

The Outline of Environmental Preservation Measures in the Taiho Dam Construction Project

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1 Introduction

Located at the southern most tip of Japan, in the only subtropical marine region of the country, Okinawa Prefecture is one of the highest rainfall areas with over 2,000 mm of annual rainfall (Figure-1). However, as a small islands Prefecture, it could not obtain stable water supplies and, under severe natural conditions, regularly suffered droughts due to shortage of rainfall when dams were not yet constructed.



Figure-1 Location of Okinawa Prefecture

In 1972, the year of Okinawa's reversion to Japan, North Dam Construction Office (Okinawa General Bureau, Cabinet Office) was founded on Okinawa Island, which had suffered a drought every year, in order to conduct dam projects to enhance development of water resources and flood control to contribute to promoting growth and development of Okinawa.

For the past 36 years since its foundation, the North Dam Construction Office has constantly supported Okinawa's growth and development through improving living standards as well as revitalizing industrial and economic activities, the primary of which has been tourism, through

completing Fukuchi Dam construction taken over from the U.S. administration and starting and completing construction of seven other multi-purpose dams. However, due to growth in population and increase of incoming tourists, the water demand still exceeds the supply capacity, and we are steadily and systematically pursuing further dam projects to secure stable water supply on Okinawa Island.

The dam construction projects on Okinawa Island have never been under privileged natural or social conditions.

Elongated north and south, Okinawa Island has no large river, and rivers with relatively ample surface water are concentrated in the northern part of the island. The basin area of the district is extremely limited with rapid streams and a poor geological condition, and the topographic features are not suitable for water storage efficiency. The dam projects on Okinawa Island were managed under such numerous constrains. We have always strived to rationalize construction methods, introduce and develop new technologies and operate the projects economically and efficiently throughout the dam projects, to meet different situations of each region.

The catchment area of Taiho River, on which Taiho Dam is located, is situated on the southern edge of "Yambaru", one of the hilliest districts on the island with an evergreen broadleaf forest. While Okinawa is blessed with numerous endemic species, inhabited in Yambaru is Preyr's Woodpecker, endemic to the region and a Special Natural Monument of Japan. Precious ecosystems and natural environments remain in the region (Figure-2).



Figure-2 Location of Taiho Dam

We have been constructing The Taiho Dam in this “Yambaru” district. So we herein introduce various environmental preservation measures in relation with Taiho Dam Construction Project in Yambaru district, a sanctuary to precious ecosystems and natural environments, including the existing conservation program for Preyr’s Woodpecker.

2 Outline of Taiho Dam Construction Project

Located on Taiho River (catchment area: 23.7 km²/length of channel: 13.25 km), the second-class river running through Ogimi Village in the northern part of Okinawa Island, Taiho Dam is a multi-purpose dam for flood control, maintenance and enhancement of normal functions of the river and supply of potable water(Figure-3).



Figure-3 Conceptual drawing of Taiho Dam

The Taiho Dam Construction Project has been executed since 1990 to develop water resources in the Taiho catchment area, and also as part of the “Okinawa Northwest Rivers General Development Program” to intake water from other dams and from eight rivers in West System Potable Water Resource Development Project by

Okinawa Enterprise Bureau.

To meet geological conditions of the catchment area, the Taiho Dam Construction Project consists of the main dam (concrete gravity dam) to be constructed on the main stream of Taiho River and the auxiliary dam (rock filled dam) to close the ridge of the left-bank at low elevation.

Construction of the both main and auxiliary dams has been constantly carried forward since commencement of their main bodies construction in 2002.

The auxiliary dam construction was completed in 2007, and as concrete pouring of the main dam was commenced in March 2006, we are currently applying ourselves closely to complete the main dam construction towards its inauguration of service in 2010 (90% of concrete casting completed as of the end of June, 2008, to be fully completed around August). To stop leakage from the stream next to the auxiliary dam, the Trapezoid-Shaped CSG Dam structure was constructed. This is the first permanent structure of this kind constructed in Japan, which was completed in April 2004.

