moreover, the maximum 99 HU gap was occurred annually from the 3rd year to the 50th year.

Table 2. Results of SI, HSI, and HU under Compensatory Mitigation Plan

	Disappeared habitat area		Disappeared habitat area E		Compensatory mitigation plan		
	Value	SI	Value	SI	No.	Value	SI
V_1 : Distance from pond to forest(m)	1.50	1.0	5.46	1.0	1	0～20	1.0
					2	0～20	1.0
					3	0～20	1.0
					4	0～20	1.0
					Average		1.0
V_2 : Depth of water (cm)	7.50	0.5	6.90	0.46	1	15～20	1.0
					2	15～20	1.0
					3	15～20	1.0
					4	15～20	1.0
					Average		1.0
V_3 : Water quality(pH)	7.10	0.9	7.30	0.7	1	6.7～7.0	1.0
					2	6.7～7.0	1.0
					3	6.7～7.0	1.0
					4	6.7～7.0	1.0
					Average		1.0
V_4 : Water temperature(℃)	8.84	0.59	8.84	0.59	1	15～20	1.0
					2	15～20	1.0
					3	15～20	1.0
					4	15～20	1.0
					Average		1.0
HSI	0.72		0.66		1	1.0	
					2	1.0	
					3	1.0	
					4	1.0	
					Average	1.0	
Area(m^2)	453		71		1	86.3	
					2	125.5	
					3	249.7	
					4	125	
					Average	586.5	
HU per a year	325		47		1	86	
					2	126	
					3	250	
					4	125	
Total	372				Total	587	
Total HU (50 years)	16259		2343		29325		
Net gain HU (50 years)	10723		AAHU		215		

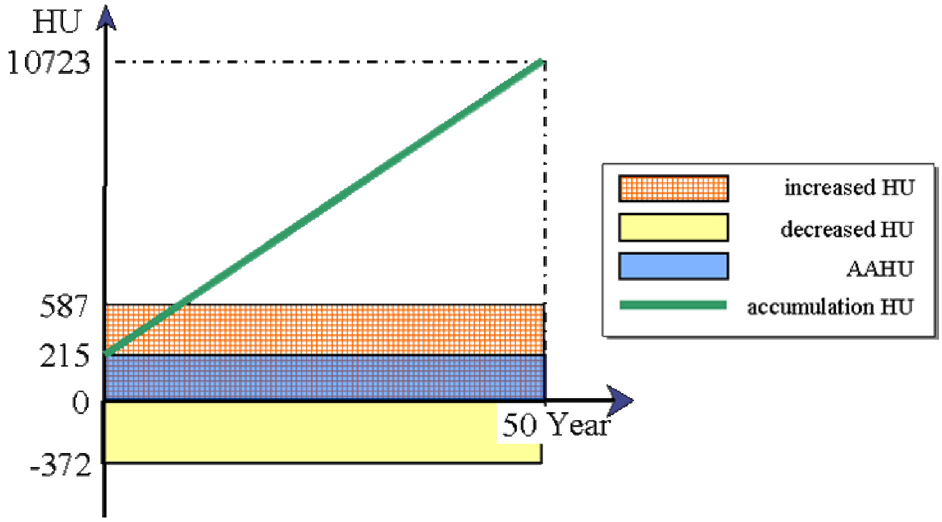

Figure 12. Future Prediction of the HU after Project Enforcement

Table 3. Results of Compare the Substitutive Ponds with Compensatory Mitigation Plan

	Pond No.	Difference in Value
HSI	1	0.28
	2	0.17
	3	0.16
	4	0.09
Average HSI		0.18
HU per a year (from 0^{th} to 3^{th})	1	86
	2	126
	3	250
	4	125
Total		587
HU per a year (from 3^{th} to 50^{th})	1	24
	2	22
	3	41
	4	11
Total		99
Total HU (50 years)		6340
Net gain HU (50 years)		6377
AAHU		128

6. CONCLUSION

The substitutive spawning ponds for Tokyo salamander created by JH were evaluated as the successful case of the compensatory mitigation project. However, the created substitutive ponds are completed for 3 years after the project began, this directly affects to the HU losses. During three years, JH tried to protect Tokyo salamander by collecting their eggs, hatching them artificially and releasing them to the natures. However, the HU was defined as 0 under the evaluation of SI model, because there were no habitats.

On the other hand, it is revealed that the ideal ponds suggested by this study based on the compensatory mitigation plan has 6,377 HU more and better quality of habitat environment compared with the substitutive ponds created by JH. Concerning with the implementation possibility of road projects around this area in the near future, it is necessary to conserve the habitat environment for Tokyo salamander by acquiring more of HU. The conclusion of this paper is that the conservation plan for habitat using SI model must be drafted before implementing road projects and the compensatory mitigation must be curried out at the beginning of a project.

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