As described above, Taiho Dam is distinctive while consisting of three different types of structures facing the same reservoir.

The total storage capacity of Taiho Dam will be 20,050,000 m³ when completed, which will make it the second largest, after Fukuji Dam, among the seven dams managed by Okinawa General Bureau, Cabinet Office.

3 Concept of the Environmental Preservation Measures in the Taiho Dam Construction Project

Until now, the North Dam Construction Office had taken many sorts of conservation measures for natural environment in the Dam projects, cooperating with the concerned administrative authorities and the experts with experience or academic. Especially the Taiho Dam was planned to construct in Yambaru district where the precious ecosystems and natural environments remains, so that possible measures were taken, considering of them.

The following is the introduction that various environmental preservation measures in the ecosystems, water environments and so on, especially for Preyr’s Woodpecker, were taken in relation with Taiho Dam Construction.

4 Pryer's Woodpecker Protection Measures

4.1 Pryer's Woodpecker – Overview

4.1.1 Ecological Characteristics

The Pryer's Woodpecker (*Sapheopio noguchii*) (Picture-1), order Piciformes, family Picidae, genus Sapheopio, is a sole specimen of its genus and species and is taxonomically considered a unique bird. Its only habitat is the forests of northern Okinawa Island, where only a small population lives. Approximately 31 cm in total length, the Pryer's Woodpecker is blackish-brown in body color, with a lighter color on the face.

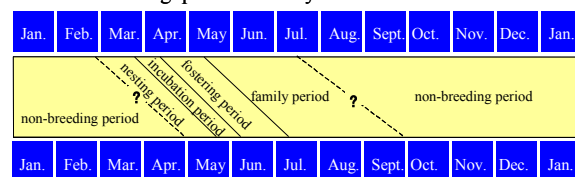


Picture-1 Pryer's Woodpecker

4.1.2 Breeding

The breeding starts with the male and female finding a mate, and nesting in the trunk of a large-diameter tree such as the Itajii (*Castanopsis sieboldii*). This is followed by egg laying and incubation, a period which is called the incubation period. Once the eggs hatch, the parents spend approximately a month feeding and caring for the baby birds, a period which is called the fostering period. After about a month of fostering, the young birds leave the nest, but continue to take actions with the parents. This period is called the family period. The nesting, incubation, fostering and family periods are collectively called the breeding period; all other periods are called the non-breeding period.

Starts of breeding period in early case



Starts of breeding period in late case

Figure-4 Life cycle of Pryer's Woodpecker

4.1.3 Habitat Environment

The habitat of the Pryer's Woodpecker is restricted to a mature stand of large Itajii trees of 40 years or older, with many dead and fallen trees providing home to wood-boring insects. Since the Pryer's Woodpecker feeds on arthropods that live in the soil and on the ground surface, a damp forest with rich soil fauna is an important element to its habitat.

4.1.4 Distribution

The distribution of the Pryer's Woodpecker is limited to specific parts of northern Okinawa Island. Its distribution range is the smallest of all existing woodpeckers. In the survey conducted by the North Dam Construction Office from 1987 through 1996, the Taiho River Basin was found to be the southern limit of its habitat. The distribution of the Pryer's Woodpecker in the Taiho River Basin is considered to be approximately 10% of the total population.

4.2 Background of the Survey and Research

In 1992, the North Dam Construction Office conducted an environmental impact assessment for the Taiho Dam Construction Project in accordance with the Outline of the Environmental Impact Assessment Procedures for Ministry of Construction Projects. In the process, it adopted a policy on the Pryer's Woodpecker to "protect as much as possible by maintaining a habitable environment".

Based on the knowledge gained on the ecology of the Pryer's Woodpecker in the Taiho River Basin through preliminary surveys and researches, the North Dam Construction Office surveys have been conducted on the ecology of the Pryer's Woodpecker and its habitat from 1996 to present, in order to understand the current conditions in the Taiho River Basin.

The results of these surveys have been reported to the Northern Dam Ecosystem Preservation Study Committee, Rare Birds Subcommittee, comprised of experts on birds and forests. The committee provides guidance and advice on the surveys, researches, and the protection measures.

4.3 Pryer's Woodpecker Protection Measures

4.3.1 Basic Policy on Protection Measures

The basic policy on the protection of the Pryer's Woodpecker in the Taiho Dam Construction Project is to preserve its population

in the upstream of Taiho Dam by maintaining a habitable environment, thereby providing protection to the fullest extent possible.

4.3.2 Goal Setting

Although the goal set out in the basic policy is to preserve the population in the Taiho River Basin, the accurate population cannot not be ascertained because of the difficulty in identifying each individual bird and also due to the few number of sightings during non-breeding periods.

As such, the number of nesting grounds within the river basin was used as the indicator for population, and the preservation of the same number of nesting grounds was set as the preservation goal. This method did not account for birds not participating in the breeding; however, it was considered to be an effective indicator for population within the river basin. It allowed population data collection that captured approximate population changes from year to year, with a low risk of counting the same individual more than once.

4.3.3 Forecasted Impacts of Dam Construction

i) Factors leading to reduced population

In general, the main factors leading to the reduction of the Pryer's Woodpecker population are: (1) decrease in habitat; (2) breakdown of habitat into isolated pockets; (3) environmental deterioration and pollution in the habitat; (4) introduction of foreign species; and (5) rapid spread of diseases and illnesses.

Of these, the possible factors that may be brought about by the dam construction project are: (1) decrease in habitat (loss of feeding and nesting grounds); and (3) environmental deterioration and pollution in the habitat (impacts of mechanical, vehicular and human activity that accompany construction). The Taiho Dam project will not cause the distribution of the Pryer's Woodpecker to break down into isolated pockets (genetic effects by the near relation crossbreeding). As such, breakdown of habitat into isolated pockets was not considered to be one of the impacts of the dam construction project.

ii) Understanding the impacts on the habitat environment

First, past survey and research results were reviewed to understand the current habitat environment, with a focus on environmental

features that affect the habitat for the Pryer's Woodpecker (such as vegetation and tree diameter at breast height).

Next, the impacts of dam construction were studied by examining the environmental changes expected from land alteration. Forecasts were made on the habitat environment upon dam completion, with eyes on the maximum loss of forest area immediately after cutting trees for reservoir construction.

The forecast indicated that 7% of the suitable or potential nesting grounds in the river basin will be lost or altered by tree cutting. This is after taking into account the increased area of better quality forests due to tree growth.

4.3.4 Outline of the Conservation Measures

The natural environment around Taiho Dam, combined with the entire river basin, is a part of a large forest ecosystem, with the Pryer's Woodpecker being one of its members. As such, protection measures must consider the natural environment of the river basin as a whole.

The basic approach is to "protect the forest"; when alterations were absolutely required for the construction project, measures were taken to preserve those parts of the forest that need not be cut down. At the same time, efforts were made to "restore and create the forest" through early tree-planting efforts on the roadside slopes.

As an "immediate emergency response effort", artificial nesting trees were installed as interim measures until the surrounding forest grew to the size that accommodated nesting by the Pryer's Woodpecker.

i) Forest Preservation

(1) Considerations made on road route selection

For economic reasons, the most common route selection for the road replacing what will be submerged under water is to run the road through the forest on the hillside on both banks of the reservoir. But at Taiho Dam, the road will run over the reservoir as much as possible, from the standpoint of forest preservation (Figure-5). The plan calls for minimum forest alteration and reduced impacts of dividing up the forest to isolated pockets.

Where the replacement road crosses a valley, filling of the valley is the common method taken due to the relative ease in execution. In the Taiho Dam plan, however, a bridge structure was adopted to reduce the impacts on the forests, thereby decreasing forest alteration and controlling obstacles to rainwater drainage.

To keep the forest alteration area as small as possible, the horizontal and vertical profile of the replacement road was set so that the soil cutting and filling will be kept to a minimum.

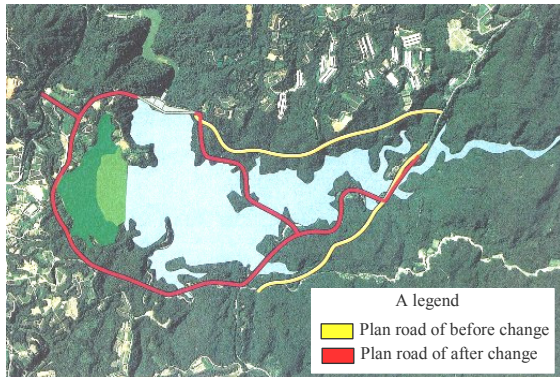


Figure-5 Plan road route selection

(2) Selection of the auxiliary dam quarry site

The material for the auxiliary dam was gathered from within the future site of the reservoir to ensure minimum forest alteration.

The material for the auxiliary dam will be secured from a quarry site within the reservoir area. Because of the thick sedimentation of strongly weathered soil layer, extensive excavation is required to uncover the rock material. Most of the excavated soil will be spoils. Normally, spoils are used to fill ravines around the dam. But in order to minimize the amount of soil disposal and to keep the surrounding environment intact, the spoils will be sifted and put to effective uses as dam construction material as long as it does not negatively impact the stability of the dam body. The spoils will also be used to fill the outside of the dam (outside the reservoir), minimizing alteration and reducing the soil disposal site required around the dam.

(3) Use of the tree-belt system

To prevent runoff of turbid water and red soil into the dam reservoir, a stretch of land adjacent to the dam bank will be designated as the tree-belt area and the dam management office will continue to preserve the trees in the tree-belt area in order to upkeep the function of the tree-belt. The tree-belt (under the current plan) is within mostly 50 meters above the dam crest level (EL 73.5 m at Taiho Dam) in area of slope distance. If designated, the tree-belt at Taiho Dam will be the first area to receive such designation in Okinawa Prefecture.

In normal dam construction, all trees located

below the surcharge water level are cut down. But Taiho Dam is an emergency water supply dam and does not exceed the normal water level too often. As such, a decision was made to keep the trees between the normal water level and the surcharge level (“surcharge zone”). This reduces the wind blowing over the reservoir to blow into the forests in the back, thereby reducing tree deaths.

In the normal test filling of the reservoir, trees may die due to being submerged in water for a prolonged time. Additional efforts are underway to reduce death of trees remaining in the surcharge zone by utilizing the Fukuji-Taiho water tunnel to complete the test water fill in a short amount of time(Figure-6).

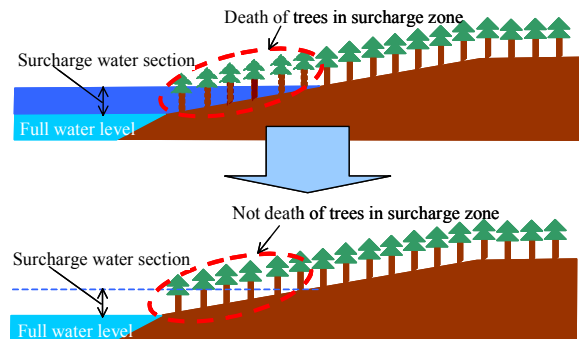


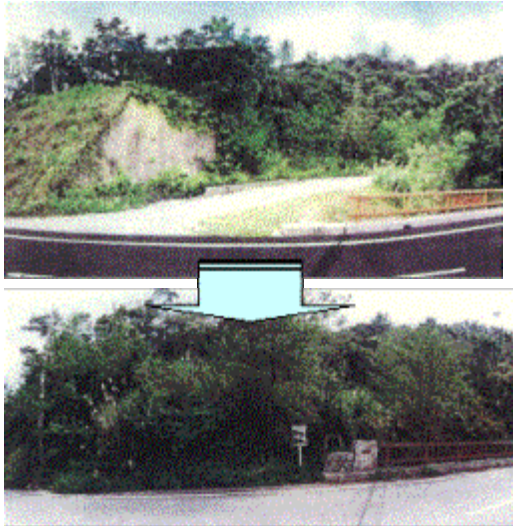
Figure-6 First impoundment of utilizing the Fukuji-Taiho water tunnel

ii) Forest Restoration

(1) Forest Restoration through early tree-planting efforts on the roadside slopes

In normal road replacement, the old road will remain in place although no longer in service. But in the Taiho Dam project, the topography was restored to its original condition to restore the forest environment. Tree types that provided visual continuity to the surrounding vegetation were planted.

Roadside slopes become bare and exposed during construction of the replacement road. To promote early forest recovery, early tree restoration efforts included both seedling planting and seed spraying using seeds of native tree species(Picture-2).



Picture-2 Forest restoration

(2) Cooperation with the project “Forest Plan for Longevity and Ease in Ogimi Village”

The project “Forest Plan for Longevity and Ease in Ogimi Village” is the project to improve the forest area with the function of the contact with nature, the people exchange and the stay on the hill facing the Taiho Dam reservoir. In cooperation with that project, the peninsula between the Main Dam and Auxiliary Dam, used as an interim storage yard during construction of the Auxiliary Dam, will be developed under the Environment Development Plan and be the site of the Control Office, restoring and creating the forest through early tree-planting efforts in order to contact easily with nature in ‘Yambaru’ and do hands-on learning.

iii) The immediate “emergency” response effort
 (1) Installation of the artificial nesting trees

By cutting down the trees through the Dam construction, the forest would be disappeared, but in a few years, young trees in the surrounding forest would grow up and the area would be created the environment for nesting by the Pryer’s Woodpecker. By installing artificial nesting trees as the immediate “emergency” response effort until the surrounding forest grew to the size that accommodated nesting, the impact would be reduced(Picture-3).

Itajii tree is used for the artificial nesting tree. Itajii tree is the favorite tree of the Pryer’s Woodpecker in nesting, the artificial nesting tree was made to be hollowed out the log that was cut down at the construction site and be filled with the gathered chips by the natural glue in order that the Pryer’s Woodpecker could nest

easily(Picture-4). When installing in the forest, The condition of the trees is to installing at an angle of 20 degrees – 29 degrees, approximately 4m high from the ground, and the place having enough space to fly, through the surveys and researches on its habitat.



Picture-3 Artificial nesting trees



Picture-4 Made of artificial nesting trees

(2) Installation of the artificial feeding trees

When alterations were required for the Dam construction, measures were taken to restore and create the forest in order to reduce impacts of forest alteration. By the installation of the artificial feeding trees that were the Pryer’s Woodpecker feeder as the immediate “emergency” response effort until the forest was restored, impacts would be reduced(Picture-5).



Picture-5 Installation of the artificial feeding trees

4.3.5 Monitoring research

In order to maintain a habitable environment of the Pryer's Woodpecker, inhabitation research gives useful information to check conservation measures and take additional measures. So monitoring research is done.

i) Monitoring research of the population

(1) Research of breeding habitat (the incubation period and the fostering period)

Since the preservation of the same number of nesting grounds was set as the preservation goal, the monitoring research of the number of nesting grounds in the incubation period and the fostering period has been done. That research has been done since 1998. As a result, the number of nesting grounds preserve between 10 trees to 15 trees. As such, the nesting grounds are considered to be preserved (including the artificial nesting trees as the immediate "emergency" response effort)(Figure-7).

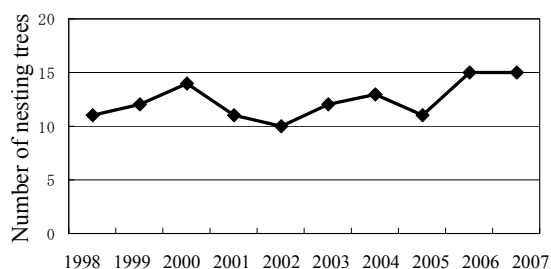


Figure-7 Change of the number of nesting grounds within the river basin

ii) Monitoring research of the habitable environment

(1) Forest environment research (such as the speed research of tree growth)

By monitoring research of the age of trees cut down in the future site of reservoir area and measure the tree diameter at breast height in the Taiho River Basin, the forecasted growth of trees in the surveys and researches for forecasted impacts of the habitable environment was inspected.

(2) Monitoring research of the artificial nesting trees

The practical tests of the artificial nesting trees in the Taiho River Basin were begun in 1998(the first installation in around autumn, non-breeding period). And one nesting ground was checked for the first time in 1999 and three nesting grounds were checked in 2000.

Based on The result of the practical tests, the artificial nesting trees as the conservation measure were installed in the Taiho River Basin since 2001, corresponding to the construction site or the type of works. The nesting grounds were actually checked in the area of the auxiliary dam site and the quarry site taking conservation measures from 2003 to 2006. Only in this area, the total of 11 young birds left the nests of the artificial nesting trees .So the validity of "the artificial nesting tree" as the conservation measure was also checked.

9 artificial nesting trees in the whole of the artificial nesting trees were nested by the Pryer's Woodpeckers, so for and it was checked that the total of 18 young birds left the nests in total(Table-1).

Table-1 The results of artificial nesting trees

The year	Artificial nesting trees	
	Number of nesting trees	Number of the young birds leave the nest
1999	One tree	Abandon of incubation
2000	Three trees	Five young birds
2002	One tree	Two young birds
2003	One tree	Three young birds
2004	One tree	Two young birds
2005	One tree	Three young birds
2006	One tree	Three young birds
The sum total	Nine trees	Eighteen young birds

5 Others of the Conservation Measures for Ecosystem

5.1 Measure to fulfill for environmental preservation

The results of the impacts on the natural environment through surveys in the Dam construction have been reported to the committees (Northern Dam Ecosystem Preservation Study Committee, Rare Birds Subcommittee, Water Environment Impact Assessment Subcommittee), comprised of experts on birds and forests. Guidance and advice in the Dam construction are provided by the committees.

The North Dam Construction Office has positioned environmental wardens since 1995 (Picture-6). Environmental wardens are responsible for investigating valuable flora and fauna in the construction site and its surrounding areas as well as monitoring the construction site before starting to work. In order to fulfill work

smoothly considering of the natural environment and make construction company staff enlighten, the wardens provide instructions to the North Dam Construction Office staff and/or construction company and hold explanatory meetings about the environment conservation measures.



Picture-6 Environmental Warden

5.2 Consideration under construction

5.2.1 Control of turbid water, noise, traffic vibration and dust

When the drainage from the construction area had to be discharged into the river, it is discharged after the muddy water caused by the construction of the main Dam and the replacement road, decrease by the turbid water treatment plant and/or the setting basin.

In consideration of the affection caused by noise, traffic vibration and dust in the construction to people living in the neighborhood and the ecosystem and the environment in the surrounding forest near the construction area, the measures of are taken.

5.2.2 Effective use of surplus soil by cooperating with the reclamation of public water surface area project at the open sea of Shioya Bay

The site proposed for the removal of surplus soil was restricted to the forest area around the dam, as the only area had open space to be filled in geographical features at the beginning. On the other hand, since there was a shortage of the level land available, and public facilities were decentralized in Ogimi Village, Ogimi Village had planned the reclamation of public water surface area project at the open sea of Shioya Bay as the solution to those problems.

So after considering all the factors from the viewpoint of the protection of the forest, the cost reduction of the removal of surplus soil and the

effective use of surplus soil, most of surplus soil from Taiho Dam Construction Project were reached to be removed to the site at the open sea of Shioya Bay.

5.2.3 Consideration in cutting down the trees

Since there are precious ecosystems including the Preyr's Woodpecker around the construction area, cutting down the trees was considered to be avoided cutting in the breeding period.

And as the process to cut trees in the future site of the reservoir area, the whole area was divided into the downstream area and the upstream area, in order to urge animals on forward to take shelter from the area cutting trees to the outside. The trees in the future site of the reservoir area are going to cut down for two years, at the downstream area in the first year and the upstream area in the second year(Figure-8).

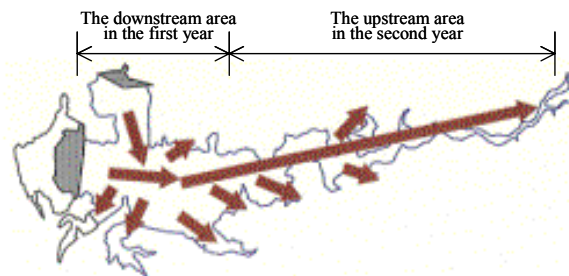


Figure-8 Procedure in cutting down the trees

5.3 Consideration of habitat

5.3.1 the consideration to preserve diverse habitats

The trees cutting down in the construction area are piled up in various places in the Taiho River Basin to provide insects and small animals a habitat or a hiding place as the shelter. And Honeycomb plates (plates like the form of honeycomb) for birds and insects as the habitat are being constructed(Picture-7).



Picture-7 Honeycomb plates

5.3.2 Consideration of the migration for terrestrial organisms

The “eco-road” which is the underpass across the road was set so that small animals could cross the street freely. And the preventive fences against the invasion of animals not to be killed on the road, and the signs to call construction company staff’s attention along by road were set. Moreover, the ditches that small animals could creep up all by themselves in case of falling were set(Picture-8).



Picture-8 The ditches in consideration for the small animals

5.3.3 Preservation of the migration in river zone

Fishways for crustaceans are established for aquatic life as their movement to upper and lower reaches will be limited due to the dam body.

5.4 Habitat restoration

5.4.1 Restoration of the biotope pond

The biotope pond lost to the Auxiliary Dam construction will be restored downstream at the Auxiliary Dam area as the compensation measure(Figure-9).

The topsoil of the biotope pond to be restored was gathered previously before construction, and has been in safekeeping temporarily to be utilized.



Figure-9 Conceptual drawing of the biotope pond

5.4.2 Conservation measure for valuable plants

The valuable plants, which were growing in the area to be submerged, or the area where construction work was expected, were transplanted to a similar environment within the basin, provided guidance and advice by experts. But the valuable plants, which were the sort of plants that had no knowledge of the transplantation, and which were the sort of plants technically difficult to transplant, had been in safekeeping temporarily, checking the condition. After that, those plants were tried to transplant or seed.

In order to reduce micro meteorology change, the net for protection against the wind and shading were set for the plants near the area where construction work was expected (Picture-9).



Picture-9 The net for protection against the wind and shading

5.5 Conservation of aquatic environment

The results of the calculations of water quality prediction after the Dam operation starts showed that the influences of water temperature of the downstream sector at the Dam site (the discharge of cold water or warm water) , the eutrophic phenomena in the reservoir and the dissolved oxygen (anoxic bottom water) were worried about. As a result, in order to reduce those influences, the selective water intake facility, the deep aeration facility and the Fukuji-Taiho water tunnel (water conveyance from the nearby Dam for the dilution) will be used and operated together for water quality control.

6 Conclusion

The natural environment around Taiho Dam, combined with the entire river basin, is a part of a large forest ecosystem, so that it is important to consider the natural environment of the river

basin as a whole. In order to prevent runoff of soil into the dam reservoir and preserve the diverse ecosystem, it is necessary to preserve the forest properly.

In order to protect the native species in Yambaru such as the Pryer's Woodpecker, the Yambaruina, which is a flightless rail bird native to Yambaru and already on the Japan's official Red List of endangered species, it is necessary to control the introduction of foreign species, the invasion of the natural enemy such as pets being abandoned and the rapid spread of diseases and illnesses. So it is important to continue to cooperate with the concerned administrative authorities and the experts with experience or an academic, for fulfilling the properly measures.

The Taiho Dam Construction Project is at the peak of construction, and we are currently applying ourselves closely to complete the main dam construction towards its inauguration of service.

Precious ecosystems and diverse natural environments remain in the Yambaru district in the northern part of Okinawa Island, at which Taiho Dam is located. So people living in Ogimi Village hope that the Taiho Dam Construction Project contribute largely to the regional vitalization. The North Dam Construction Office continue to make efforts to construct the public open dam as the key area in local development.